Final

Uniform Federal Policy-Quality Assurance Project Plan
for the
CC RVAAP-69 Building 1048 Fire Station
Vapor Intrusion Study of Building 1037
Ravenna Army Ammunition Plant Restoration Program

Camp James A. Garfield Joint Military Training Center
Portage and Trumbull Counties, Ohio

Contract No. W912QR-21-D-0016
Delivery Order No. W912QR23F0014

Prepared for:

U.S. Army Corps of Engineers
Louisville District

Prepared by:

Leidos
8866 Commons Boulevard, Suite 201
Twinsburg, Ohio 44087

June 7, 2024

Final

Uniform Federal Policy-Quality Assurance Project Plan
CC RVAAP-69 Building 1048 Fire Station
Vapor Intrusion Study of Building 1037

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Final
Uniform Federal Policy-Quality Assurance Project Plan
for the CC RVAAP-69 Building 1048 Fire Station
Vapor Intrusion Study of Building 1037
Ravenna Army Ammunition Plant Restoration Program
Camp James A. Garfield Joint Military Training Center
Portage and Trumbull Counties, Ohio

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Spurr, Charles, A.

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Leidos
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U.S. Army Corps of Engineers
600 Martin Luther King Jr., Place
Louisville, Kentucky 40202-2232

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13. SUPPLEMENTARY NOTES
None.

14. ABSTRACT

The UFP QAPP provides a plan to further assess potential impacts from VOCs at CC RVAAP-69 Building 1048 Fire Station by evaluating the potential VI pathway to nearby Building 1037 and collecting an additional round of groundwater sampling for VOC analysis. This consists of five inter-related tasks: 1) prepare a UFP-QAPP, 2) conduct a VI study at Building 1037, 3) groundwater sampling data collection activities at and downgradient of CC RVAAP-69 Building 1048 Fire Station, 4) conduct data validation and laboratory oversight activities, and 5) evaluate data from the field effort and applicable historical information to support an FS Report.

15. SUBJECT TERMS
groundwater, vapor intrusion, remedial investigation, CERCLA, environmental sampling

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			Nathaniel Peters, II
U	U	U	U	542	**19b. TELEPHONE NUMBER** *(Include area code)* 502-315-2624

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Ohio Environmental Protection Agency

EPA.Ohio.gov

Mike DeWine, *Governor* Jon Husted, *Lt. Governor* Anne M. Vogel, *Director*

Received October 21, 2024

October 18, 2024

TRANSMITTED ELECTRONICALLY

Mr. Kevin Sedlak
Restoration Program Manager
ARNG-ILE Clean Up
Camp James A Garfield JTC
1438 State Route 534 SW
Newton Falls, OH 44444

RE: US Army Ammunition Plt RVAAP
Remediation Response
Project Records
Remedial Response
Portage County
ID # 267000859269

Sent via email to: Kevin.m.sedlak.ctr@army.mil

Subject: Former Ravenna Army Ammunition Plant
Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP), CC RVAAP-69 Building 1048 Fire Station Vapor Intrusion Study of Building 1037
Ohio EPA Approval

Dear Mr. Sedlak:

The Ohio Environmental Protection Agency (Ohio EPA) has received the "Final Uniform Federal Policy-Quality Assurance Project Plan" (UFP-QAPP) for Ravenna Army Ammunition Plant (RVAAP) Restoration Program, Portage/Trumbull Counties, CC RVAAP-69 Building 1048 Fire Station Vapor Intrusion Study of Building 1037 [1]. This document was received at Ohio EPA's Northeast District Office (NEDO), Division of Environmental Response and Revitalization (DERR) via email on June 12th, 2024.

The final document was reviewed by personnel from Ohio EPA's Division of Environmental Response and Revitalization (DERR). Pursuant to the Director's Findings and Orders paragraph 39 (b), Ohio EPA considers the document final and approved.

This letter is an official response from Ohio EPA that will be maintained as a public record.

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[1] http://edocpub.epa.ohio.gov/publicportal/ViewDocument.aspx?docid=2966445

If you have any questions regarding this letter, please contact me at (330) 963-1109, or via email at craig.kowalski@epa.ohio.gov.

Sincerely,

Craig Kowalski

Craig Kowalski
Site Coordinator
Division of Environmental Response and Revitalization

CK/cm

ec: T. Zack Bayne, USACE Louisville
Angela Cobbs, Chenega Reliable Services
Jennifer Tierney, Chenega Reliable Services
Steve Kvaal, USACE Louisville
Nathaniel Peters, USACE Louisville
Katie Tait, OHARNG RTLS, CJAG
Jed Thomas, Leidos
Liam McEvoy, Ohio EPA, NEDO
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Natalie Oryshkewych, Ohio EPA, NEDO DERR
Carrie Rasik, Ohio EPA, CO DERR
Thomas Schneider, Ohio EPA, SWDO DERR

CONTRACTOR STATEMENT OF INDEPENDENT TECHNICAL REVIEW

Company Name: Leidos

Contract and Delivery Order Number: Contract No. W912QR-21-D-0016, Delivery Order No. W912QR23F0014

Document Name: Uniform Federal Policy-Quality Assurance Project Plan for CC RVAAP-69 Building 1048 Fire Station Vapor Intrusion Study of Building 1037, Ravenna Army Ammunition Plant Restoration Program, Camp James A. Garfield Joint Military Training Center, Portage and Trumbull Counties, Ohio

Notice is hereby given that an independent technical review, that is appropriate to the level of risk and complexity inherent in the project, has been conducted. During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of assumptions; methods, procedures, and material used in analyses; alternatives evaluated; the appropriateness of data used and level obtained; and reasonableness of the result, including whether the product meets the customer's needs consistent with law and existing Corps policy. All concerns and comments resulting from these independent technical reviews have been resolved.

06/07/2024

Charles Spurr
Study/Design Team Leader

Date

06/07/2024

Abhijit Modak
Independent Technical Review Team Leader

Date

Significant concerns and explanation of the resolutions are documented within the project file.

As noted above, all concerns resulting from the independent technical review of the document have been fully resolved.

06/07/2024

Lisa Jones-Bateman, REM, PMP
Senior Program Manager

Date

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Final

Uniform Federal Policy-Quality Assurance Project Plan for the CC RVAAP-69 Building 1048 Fire Station Vapor Intrusion Study of Building 1037 Ravenna Army Ammunition Plant Restoration Program

Camp James A. Garfield Joint Military Training Center
Portage and Trumbull Counties, Ohio

Contract No. W912QR-21-D-0016
Delivery Order No. W912QR23F0014

Prepared for:
U.S. Army Corps of Engineers
Louisville District

Prepared by:
Leidos
8866 Commons Boulevard, Suite 201
Twinsburg, Ohio 44087

June 7, 2024

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DOCUMENT DISTRIBUTION
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For CC RVAAP-69 Building 1048 Fire Station
Vapor Intrusion Study of Building 1037
Ravenna Army Ammunition Plant Restoration Program
Camp James A. Garfield Joint Military Training Center
Portage and Trumbull Counties, Ohio

Name/Organization	Distribution
Craig Kowalski, Ohio EPA-NEDO	Electronic submittal via Ohio EPA File Transfer (Powered by LiquidFiles)
Megan Oravec, Ohio EPA-NEDO	
Liam McEvoy, Ohio EPA-NEDO	
Carrie Rasik, Ohio EPA-CO	
Katie Tait, OHARNG	Electronic Version Posted to DoD SAFE
Kevin Sedlak, ARNG	
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Natalie Oryshkewych, Ohio EPA-NEDO	Email transmittal letter only
Tom Schneider, Ohio EPA-SWDO	
Steve Kvaal, USACE – Louisville District	
Jed Thomas, Leidos	
Ryan Laurich, Leidos	
Jennifer Tierney, Chenega (Administrative Record)	1 electronic version, 1 hard copy

ARNG = Army National Guard
CO = Central Office
NEDO = Northeast District Office
DoD = U.S. Department of Defense
NEDO = Northeast District Office
OHARNG = Ohio Army National Guard
Ohio EPA = Ohio Environmental Protection Agency
SAFE = Secure Access File Exchange
SWDO = Southwest District Office
USACE = U.S. Army Corps of Engineers

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LIST OF ACRONYMS AND ABBREVIATIONS

Army	U.S. Army
ARNG	Army National Guard
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIH	Certified Industrial Hygienist
CJAG	Camp James A. Garfield
CSEM	Conceptual Site Exposure Model
CSM	Conceptual Site Model
CSP	Certified Safety Professional
COC	Chemical of Concern
DoD	U.S. Department of Defense
ELLE	Eurofins Lancaster Laboratories Environmental, LLC
FS	Feasibility Study
HHRA	Human Health Risk Assessment
IDW	Investigation-Derived Waste
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
NCP	National Contingency Plan
P.E.	Professional Engineer
P.G.	Professional Geologist
PMP	Project Management Professional
QA	Quality Assurance
QC	Quality Control
REM	Registered Environmental Manager
RI	Remedial Investigation
RVAAP	Ravenna Army Ammunition Plant
UFP-QAPP	Uniform Federal Policy-Quality Assurance Project Plan
USACE	U.S. Army Corps of Engineers
VI	Vapor Intrusion
VOC	Volatile Organic Compound
WWA	White Water Associates, Inc.

Note: The above acronym list contains the acronyms used in the Introduction and Worksheets #1, #2, #3, and #5. Each additional worksheet contains its own acronym list.

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Introduction

Leidos has been contracted by the U.S. Army Corps of Engineers (USACE), Louisville District under USACE Louisville District Contract No. W912QR-21-D-0016, Delivery Order No. W912QR23F0014 to conduct a vapor intrusion (VI) study of Building 1037 and groundwater sampling for volatile organic compounds (VOCs) associated with CC RVAAP-69 Building 1048 Fire Station within the former Ravenna Army Ammunition Plant (RVAAP), now known as Camp James A. Garfield (CJAG). The Army National Guard (ARNG) is the lead agency and manages the environmental investigation at the former RVAAP, now CJAG, on behalf of the U.S. Army (Army) and U.S. Department of Defense. The Ohio Environmental Protection Agency (Ohio EPA) is the supporting state regulatory agency.

The *Remedial Investigation Report for CC RVAAP-69 Building 1048 Fire Station* (USACE 2023) evaluated soil and groundwater in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 and the National Oil and Hazardous Substances Pollution Contingency Plan. While the Remedial Investigation (RI) sufficiently delineated nature and extent of soil and groundwater contamination, the human health risk assessment (HHRA) concluded that there are two chemicals of concern (COCs) in groundwater (i.e., carbon tetrachloride and chloroform) that should be evaluated in a Feasibility Study (FS) Report. Accordingly, the Army is assessing the potential VI pathway to nearby Building 1037 and collecting an additional round of groundwater samples at and downgradient of the area of CC RVAAP-69 Building 1048 Fire Station. The RI Report (USACE 2023) also concluded that there are no COCs in the soil; however, the subsurface soil should be evaluated in the FS Report as a source of contamination to the groundwater.

SCOPE

The scope of work, as presented in this Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP), is to further assess potential impacts from VOCs migrating from CC RVAAP-69 Building 1048 Fire Station by evaluating the potential VI pathway to nearby Building 1037 and collecting an additional round of groundwater sampling for VOC analysis. This consists of five inter-related tasks: 1) prepare a UFP-QAPP, 2) conduct a VI study at Building 1037, 3) groundwater sampling data collection activities at and downgradient of CC RVAAP-69 Building 1048 Fire Station, 4) conduct data validation and laboratory oversight activities, and 5) evaluate data from the field effort and applicable historical information to support an FS Report.

Leidos is the prime contractor leading the VI study and groundwater sampling. Additional Leidos team members for this project include laboratory analytical services provided by White Water Associates (WWA), Eurofins Lancaster Laboratories Environmental, LLC (ELLE), and Eurofins Air Toxics; drilling services provided by Terra Probe Environmental, Inc.; and investigation-derived waste disposal (IDW) provided by Clean Harbors, Inc.

PROJECT OBJECTIVES

The objectives are to assess the potential VI pathway to nearby Building 1037 and collect an additional round of groundwater samples at and downgradient from CC RVAAP-69 Building 1048 Fire Station.

After the VI study and groundwater sampling activities are completed, an FS Report will be prepared to assess potential remedial options for two VOCs in groundwater (i.e., carbon tetrachloride and chloroform). While there are no COCs in surface soil, the subsurface soil also will be evaluated in the FS Report as a potential source of contamination to the groundwater.

Laboratory analyses will be conducted in accordance with project quality assurance/quality control (QA/QC) requirements. The field activities will follow site-specific sampling and health and safety protocols, as identified in the *Accident Prevention Plan for Additional CERCLA Work for Nine AOCs (RVAAP-34, RVAAP-38, RVAAP-42, RVAAP-45, RVAAP-69, RVAAP-70, RVAAP-76, RVAAP-78, and RVAAP-79)* (Leidos 2023).

QAPP Worksheets #1 and #2 – Title and Approval Page

1. Project Identifying Information

    a. CC RVAAP-69 Building 1048 Fire Station Vapor Intrusion Study of Building 1037
    b. Camp James A. Garfield, Portage and Trumbull Counties, Ohio
    c. Contract No. W912QR-21-D-0016, Delivery Order No. W912QR23F0014

2. Lead Organization

    a. Army National Guard (ARNG)
    Kevin Sedlak, Restoration Program Manager

    SEDLAK.KEVIN.MICHAEL.1254440171 Digitally signed by SEDLAK.KEVIN.MICHAEL.1254440171
    Date: 2024.10.22 07:42:12 -04'00'

    Signature, Date

    b. U.S. Army Corps of Engineers (USACE) – Louisville District
    Steven Kvaal, Project Manager

    Steven Kvaal Digitally signed by Steven Kvaal
    Date: 2024.10.21 15:41:47 -04'00'

    Signature, Date

    c. USACE – Louisville District
    Nathaniel Peters II, Contracting Officer's Representative

    PETERS.NATHANIEL.II.1248279466 Digitally signed by PETERS.NATHANIEL.II.1248279466
    Date: 2024.10.21 15:14:43 -04'00'

    Signature, Date

3. Other Stakeholders – None

4. Plans and reports from previous investigations relevant to this project:

ECC (Environmental Chemical Corporation). 2012. *Site Inspection and Remedial Investigation Work Plan at Compliance Restorations Sites, Ravenna Army Ammunition Plant, Ravenna, Ohio*. October 3.

ECC. 2015a. *Field Change Notice, CC RVAAP-69 Building 1048 Fire Station, Former Ravenna Army Ammunition Plant Portage and Trumbull Counties*. March 4.

ECC. 2015b. *Site Inspection Report CC RVAAP-72 Facility-Wide Underground Storage Tanks, Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio*. July 8.

Parsons (Parsons Corporation). 2017. *Work Plan, Additional Sampling for CC RVAAP-69 Building 1048 Fire Station, CC RVAAP-70 East Classification Yard, and CC RVAAP-74 Building 1034-Motor Pool Hydraulic Lift, Ravenna Army Ammunition Plant Restoration Program, Camp Ravenna, Portage and Trumbull Counties, Ohio*. November 30.

ECC. 2015b. *Site Inspection Report CC RVAAP-72 Facility-Wide Underground Storage Tanks, Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio*. July 8.

Parsons (Parsons Corporation). 2017. *Work Plan, Additional Sampling for CC RVAAP-69 Building 1048 Fire Station, CC RVAAP-70 East Classification Yard, and CC RVAAP-74 Building 1034-Motor Pool Hydraulic Lift, Ravenna Army Ammunition Plant Restoration Program, Camp Ravenna, Portage and Trumbull Counties, Ohio*. November 30.

Parsons. 2018. *Update and Progress Report on Remedial Investigation at CC RVAAP-69 Building 1048 Fire Station, Ravenna Army Ammunition Plant Restoration Program, Camp Ravenna, Portage and Trumbull Counties, Ohio*. July 24.

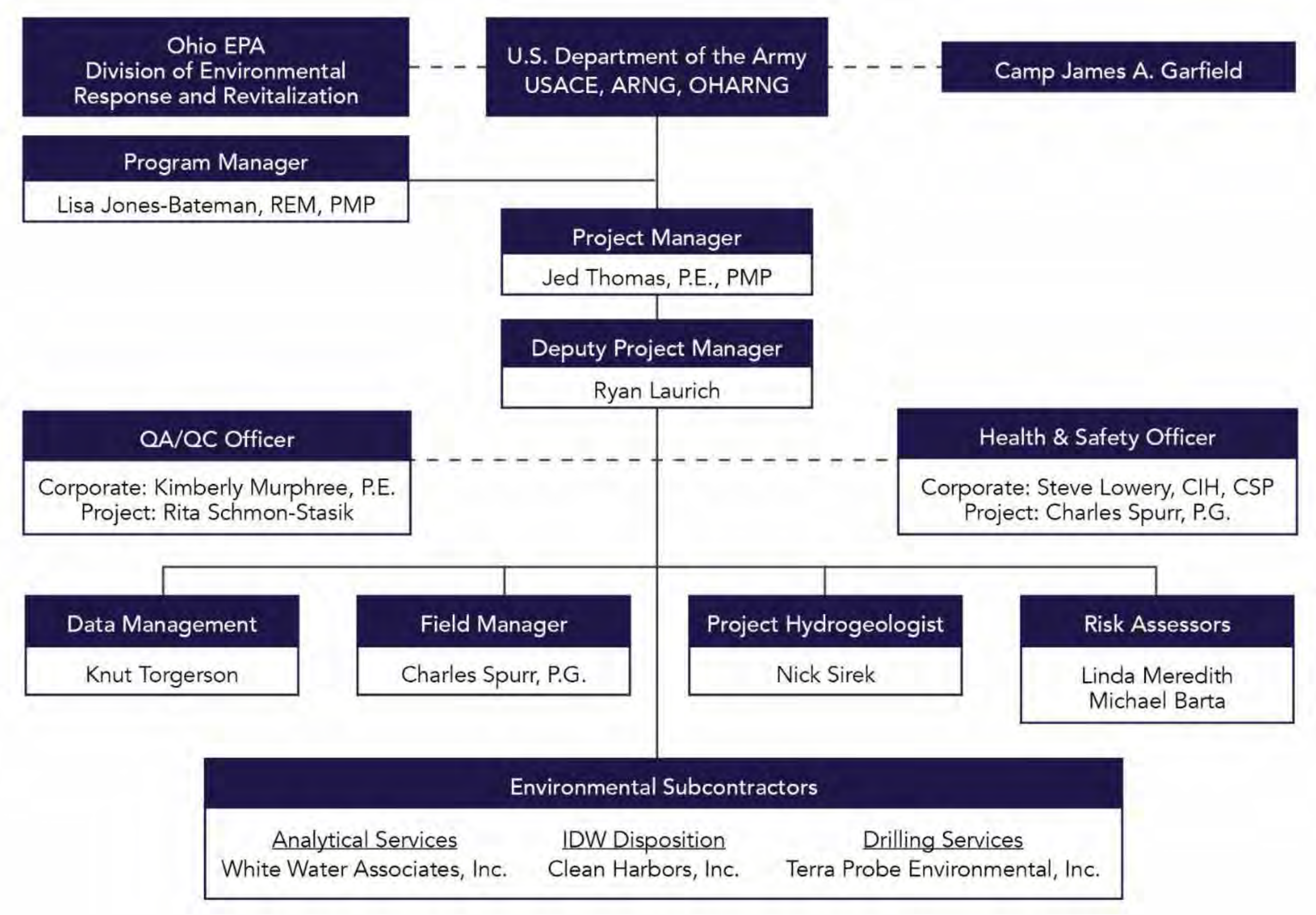
Parsons. 2019. *Second Update and Progress Report on Remedial Investigation at CC RVAAP-69 Building 1048 Fire Station, Ravenna Army Ammunition Plant Restoration Program, Camp James A. Garfield, Portage and Trumbull Counties, Ohio*. June 10.

SAIC (Science Applications International Corporation). 2011. *Historical Records Review Report for the 2010 Phase I Remedial Investigation Services at Compliance Restoration Sites (9 Areas of Concern), Ravenna Army Ammunition Plant, Ravenna, Ohio*. December 22.

USACE (U.S. Army Corps of Engineers). 2023. *Remedial Investigation for CC RVAAP-69 Building 1048 Fire Station Ravenna Army Ammunition Plant Restoration Program Portage and Trumbull Counties, Ohio*. February 14.

QAPP Worksheets #3 and #5 – Project Organization and QAPP Distribution

3.1 PROJECT ORGANIZATION



3.2 QAPP DISTRIBUTION

The distribution of this UFP-QAPP is as presented in the Document Distribution list at the beginning of this plan.

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QAPP Worksheets #4, #7, and #8 – Personnel Qualifications and Sign-Off Sheet

Organization: Leidos

Project Personnel	Title/Role	Education/Experience	Specialized Training/Certifications	Additional Required Training	Signature[b]
Jed Thomas	Project Manager	B.S., Chemical Engineering M.S., Chemical Engineering 21 years of experience	P.E., PMP, HAZWOPER Supervisor[a]	None	Jed Thomas
Ryan Laurich	Deputy Project Manager	B.S., Environmental Biology M.S., Environmental Science 15 years of experience	HAZWOPER 40-Hour Supervisor[a]	None	
Charles Spurr	Field Manager and Project Health and Safety Officer	B.A., Geology M.S., Geology/Geophysics 6 years of experience	P.G., PMP, HAZWOPER Supervisor[a]	None	Charles A. Spurr
Rita Schmon-Stasik	Project Chemist	B.S., Chemistry 34 years of experience		None	
Nick Sirek	Project Hydrogeologist	B.S., Environmental Geology M.S., Geology 16 years of experience	HAZWOPER 40-Hour	None	Nicholas D. Sirek
Linda Meredith	Human Health Risk Assessor	B.A., Chemistry 35 years of experience		None	Linda Meredith
Michael Barta	Ecological Risk Assessor	B.S., Zoology M.S., Zoology 30 years of experience		None	
Kimberly Murphree	Corporate QA/QC Officer	B.S., Civil Engineering 24 years of experience	P.E.	None	Kimberly C. Murphree
Knut Torgerson	Data Manager	B.S., Environmental Sciences 27 years of experience		None	Knut Torgerson
Steve Lowery	Project Safety and Health Manager	M.S., Industrial Hygiene 28 years of experience	CIH, CSP, HAZWOPER Supervisor, OSHA 510, 40-hour EM 385-1-1 USACE Safety & Health	None	

[a] All field personnel scheduled for fieldwork at CJAG have been trained in accordance with HAZWOPER (29 CFR 1910.120, 29 CFR 1926.65) and are enrolled in a medical surveillance program that meets the requirements of 29 CFR Section 1910.120(f). All personnel are experienced in hazardous waste site work, use of PPE, and emergency response procedures.

[b] Signatures indicate personnel have read and agree to implement this UFP-QAPP as written.

B.A. = Bachelor of Arts
B.S. = Bachelor of Science
CFR = Code of Federal Regulations
CIH = Certified Industrial Hygienist
CJAG = Camp James A. Garfield
CSP = Certified Safety Professional
EM = Engineer Manual
HAZWOPER = Hazardous Waste Operations and Emergency Response
M.S. = Master of Science
OSHA = Occupational Safety and Health Administration
P.E. = Professional Engineer
P.G. = Professional Geologist
PMP = Project Management Professional
PPE = Personal Protective Equipment
QA = Quality Assurance
QC = Quality Control
UFP-QAPP = Uniform Federal Policy-Quality Assurance Project Plan
USACE = U.S. Army Corps of Engineers

QAPP Worksheets #4, #7, and #8 – Personnel Qualifications and Sign-Off Sheet (Continued)

Organization: Laboratory – White Water Associates, Inc. (with their subcontractor Eurofins Air Toxics and Eurofins Lancaster Laboratories Environmental, LLC)

Project Personnel	Title/Role	Education/Experience	Specialized Training/Certifications	Signature*
Bette Premo, WWA	WWA Project Manager	Ph.D., Limnology 36 years of Experience	N/A	Bette J. Premo
Jade White, Eurofins Air Toxics	Eurofins Air Toxics Project Manager	B.S., Entomology 6 years of experience	N/A	Vanessa N. Badman
Vanessa Badman, ELLE	ELLE QA Manager	B.S., Biology 20 years of experience	N/A	

*Signatures indicate personnel have read and agree to implement this UFP-QAPP as written.

B.S. = Bachelor of Science
ELLE = Eurofins Lancaster Laboratories Environmental, LLC
N/A = Not Applicable
QA = Quality Assurance
UFP-QAPP = Uniform Federal Policy-Quality Assurance Project Plan
WWA = White Water Associates, Inc.

QAPP Worksheet #6 – Communication Pathways

Communication Drivers	Responsible Entity	Name	Telephone Number/Email Address	Procedure (timing, pathway, etc.)
Primary Contractor and Project Oversight	USACE – Louisville District COR/TM	Nathaniel Peters, II	(502) 315-2624 Nathaniel.Peters.ii@usace.army.mil	Contractual and technical information about the project will be provided to the USACE COR/TM as needed by the Leidos team.
	USACE – Louisville District Project Manager	Steven Kvaal	(502) 315-6316 Steven.Kvaal@usace.army.mil	Information about the project will be provided to the USACE Project Manager as needed by the Leidos team.
	ARNG Restoration Program Manager	Kevin Sedlak	(614) 336-6000 ext. 2053 Kevin.M.Sedlak.ctr@army.mil	Information about the project will be provided to the ARNG Program Manager as needed by USACE and/or the Leidos team. In addition, significant corrective actions and/or modifications to the UFP-QAPP will be relayed to the ARNG Program Manager as soon as possible by telephone and/or email.
	OHARNG Environmental Specialist	Katie Tait	(614) 336-6136 Kathryn.S.Tait.nfg@army.mil	Information about the project will be provided to the OHARNG Environmental Specialist as needed by USACE and/or the Leidos team. In addition, significant corrective actions and/or modifications to the UFP-QAPP will be relayed to the OHARNG Environmental Specialist as soon as possible by telephone and/or email.
Regulatory Agency Interface	Ohio EPA Site Coordinator	Edward D’Amato	(330) 963-1170 Ed.Damato@epa.ohio.gov	All materials and information about the project will be provided to Ohio EPA as needed from the ARNG Program Manager or OHARNG Environmental Specialist. In addition, significant corrective actions and/or modifications to the UFP-QAPP will be relayed to the regulatory agencies as soon as possible by telephone and/or email.
	ARNG Restoration Program Manager	Kevin Sedlak	(614) 336-6000 ext. 2053 Kevin.M.Sedlak.ctr@army.mil	All appropriate materials and information about the project will be provided to the regulatory agencies by the ARNG Restoration Program Manager. In addition, significant corrective actions and/or modifications to the UFP-QAPP will be relayed to the regulatory agencies as soon as possible by telephone and/or email.

QAPP Worksheet #6 – Communication Pathways (Continued)

Communication Drivers	Responsible Entity	Name	Telephone Number/Email Address	Procedure (timing, pathway, etc.)
	OHARNG Environmental Specialist	Katie Tait	(614) 336-6136 Kathryn.S.Tait.nfg@army.mil	Information about the project will be provided to the OHARNG Environmental Specialist as needed by the USACE COR/TM, USACE Project Manager, and/or Leidos team. In addition, significant corrective actions and/or modifications to the UFP-QAPP will be relayed to the OHARNG Environmental Specialist as soon as possible by telephone and/or email.
	Leidos Project Manager	Jed Thomas	(330) 405-5802 (office) (216) 214-2599 (cell) Jed.H.Thomas@leidos.com	All appropriate information requiring regulatory input, approval, or awareness will be provided to the ARNG, OHARNG, and USACE by the Leidos Project Manager (or designee). Only with approval from ARNG/OHARNG will anyone from the Leidos team contact the regulatory agency regarding this project.
Manage all Project Phases and Leidos Primary Point of Contact	Leidos Project Manager	Jed Thomas	(330) 405-5802 (office) (216) 214-2599 (cell) Jed.H.Thomas@leidos.com	All appropriate information about the project and technical considerations will be provided to ARNG, OHARNG, and USACE by the Leidos Project Manager (or designee) through distribution of hard copies or electronic versions of the reports and/or through telephone or email.
Submit Deliverables, Monthly Reports, and Billings	Leidos Deputy Project Manager	Ryan Laurich	(330) 998-4246 (cell) Ryan.M.Laurich@leidos.com	Deliverables, Monthly Reports, and billings will be submitted to USACE by the Leidos Deputy Project Manager.
Reporting Data Quality Issues	Leidos Project Manager	Jed Thomas	(330) 405-5802 (office) (216) 214-2599 (cell) Jed.H.Thomas@leidos.com	Corrective actions or flagging of analytical results will be reported to ARNG, OHARNG, and USACE as needed by the /Leidos Project Manager (or designee) by telephone and/or email.
	Leidos Project Chemist	Rita Schmon-Stasik	(973) 715-4492 Rita.M.Schmon-stasik@leidos.com	The need for corrective actions or flagging of analytical results will be reported to the Leidos Project Manager by the Leidos Project Chemist by telephone and/or email as soon as possible after issues are identified.

QAPP Worksheet #6 – Communication Pathways (Continued)

Communication Drivers	Responsible Entity	Name	Telephone Number/Email Address	Procedure (timing, pathway, etc.)
Changes to UFP-QAPP Prior to Fieldwork	Leidos Project Manager	Jed Thomas	(330) 405-5802 (office) (216) 214-2599 (cell) Jed.H.Thomas@leidos.com	All information about the project regarding changes to the UFP-QAPP and/or corrective actions will be communicated to ARNG, OHARNG, and USACE by the Leidos Project Manager (or designee) by telephone and/or email. A Field Change Request will also be provided.
	Leidos Project Chemist	Rita Schmon-Stasik	(973) 715-4492 Rita.M.Schmon-stasik@leidos.com	Any necessary changes to the UFP-QAPP based on data quality prior to fieldwork will be communicated to the Leidos Project Manager by the Leidos Project Chemist by telephone and/or email as soon as possible after issues are identified.
Changes to UFP-QAPP Field Sampling Procedures During Fieldwork	Leidos Project Manager	Jed Thomas	(330) 405-5802 (office) (216) 214-2599 (cell) Jed.H.Thomas@leidos.com	Any necessary changes to the UFP-QAPP and/or requested changes to field sampling procedures based on field conditions will be communicated to ARNG, OHARNG, and USACE by the Leidos Project Manager (or designee) by telephone and/or email. A Field Change Request will also be provided.
	Leidos Field Manager	Charles Spurr	(330) 405-5809 (office) (216) 317-5726 (cell) Charles.Spurr@leidos.com	Any necessary changes to the UFP-QAPP and/or requested changes to field sampling procedures based on field conditions will be communicated to the Leidos Project Manager and Deputy Project Manager by the Leidos Field Manager by telephone and/or email.
Field Progress Reports	Leidos Field Manager	Charles Spurr	(330) 405-5809 (office) (216) 317-5726 (cell) Charles.Spurr@leidos.com	Progress made during execution of the fieldwork will be communicated to the Leidos Project Manager and Leidos Deputy Project Manager by the Leidos Field Manager by telephone and/or email.
Field Corrective Actions	Leidos Project Manager	Jed Thomas	(330) 405-5802 (office) (216) 214-2599 (cell) Jed.H.Thomas@leidos.com	Field-related problems and/or corrective actions identified while in the field will be communicated to ARNG, OHARNG, and USACE by the Leidos Project Manager (or designee) by telephone and/or email as soon as possible after issues are identified. A Field Change Request will also be provided.

QAPP Worksheet #6 – Communication Pathways (Continued)

Communication Drivers	Responsible Entity	Name	Telephone Number/Email Address	Procedure (timing, pathway, etc.)
	Leidos Field Manager	Charles Spurr	(330) 405-5809 (office) (216) 317-5726 (cell) Charles.Spurr@leidos.com	Field-related problems and/or corrective actions identified while in the field will be communicated to the Leidos Project Manager and Leidos Deputy Project Manager by the Leidos Field Manager by telephone and/or email as soon as possible after issues are identified.
Stopping Work Due to Health and Safety Issues or Unexpected Field Conditions	Leidos Project Manager	Jed Thomas	(330) 405-5802 (office) (216) 214-2599 (cell) Jed.H.Thomas@leidos.com	Field-related health and safety issues and/or unexpected conditions identified while in the field (including information detailing what parameters must be met to resume work) will be communicated to ARNG, OHARNG, and the USACE COR by the Leidos Project Manager (or designee) by telephone and/or email as soon as possible after issues are identified.
	Leidos Field Manager	Charles Spurr	(330) 405-5809 (office) (216) 317-5726 (cell) Charles.Spurr@leidos.com	Field-related health and safety issues and/or unexpected conditions identified while in the field will be communicated to the Leidos Project Manager and Leidos SSHO by the Leidos Field Manager by telephone and/or email as soon as possible after issues are identified.
Reporting Laboratory Issues (e.g., Sample Receipt Issues, Data Quality Issues, Laboratory QC Variances, Analytical Corrective Actions, Data Verification Issues)	USACE – Louisville District Chemist	Peter Lorey	(716) 879-4158 Peter.M.Lorey@usace.army.mil	Project chemistry or data quality issues will be communicated to ARNG, OHARNG, and USACE by the USACE Chemist by telephone and/or email.
	Leidos Project Chemist	Rita Schmon-Stasik	(973) 715-4492 Rita.M.Schmon-stasik@leidos.com	Sample receipt and data quality issues will be reported to the USACE Chemist as needed by the Leidos Project Chemist by telephone and/or email as soon as possible after the issues are identified.
	WWA/ELLE	Vanessa Badman	(717) 556-9762 Vanessa.Badman@ET.EurofinsUS.com	All sample receipt and data quality issues will be reported to the Leidos Chemist by telephone and/or email from the WWA Project Manager as soon as possible after the issues are identified.

QAPP Worksheet #6 – Communication Pathways (Continued)

Communication Drivers	Responsible Entity	Name	Telephone Number/Email Address	Procedure (timing, pathway, etc.)
Data Validation Issues, Including Noncompliance with Procedures or Methods	Leidos Project Manager	Jed Thomas	(330) 405-5802 (office) (216) 214-2599 (cell) Jed.H.Thomas@leidos.com	Data validation issues, including noncompliance with procedures or methods, will be communicated to ARNG, OHARNG, and USACE as needed by the Leidos Project Manager (or designee) as soon as possible by telephone and/or by email after the issues are identified.
	Leidos QA/QC Officer	Kimberly Murphree	(314) 770-3012 kimberly.c.murphree@leidos.com	All data validation issues, including noncompliance with procedures or methods, will be communicated to the Leidos QA/QC Officer and Leidos Project Manager as soon as possible by telephone and/or by email after the issues are identified.
	Leidos Project Chemist	Rita Schmon-Stasik	(973) 715-4492 Rita.M.Schmon-stasik@leidos.com	All data validation issues, including noncompliance with procedures or methods, will be communicated to the Leidos Project Manager by the Leidos Project Chemist as soon as possible by telephone and/or by email after the issues are identified.
Data Review Corrective Actions	Leidos Project Manager	Jed Thomas	(330) 405-5802 (office) (216) 214-2599 (cell) Jed.H.Thomas@leidos.com	Data review corrective actions will be communicated to ARNG, OHARNG, and USACE as needed by the Leidos Project Manager (or designee) by telephone and/or email as soon as possible after the issues are identified.
	Leidos Project Chemist	Rita Schmon-Stasik	(973) 715-4492 Rita.M.Schmon-stasik@leidos.com	Any necessary data review corrective actions will be communicated to the Leidos Project Manager by the Leidos Project Chemist by telephone and/or by email as soon as possible after the issues are identified.

ARNG = Army National Guard
COR = Contracting Officer's Representative
ELLE = Eurofins Lancaster Laboratories Environmental, LLC
OHARNG = Ohio Army National Guard
Ohio EPA = Ohio Environmental Protection Agency
QA = Quality Assurance
QC = Quality Control
SSHO = Site Safety and Health Officer
TM = Technical Manager
UFP-QAPP = Uniform Federal Policy-Quality Assurance Project Plan
USACE = U.S. Army Corps of Engineers
WWA = White Water Associates, Inc.

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QAPP Worksheet #9 – Project Planning Session Summary

See Appendix D for the Project Planning Session presentation and meeting minutes.

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QAPP Worksheet #10 − Conceptual Site Model

10.1 INTRODUCTION

CJAG is in northeastern Ohio within Portage and Trumbull Counties, approximately 1 mile northwest of the city of Newton Falls and 3 miles east-northeast of the city of Ravenna (Figure 10-1). The facility is approximately 11 miles long and 3.5 miles wide, and bounded by State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad to the south; Garrett, McCormick, and Berry Roads to the west; the Norfolk Southern Railroad to the north; and State Route 534 to the east.

The former RVAAP/CJAG was used as a load, assemble, and pack facility for munitions. Administrative control of the facility (21,683 acres) has been transferred to the U.S. Property and Fiscal Officer for Ohio and subsequently licensed to OHARNG for use as a military training site. The RVAAP IRP, managed by ARNG and OHARNG, encompasses investigation and cleanup of past activities over the entire 21,683 acres of the former RVAAP/CJAG.

The *Remedial Investigation Report for CC RVAAP-69 Building 1048 Fire Station* (USACE 2023) evaluated soil and groundwater in accordance with CERCLA of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 and the NCP. While the RI sufficiently delineated nature and extent of soil and groundwater contamination, the HHRA concluded that there are two COCs in groundwater (i.e., carbon tetrachloride and chloroform) that should be evaluated in an FS Report. Accordingly, the Army is assessing the potential VI pathway to nearby Building 1037 and collecting an additional round of groundwater samples at and downgradient of the area of CC RVAAP-69 Building 1048 Fire Station. The RI Report (USACE 2023) also concluded that there are no COCs present in surface soil (0 to 1 foot bgs) or subsurface soil (1 to 13 feet bgs); however, the report recommended subsurface soil should be evaluated in the FS Report as a potential source of contamination to the groundwater.

The following sections provide a site description, summarize the investigation activities performed to date, and identify areas requiring VI study and additional groundwater sampling. The proposed strategies for VI study and groundwater sampling are presented on Worksheet #17.

10.2 SITE DESCRIPTION

The CC RVAAP-69 Building 1048 Fire Station AOC is located in the south-central portion of CJAG, in the northwest quadrant of the intersection of George Road and South Service Road (Figures 10-2 and 10-3). The former fire station was located in the RVAAP Administration Area and consisted of three attached buildings:

- Building 1048A was known as the Guard Quarters
- Building 1048 was the Fire Station
- Building 1048B was known as the Ambulance Garage.

An approximately 8- by 8-foot metal storage shed, denoted as Building T-4510, was located adjacent to the former Building 1048 Fire Station. In 1968, the fire station was referred to as the Fire and Guard Building and consisted of 12,130 ft^2. No documented evidence was found regarding specific years of service for the former fire station. Site schematics dated 1941 were found, so it is assumed services commenced shortly after the 1941 building construction. The fire station was demolished in late 2008, and the site currently remains undeveloped. No remnants of the building remain, such as slabs or footers, and the area was regraded after the building was demolished.

The CC RVAAP-69 Building 1048 Fire Station AOC is a relatively flat, grassy field that is regularly maintained by mowing. Paved areas remain to the north and east, and the area to the west is partially wooded. The AOC is at an elevation of approximately 1,028 feet amsl. Based on area topography, stormwater runoff is toward George Road to the east. Surface water bodies are not present within the AOC or its immediate vicinity. Groundwater flow is east-southeast toward Building 1037 (Figures 10-4 and 10-5).

10.3 VOC CONTAMINATION

The *Remedial Investigation Report for CC RVAAP-69 Building 1048 Fire Station* (USACE 2023) evaluated soil and groundwater, and the HHRA concluded that there are two COCs in groundwater (i.e., carbon tetrachloride and chloroform) that should be evaluated in an FS Report. Potential sources of VOC contamination are spills or leaks from firefighting equipment at the former Building 1048 Fire Station. Carbon tetrachloride was commonly used through the 1950s to extinguish fires because the chemical was readily available, nonflammable, easily volatilized, and inhibited the combustion process. Former employees reported that it was common practice for the fire department to clean out fire extinguishers behind (i.e., the western side of) the fire building and to allow the contents of the fire extinguishers (carbon tetrachloride) to spill onto the ground surface (SAIC 2011a).

An SI was conducted to determine the presence or absence of environmental contamination at the site in 2015 as a joint investigation with CC RVAAP-72 Facility-Wide Underground Storage Tanks. Carbon tetrachloride was detected in a subsurface soil sample at 14 J mg/kg at 5 to 6 feet bgs located within the former Building 1048 footprint.

Results used for decision making in the RI Report (USACE 2023) were from environmental samples collected over a series of field mobilizations by ECC in 2012 and 2015 and by Parsons from 2018 through 2021. Carbon tetrachloride and chloroform were detected in 35 of 77 groundwater samples. The MDC of carbon tetrachloride in groundwater was 980 μg/L at 069MW-001, and the MDC of chloroform in groundwater was 250 μg/L at 069MW-004.

Carbon tetrachloride exceeded its MCL in four monitoring wells (069MW-001, 069MW-002, 069MW-004, and 069MW-005) and chloroform exceeded its MCL in one monitoring well (069MW-004). Concentrations in groundwater were consistent across multiple sampling events (March 2018 through March 2021). The maximum detected concentrations for carbon tetrachloride and chloroform exceeded the vapor intrusion screening level (HQ=0.1 or target risk of 10-6) using the November 2020 USEPA vapor intrusion screening level calculator.

10.4 DATA GAPS

The follow sections discuss data gaps associated with the CC RVAAP-69 Building 1048 Fire Station AOC.

10.4.1 Vapor Intrusion Concerns

Building 1037 is located approximately 200 feet east of and downgradient from the CC RVAAP-69 Building 1048 Fire Station AOC (Figure 10-2). Formerly used for onsite laundry services, Building 1037 is currently in use for CJAG Range Control operations. Building 1037 consists of approximately 4,500 ft^2.

An assessment of the potential VI pathway to Building 1037 has not been conducted. A VI study would assess if VOCs are causing potential unacceptable risk to occupants of Building 1037. The primary release mechanism is soil vapors resulting from groundwater contamination at CC RVAAP-69 Building 1048 Fire Station that may migrate beneath Building 1037. Figure 10-6 presents the conceptual site exposure model (CSEM), and Figure 10-7 presents the conceptual site model (CSM).

10.4.2 Groundwater Data Collection

Groundwater samples analyzed for carbon tetrachloride and chloroform were collected from March 2018 to May 2021. To obtain more recent data in support of the FS Report, 1 round of groundwater samples will be collected from the 14 existing monitoring wells associated with CC RVAAP-69 Building 1048 Fire Station. The CC RVAAP-74 Building 1034 Motor Pool Hydraulic Lift AOC is approximately 500 feet southeast of and downgradient from the CC RVAAP-69 Building 1048 Fire Station AOC. Accordingly, one round of groundwater samples will be collected at the three existing monitoring wells associated with the CC RVAAP-74 Building 1034 Motor Pool Hydraulic Lift AOC. The groundwater samples will be analyzed for carbon tetrachloride and chloroform.

µg/L = Micrograms per Liter
amsl = Above Mean Sea Level
AOC = Area of Concern
ARNG = Army National Guard
bgs = Below Ground Surface
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CJAG = Camp James A. Garfield
COC = Chemical of Concern
CSEM = Conceptual Site Exposure Model
CSM = Conceptual Site Model
ECC = Environmental Chemical Corporation
FS = Feasibility Study
HHRA = Human Health Risk Assessment
IRP = Installation Restoration Program
MCL = Maximum Concentration Limit
MDC = Maximum Detected Concentration
mg/kg = Milligrams per Kilogram
NCP = National Oil and Hazardous Substances Pollution Contingency Plan
OHARNG = Ohio Army National Guard
Parsons = Parsons Corporation
RI = Remedial Investigation
RVAAP = Ravenna Army Ammunition Plant
SI = Site Inspection
UST = Underground Storage Tank
VI = Vapor Intrusion
VISL = Vapor Intrusion Screening Level
VOC = Volatile Organic Compound

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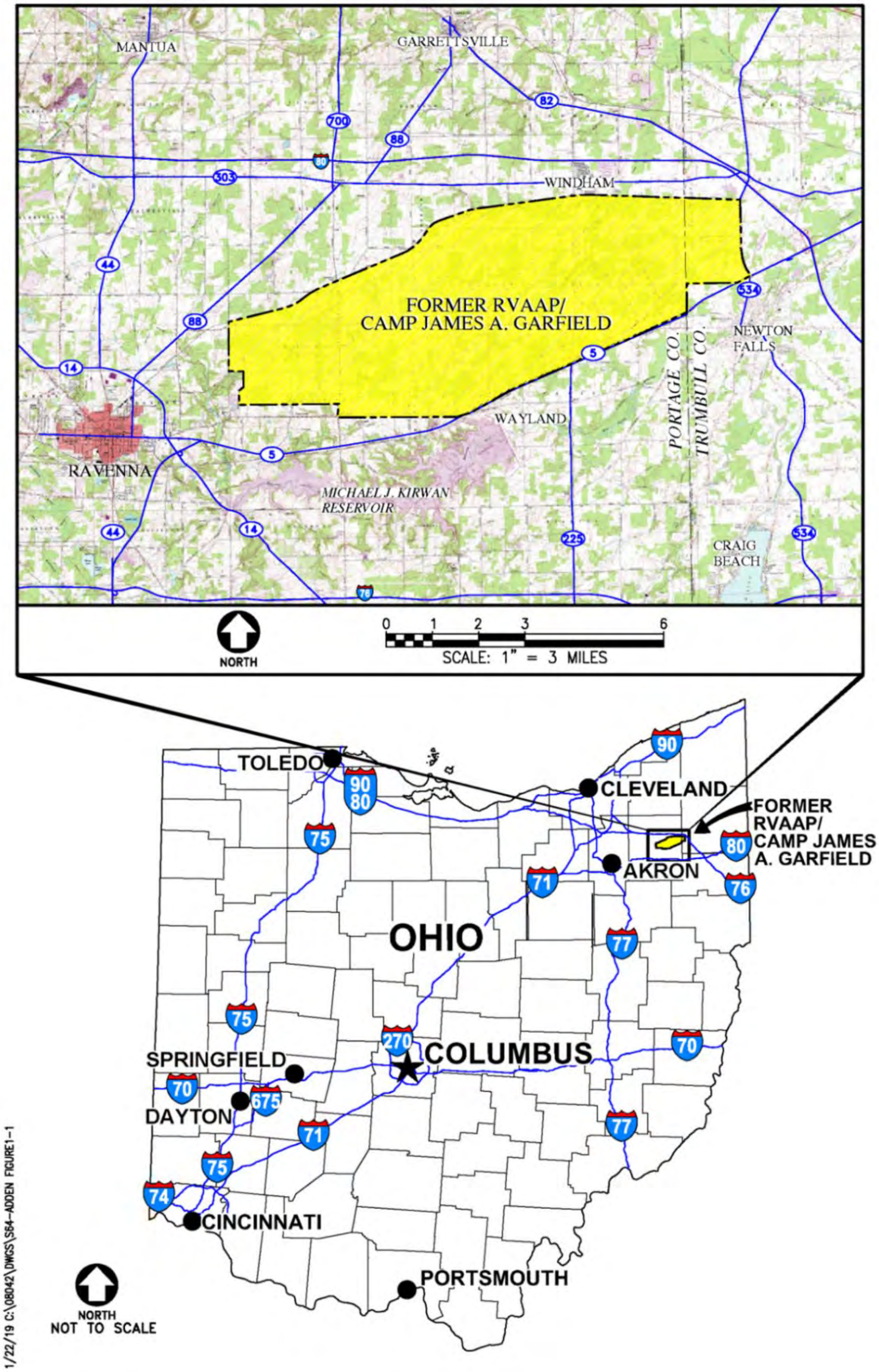

Figure 10-1. General Location and Orientation of Former RVAAP/CJAG

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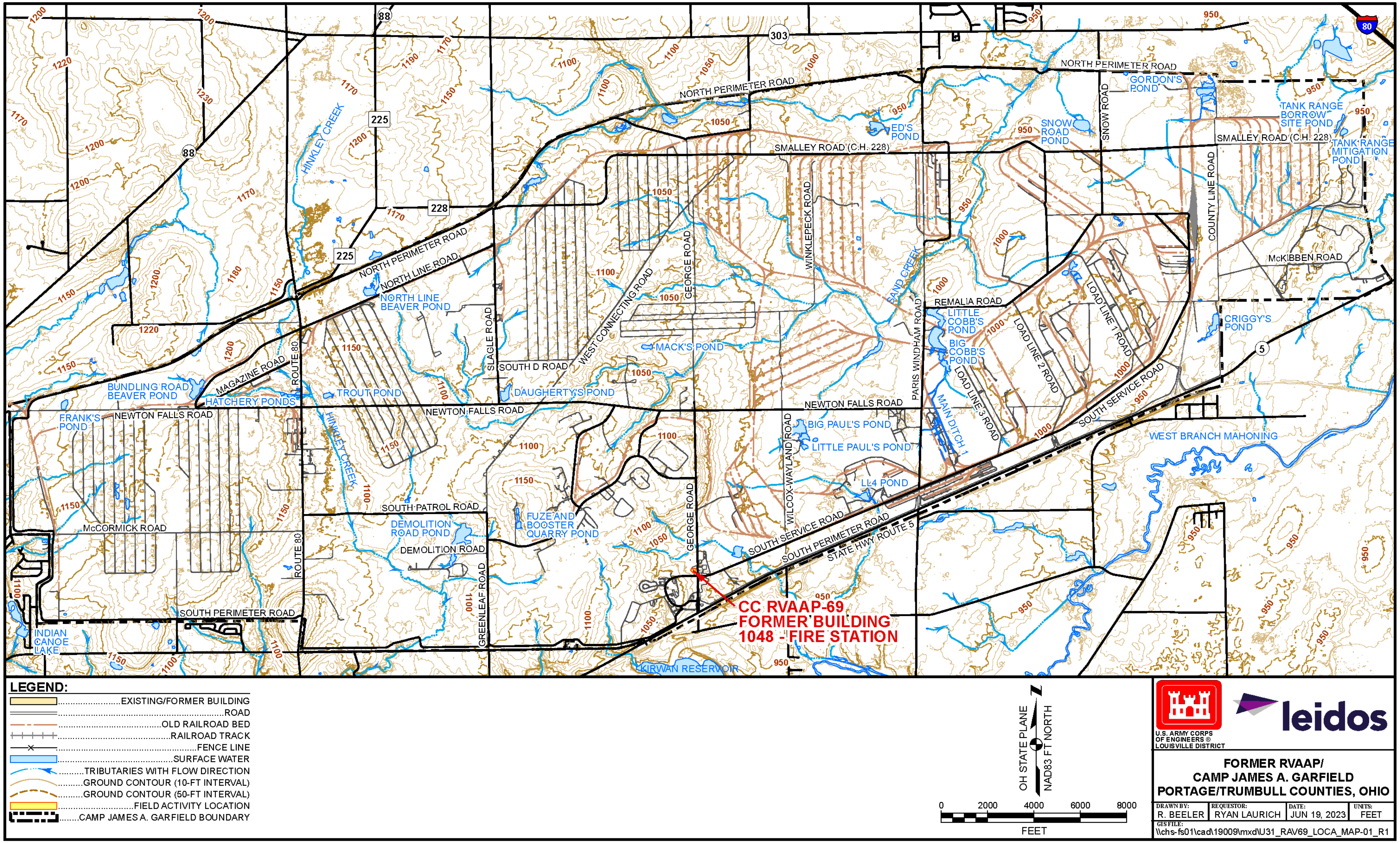

Figure 10-2. Location of CC RVAAP-69 Building 1048 Fire Station Within CJAG

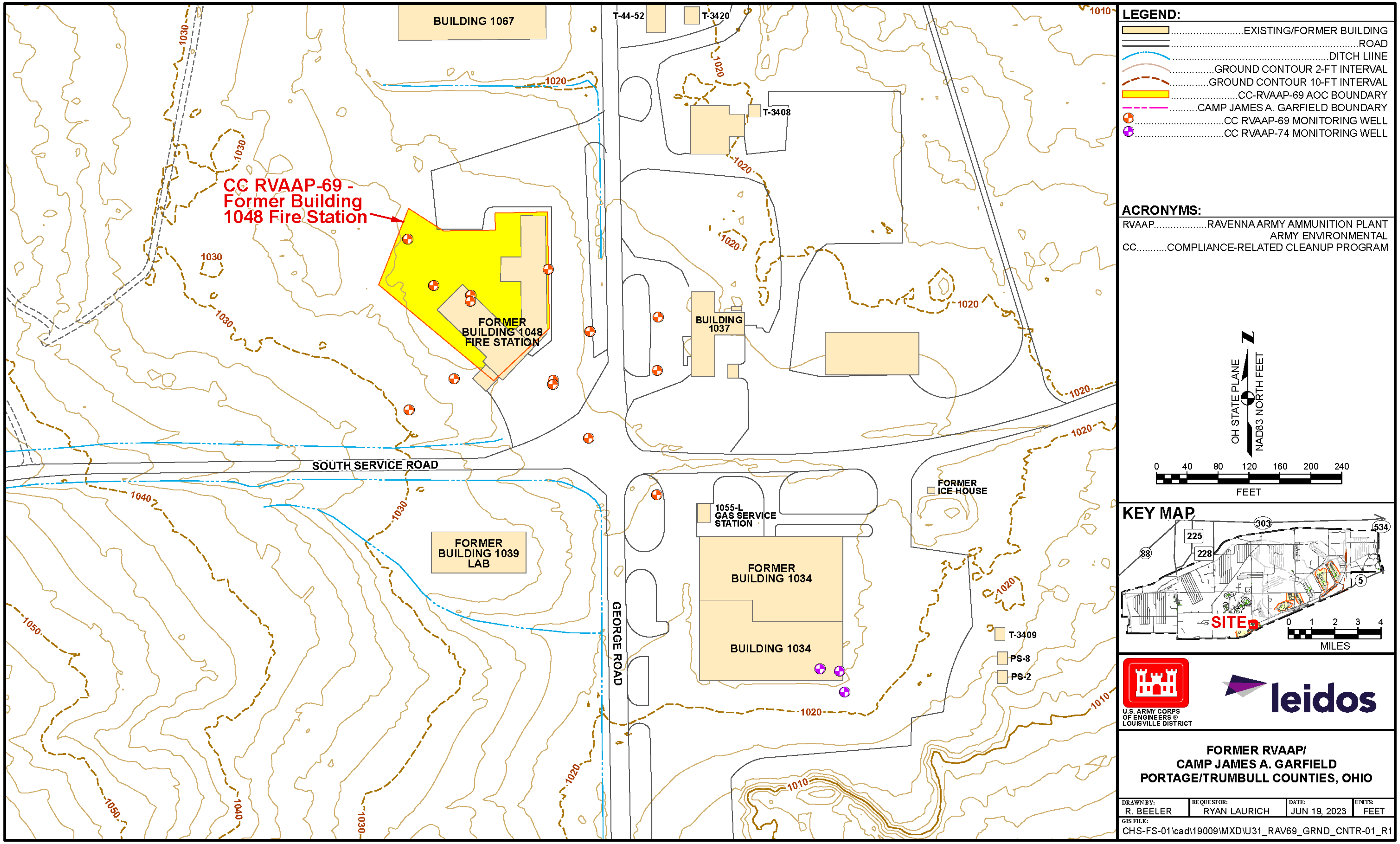

Figure 10-3. CC RVAAP-69 Building 1048 Fire Station Topography and Surface Features

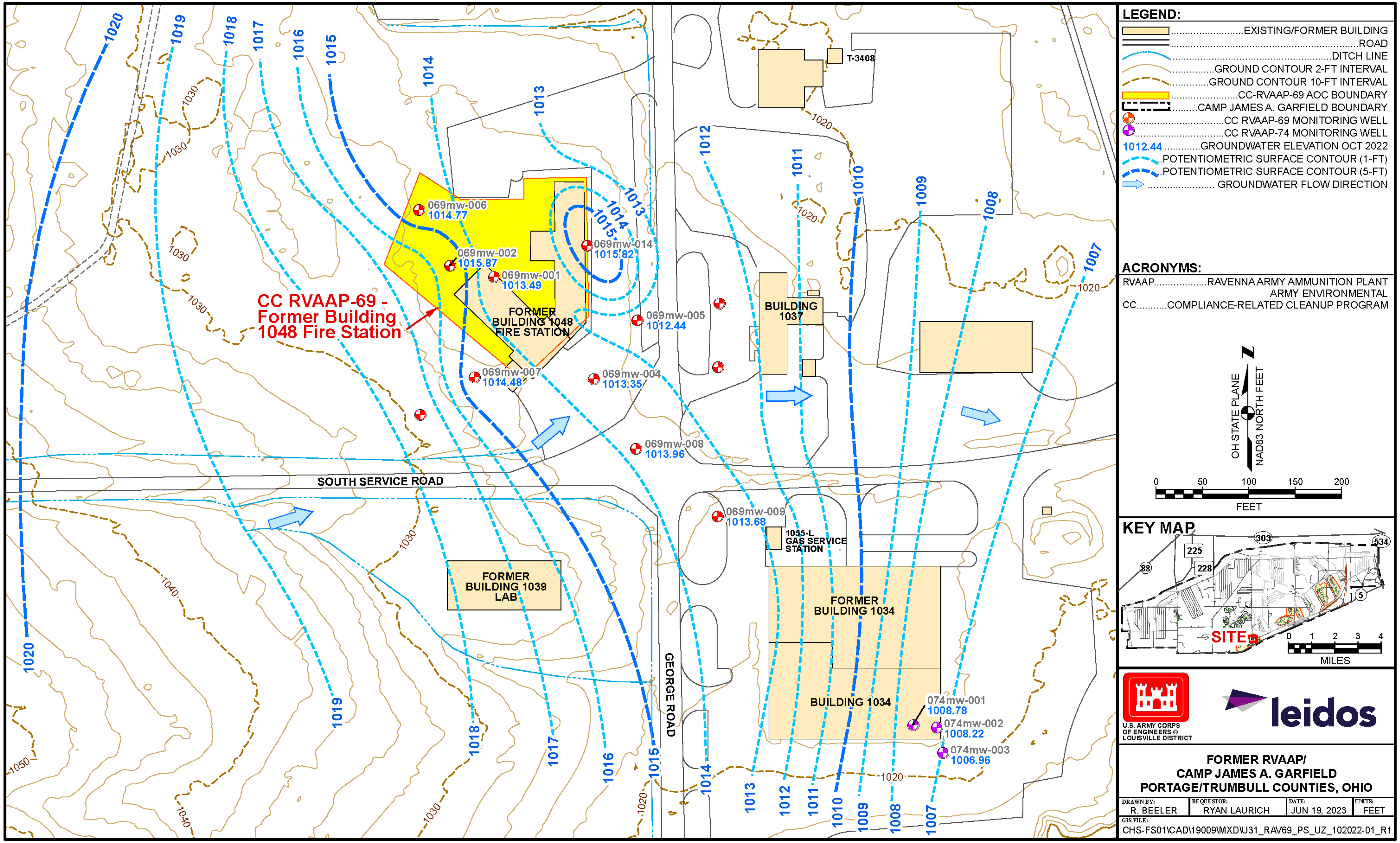

Figure 10-4. CC RVAAP-69 Building 1048 Fire Station – Unconsolidated Zone Potentiometric Surface Map, October 2022

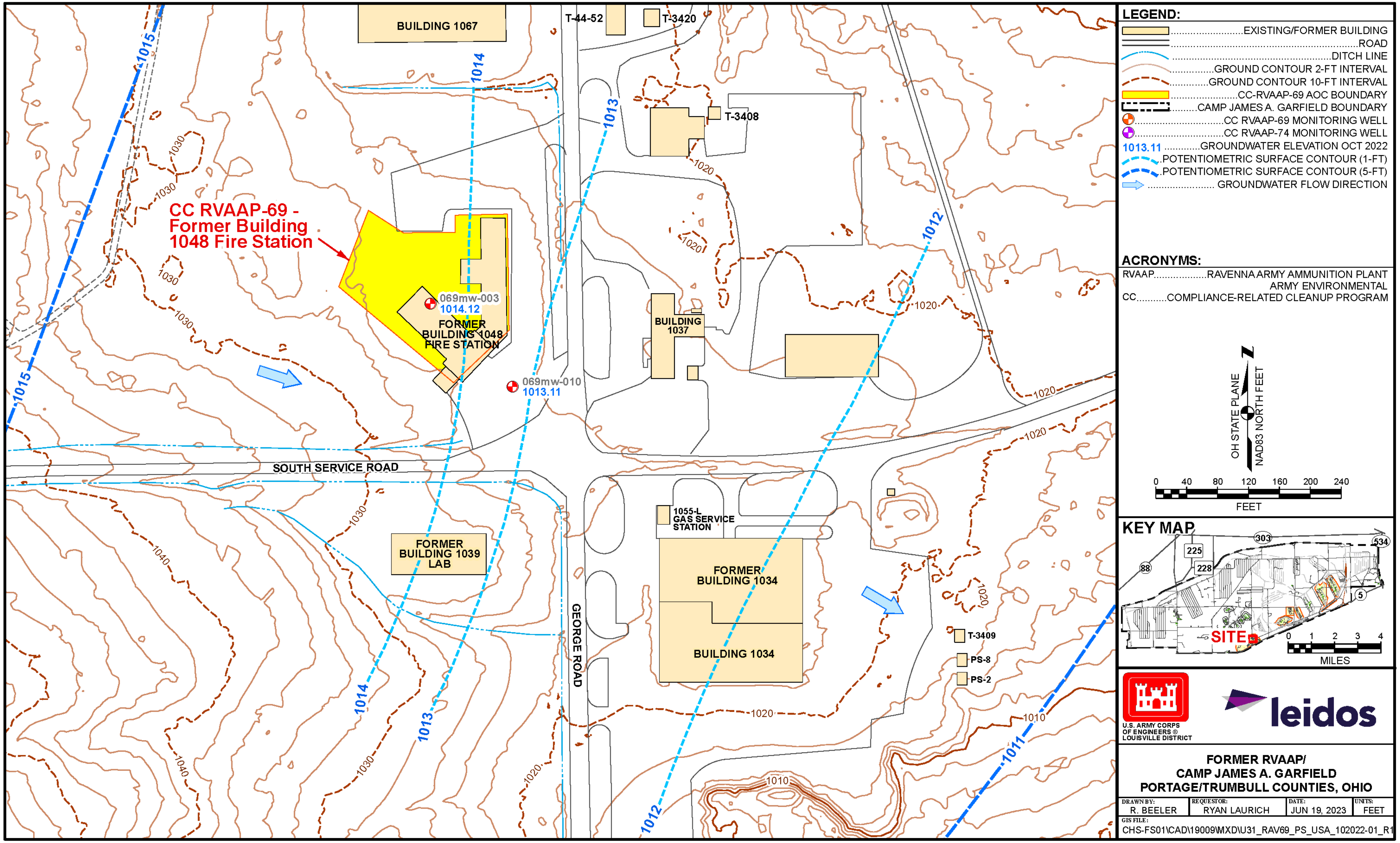

Figure 10-5. CC RVAAP-69 Building 1048 Fire Station – Upper Sharon Zone Potentiometric Surface Map, October 2022

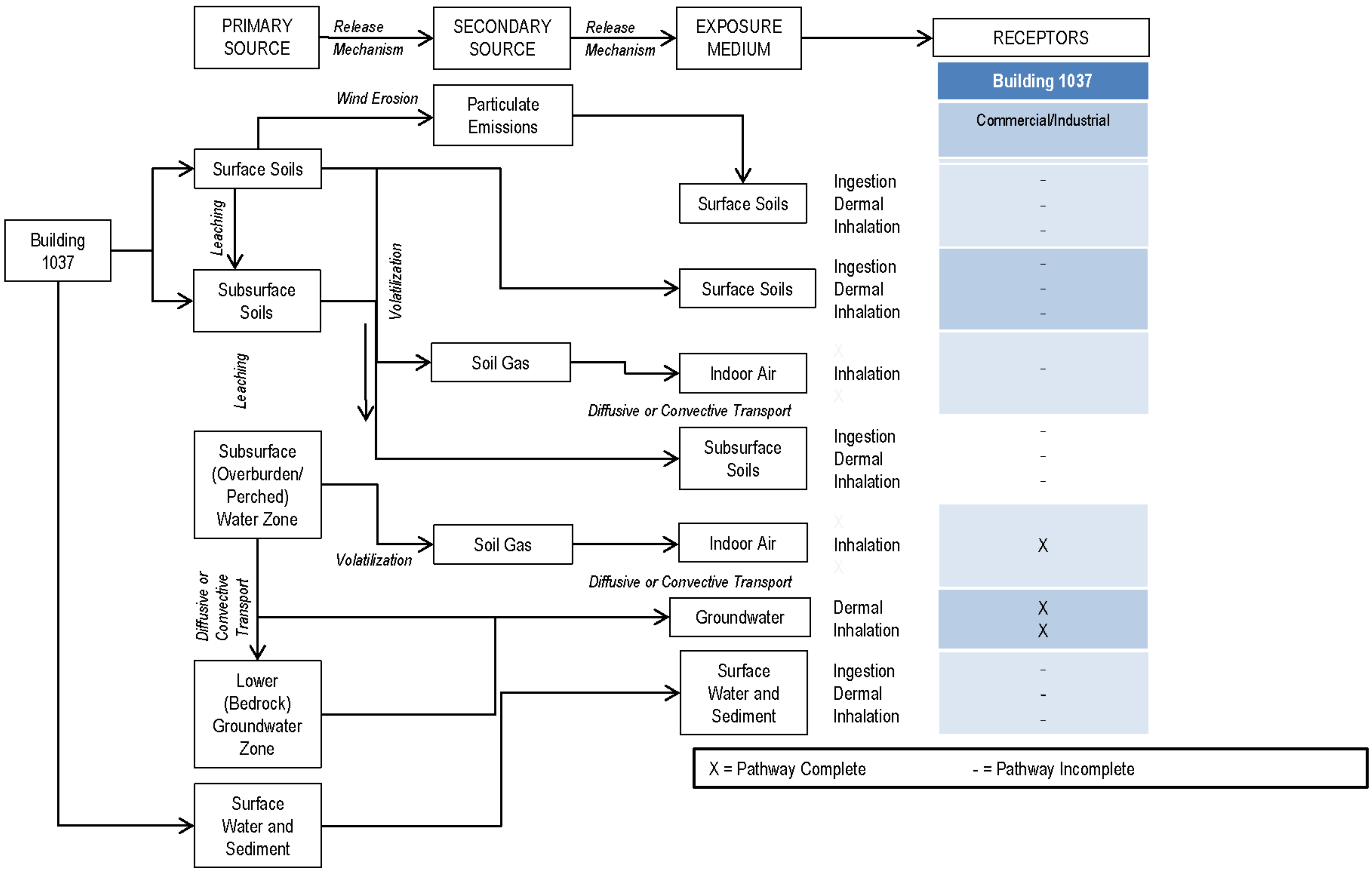

Figure 10-6. Conceptual Exposure Site Model

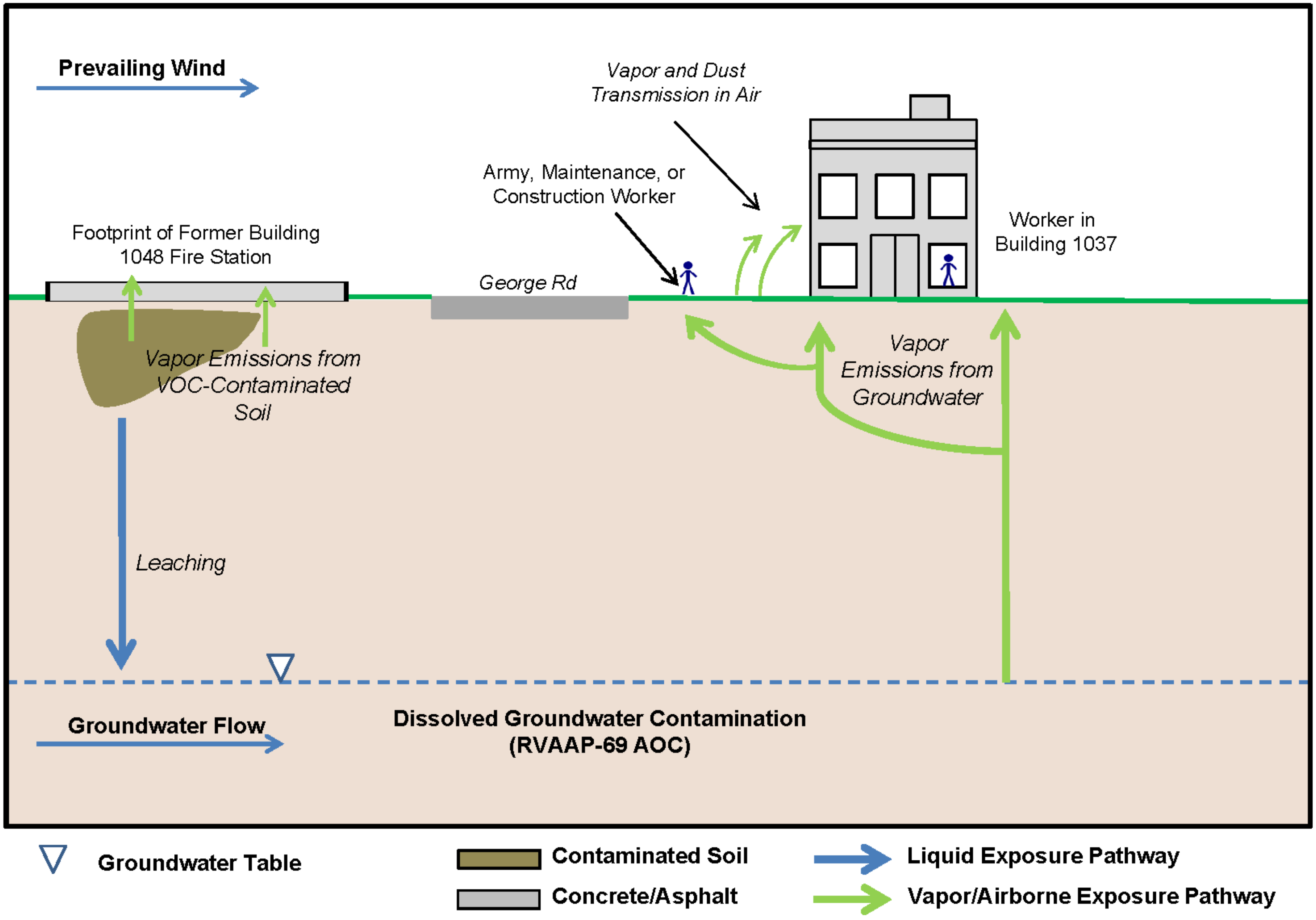

Figure 10-7. Conceptual Site Model

QAPP Worksheet #11 – Project/Data Quality Objectives

This worksheet documents the problem statement and study goals for each data gap presented on Worksheet #10. Following the discussion of the problem statement and study goals, the discussion identifies the information inputs and boundaries of each study. More detailed descriptions of field investigative approaches are presented in subsequent worksheets. DQOs, discussed herein, were developed in accordance with USEPA guidance (USEPA 2006), the USACE Technical Planning Process (USACE 1998), and the Optimized UFP-QAPP Worksheets (IDQTF 2012).

11.1 VAPOR INTRUSION STUDY

11.1.1 Step 1: State the Problem

Multiple VOCs have been detected in environmental media (i.e., soil and groundwater) at the CC RVAAP-69 Building 1048 Fire Station AOC, which is immediately upgradient of Building 1037. VOCs may pose unacceptable risk for VI. Since sub-slab soil vapor sampling has not been conducted at Building 1037, potential for VI has not been evaluated.

11.1.2 Step 2: Identify the Goals of the Study

The goals of the VI study at Building 1037 are to perform indoor air and sub-slab soil vapor sampling and determine if the VI pathway poses a potential unacceptable risk for building occupants.

The following study question will be addressed during this study:

- Are current or future receptors (occupants of Building 1037) exposed to VOCs from VI at concentrations that pose unacceptable risks?

The alternative outcomes for this study are as follows:

- VOCs are detected in indoor air and/or soil vapor samples collected during the VI study, and the detections exceed the PALs presented on Worksheet #15. The soil vapor contamination has not been delineated, and further evaluation may be warranted.
- VOCs are detected in indoor air and/or soil vapor, but the detections are less than the PALs presented on Worksheet #15.
- VOCs are not detected in indoor air and/or soil vapor samples.

11.1.3 Step 3: Identify Information Inputs

Primary information inputs on this project will include:

- Historical and site-specific information through document reviews, site planning visits, and conference calls. This includes secondary data listed on Worksheet #13.

- Feedback from regulators obtained during UFP-QAPP scoping sessions and field scoping sessions that will share status updates, provide results, solicit input, foster collaboration, and achieve consensus.
- Analytical results of the soil vapor sampling outlined on Worksheets #17 and #18.
- Field observations made during preliminary site visits and execution of field activities per this UPF-QAPP.

11.1.4 Step 4: Define the Boundaries of the Study

This section defines the project's target populations, defines the spatial and temporal boundaries, and specifies the target analytes:

- ***Target Populations***
    - For the VI study, the target population consists of the detected VOC concentrations from the soil vapor sampling.
    - A sampling unit from this target population would correspond to each decision unit and its associated sample volumes discussed on Worksheets #19 and #30.
- ***Spatial Boundaries***—Lateral boundaries were determined from historical aerial photographs, maps showing building locations and uses, and previous soil and groundwater investigation results. The lateral boundary for the sub-slab soil vapor and indoor air sampling consists of Building 1037, which is currently in use as Range Control for CJAG. Current boundaries of these areas are presented on the Worksheet #17 figures.
- ***Temporal Boundaries***—The schedule for the VI study field activities is provided on Worksheets #14 and #16. The field activities will be conducted during the portions of the year when weather conditions are favorable for onsite work. The temporal boundaries begin when the indoor air canisters and sub-slab sampling ports are installed and end when the sample collection is completed at least 24 hours later. The indoor air samples will take 8 hours to collect. Both the indoor air and sub-slab soil vapor sampling will be conducted during two different seasons. If feasible, air data will be collected under desirable sampling conditions that will result in the highest potential concentrations (e.g., dry soil and closed doors and windows), as described in Table 2 of Ohio EPA's *Sample Collection and Evaluation of Vapor Intrusion to Indoor Air for Remedial Response, Resource Conservation and Recovery Act, and Voluntary Action Programs* (Ohio EPA 2020a).
- ***Chemical Boundaries***—The chemical boundaries for indoor air and/or soil vapor sampling are limited to analysis of VOCs for air by TO-15.

11.1.5 Step 5: Develop the Analytic Approach

The following activities will be performed as part of the analytic approach to support the CC RVAAP-69 Building 1048 Fire Station VI study at Building 1037:

- Developing a site-specific CSM to identify potential contaminant source(s), release and transport mechanisms, exposure media, exposure routes, and potentially exposed populations.

The CSM will be updated, as necessary, as part of the CC RVAAP-69 Building 1048 Fire Station FS Report.

- Conducting indoor air and/or sub-slab soil vapor sampling to determine if the VI pathway poses a potential unacceptable risk for Building 1037 occupants.
- Potential risk from VI into a current commercial building and hypothetical future residential buildings will be evaluated using USEPA VISLs (https://www.epa.gov/vaporintrusion/vapor-intrusion-screening-levels-visls) for air and soil vapor. Results of the data screening will be used to conduct an HHRA.

The decision rule for sampling data for each building is provided below:

- If VOCs are detected, depending on location and concentrations, additional investigation or evaluation may be warranted. (Additional sampling points and/or samples may be required.)

11.1.6 Step 6: Specify the Performance and Acceptance Criteria

Performance and acceptance will be achieved through application of the QA/QC methods and procedures outlined within this UFP-QAPP, and ultimately determined through USACE approval of and regulatory concurrence with the final results, as presented in the VI study.

The following performance and acceptance criteria will be used during VI study activities:

- The Field Manager will complete the daily standardized PPE/equipment checklist (provided in the SOP).
- The Field Manager will verify that field procedures defined in this UFP-QAPP are properly followed daily during fieldwork. The QA/QC Officer or designee will verify field procedures are being conducted appropriately through field audits. Any deviations will be addressed and documented promptly.
- The laboratories will adhere to analytical performance/acceptance criteria per method as detailed in the DoD QSM Version 5.4 ([DoD 2021] or most current) and defined on Worksheet #12.
- One hundred percent of the data will be validated at a minimum of Stage 2B, and 10 percent of the data will be validated at Stage 4 with recalculations of appropriate data by a qualified chemist, as detailed on Worksheet #36. A DUA of the validated data will be performed, as described on Worksheet #37. The results of the DUA will be included in the VI Study Report and will identify the limitations of the data and the effect qualified results have on decision making. USACE will then evaluate the DUA for final approval. Data completeness of 90 percent usable data is required. USACE will review and accept the VI Study Report prior to submittal for regulatory review and approval.

11.1.7 Step 7: Develop the Details Plan for Obtaining Data

Worksheet #17 provides the basis for proposed sampling, with individual sample details provided on Worksheet #18. Worksheets #19, #20, #24 through #28, and #30 provide specific design analytical requirements.

11.2 GROUNDWATER SAMPLING

11.2.1 Step 1: State the Problem

Groundwater samples from CC RVAAP-69 Building 1048 Fire Station analyzed for carbon tetrachloride and chloroform were collected from March 2018 to May 2021. More recent data are needed to supplement the FS Report associated with this site.

11.2.2 Step 2: Identify the Goals of the Study

The goal of the groundwater sampling event is to bolster the groundwater data set associated with CC RVAAP-69 Building 1048 Fire Station to supplement the FS Report.

The following study question will be addressed during this study:

- Are current or future receptors exposed to carbon tetrachloride and/or chloroform in groundwater at concentrations that pose unacceptable risks?

The alternative outcomes for this study are as follows:

- Carbon tetrachloride and/or chloroform are detected in groundwater samples, and the detections exceed the PALs presented on Worksheet #15.
- Carbon tetrachloride and/or chloroform are detected in groundwater samples, but the detections are less than the PALs presented on Worksheet #15.
- Carbon tetrachloride and/or chloroform are not detected in groundwater samples.

11.2.3 Step 3: Identify Information Inputs

Primary information inputs on this project will include:

- Historical and site-specific information through document reviews, site planning visits, and conference calls. This includes secondary data listed on Worksheet #13.
- Feedback from regulators obtained during UFP-QAPP scoping sessions and field scoping sessions that will share status updates, provide results, solicit input, foster collaboration, and achieve consensus.
- Analytical results of the groundwater sampling outlined on Worksheets #17 and #18.
- Field observations made during preliminary site visits and execution of field activities per this UPF-QAPP.

11.2.4 Step 4: Define the Boundaries of the Study

This section defines the project’s target populations, defines the spatial and temporal boundaries, and specifies the target analytes:

- ***Target Populations***
    - For the groundwater sampling, the target population consists of the detected carbon tetrachloride and/or chloroform concentrations.

  - A sampling unit from this target population would correspond to each decision unit and its associated sample volumes discussed on Worksheets #19 and #30.
- ***Spatial Boundaries***—Lateral boundaries were determined from historical aerial photographs, maps showing building locations and uses, and previous soil and groundwater investigation results. The lateral boundary for the groundwater sampling consists of the area surrounding and downgradient from CC RVAAP-69 Building 1048 Fire Station (which includes CC RVAAP-74 Building 1034 Motor Pool Hydraulic Lift). The vertical boundary for the investigation is the depth to groundwater. Current boundaries of these areas are presented on the Worksheet #17 figures.
- ***Temporal Boundaries***—The schedule for the field activities is provided on Worksheets #14 and 16. Groundwater sampling will be conducted concurrently with one of the indoor air and sub-slab soil vapor sampling events.
- ***Chemical Boundaries***—The chemical boundaries for groundwater sampling are limited to analysis of VOCs for groundwater by SW-846 8260.

11.2.5 Step 5: Develop the Analytic Approach

The following activities will be performed as part of the analytic approach to support the groundwater sampling:

- Developing a site-specific CSM to identify potential contaminant source(s), release and transport mechanisms, exposure media, exposure routes, and potentially exposed populations. The CSM will be updated, as necessary, as part of the CC RVAAP-69 Building 1048 Fire Station FS Report.
- Conducting groundwater sampling to bolster the dataset that will be used in the FS Report.

The decision rule for sampling data is provided below:

- If carbon tetrachloride and/or chloroform exceed MCLs, the recommendation for remediation in an FS Report may be further bolstered.

11.2.6 Step 6: Specify the Performance and Acceptance Criteria

Performance and acceptance will be achieved through application of the QA/QC methods and procedures outlined within this UFP-QAPP and ultimately determined through USACE approval of and regulatory concurrence with the final results, as presented in the FS Report.

The following performance and acceptance criteria will be used during groundwater sampling activities:

- The Field Manager will complete the daily standardized PPE/equipment checklist (provided in the SOP).
- The Field Manager will verify that field procedures defined in this UFP-QAPP are properly followed daily during fieldwork. The QA/QC Officer or designee will verify field procedures

are being conducted appropriately through field audits. Any deviations will be addressed and documented promptly.

- The laboratories will adhere to analytical performance/acceptance criteria per method as detailed in the DoD QSM Version 5.4 ([DoD 2021] or most current) and defined on Worksheet #12.
- One hundred percent of the data will be validated at a minimum of Stage 2B, and 10 percent of the data will be validated at Stage 4 with recalculations of appropriate data by a qualified chemist, as detailed on Worksheet #36. A DUA of the validated data will be performed, as described on Worksheet #37. The results of the DUA will be included in the FS Report and will identify the limitations of the data and the effect qualified results have on decision making. The DUA then will be evaluated by USACE for final approval. Data completeness of 90 percent usable data is required. USACE will review and accept the FS Report prior to submittal for regulatory review and approval.

11.2.7 Step 7: Develop the Details Plan for Obtaining Data

Worksheet #17 provides the basis for proposed sampling, with individual sample details provided on Worksheet #18. Worksheets #19, #20, #24 through #28, and #30 provide specific design analytical requirements.

AOC = Area of Concern
CJAG = Camp James A. Garfield
CSM = Conceptual Site Model
DoD = U.S. Department of Defense
DQO = Data Quality Objective
DUA = Data Usability Assessment
FS = Feasibility Study
HHRA = Human Health Risk Assessment
MCL = Maximum Concentration Limit
Ohio EPA = Ohio Environmental Protection Agency
PAL = Project Action Limit
PPE = Personal Protective Equipment
QA = Quality Assurance
QC = Quality Control
QSM = Quality Systems Manual
SOP = Standard Operating Procedure
UFP-QAPP = Uniform Federal Policy-Quality Assurance Project Plan
USACE = U.S. Army Corps of Engineers
USEPA = U.S. Environmental Protection Agency
VI = Vapor Intrusion
VISL = Vapor Intrusion Screening Level
VOC = Volatile Organic Compound

QAPP Worksheet #12 – Measurement Performance Criteria

Matrix: Aqueous **Analytical Group:** VOCs **Concentration Level:** Low to High		
Data Quality Indicator	**QC Sample and/or Activity Used to Assess Measurement Performance**	**Measurement Performance Criteria**
Overall Precision	Field duplicate	RPD ≤30 percent when detected in both samples ≥5× sample-specific LOQ. If one or both results are <5× sample-specific LOQ, then criteria is the absolute difference between results ≤3× sample-specific LOQ.
Analytical Precision Laboratory and Matrix Effects – MSD	MSD	Percent recovery per QSM 5.4, Table C-24. RPD ≤20%.
Analytical Accuracy/Bias Laboratory – LCS Laboratory and Matrix Effects – MS	LCS/MS	Percent recovery per QSM 5.4, Table C-24.
Laboratory Accuracy/Bias (Contamination)	Method blank	No target analyte concentrations ≥1/2 LOQ or >1/10 sample concentration or >1/10 regulatory limit, whichever is greater. No common laboratory contaminants >LOQ.
Analytical Accuracy/Bias	Surrogate	See QSM 5.4, Table C-24.
Analytical Accuracy/Bias	IS	Retention time ±10 seconds. Area within -50 to +100 percent of midpoint standard in ICAL.
Accuracy/ Contamination	Field blank, trip blank, rinsate blank	No detected target compounds at concentrations ≥1/2 LOQ or >1/10 sample concentration.
Sensitivity	Lowest calibration standard	See Worksheet #15.
Completeness	Number of valid data points attained versus the planned number	90 percent. Completeness will be evaluated for each AOC.

QAPP Worksheet #12 – Measurement Performance Criteria (Continued)

Matrix: Gaseous		
Analytical Group: VOCs		
Concentration Level: Low to High		
Data Quality Indicator	**QC Sample and/or Activity Used to Assess Measurement Performance**	**Measurement Performance Criteria**
Overall Precision	Field duplicate (split sample)	RPD ≤50 percent.
Precision	LCS/LCSD	Percent recovery per QSM 5.4, Table C-43. RPD <30%.
Accuracy	LCS/LCSD	Percent recovery per QSM 5.4, Table C-43.
Accuracy/Bias (Contamination)	Method blank (and field blanks)	No target analyte concentrations ≥1/2 LOQ. No common laboratory contaminants >LOQ.
Accuracy	Surrogate	70 to 130 percent recovery or per laboratory control limits.
Sensitivity	Lowest calibration standard	See Worksheet #15.
Completeness	Number of valid data points attained versus the planned number	>90 percent.

AOC = Area of Concern
ICAL = Initial Calibration
IS = Internal Standard
LCS = Laboratory Control Sample
LCSD = Laboratory Control Sample Duplicate
LOQ = Limit of Quantitation
MS = Matrix Spike
MSD = Matrix Spike Duplicate
QC = Quality Control
QSM = Quality Systems Manual
RPD = Relative Percent Difference
VOC = Volatile Organic Compound

QAPP Worksheet #13 – Secondary Data Uses and Limitations

Data Type	Source	Data Use	Factors Affecting the Reliability of Data and Limitations on Data Use
Facility background information and operational history	SAIC 2011a. *Historical Records Review Report for the 2010 Phase I Remedial Investigation Services at Compliance Restoration Sites (9 Areas of Concern), Ravenna Army Ammunition Plant, Ravenna, Ohio*. December. ECC 2015b. *Final Site Inspection Report CC RVAAP-72 Facility -Wide Underground Storage Tanks, Revision 0, Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties*, July. USACE 2023. *Remedial Investigation for CC RVAAP-69 Building 1048 Fire Station, Ravenna Army Ammunition Plant Restoration Program, Portage and Trumbull Counties*, February.	Contribute to the understanding of historical activities at CJAG and corresponding restoration activities.	• Ongoing evaluation and refinement of knowledge pertaining to the facility-wide CSM, groundwater flow, and bedrock layers. • Interviews conducted with persons with inadequate knowledge of site history. • Personnel who were present at the time of critical events were not available for an interview. • Possible unreported releases.
Historical data, including site photographs and aerial photographs	SAIC 2011a. *Historical Records Review a Report for the 2010 Phase I Remedial Investigation Services at Compliance Restoration Sites (9 Areas of Concern), Ravenna Army Ammunition Plant, Ravenna, Ohio*. December. ECC 2015b. *Final Site Inspection Report CC RVAAP-72 Facility -Wide Underground Storage Tanks, Revision 0, Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties*, July. USACE 2023. *Remedial Investigation for CC RVAAP-69 Building 1048 Fire Station, Ravenna Army Ammunition Plant Restoration Program, Portage and Trumbull Counties*, February.	Contribute to the understanding of historical activities and site conditions as they pertain to potential and/or known contamination source areas.	• Potential errors in reported analytical or survey data. • Potential errors in data outputs provided by REIMS.

QAPP Worksheet #13 – Secondary Data Uses and Limitations (Continued)

Data Type	Source	Data Use	Factors Affecting the Reliability of Data and Limitations on Data Use
Existing hydrologic/geologic/ hydrogeologic studies	Facility-Wide Groundwater Monitoring Program	Hydrologic, geologic, and hydrogeologic characterization, inclusive of detailed drawings and hydrogeologic cross-sections, to help understand groundwater flow at CJAG and individual sites.	• Ongoing evaluation and refinement of knowledge pertaining to the facility-wide CSM, groundwater flow, and bedrock layers. • Potential errors in reported historical data.
Interviews	SAIC 2011a. *Historical Records Review a Report for the 2010 Phase I Remedial Investigation Services at Compliance Restoration Sites (9 Areas of Concern), Ravenna Army Ammunition Plant, Ravenna, Ohio*. December.	Contribute to the understanding of historical activities and site conditions as they pertain to potential and/or known source areas and/or releases to environmental media.	• Interviews conducted with persons with inadequate knowledge of site history. • Personnel that were present at the time of critical events were not available for an interview. • Possible unreported releases.
Analytical data collected during prior investigations	ECC 2015. *Final Site Inspection Report CC RVAAP-72 Facility -Wide Underground Storage Tanks, Revision 0, Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties,* July. USACE 2023. *Remedial Investigation for CC RVAAP-69 Building 1048 Fire Station, Ravenna Army Ammunition Plant Restoration Program, Portage and Trumbull Counties,* February.	Contribute to the understanding of VOCs in environmental media throughout CC RVAAP-69.	• Potential errors in reported analytical or survey data. • Potential errors in data outputs provided by REIMS. • Variations of VOC screening levels during the PA, SI, and RI.

CJAG = Camp James A. Garfield
CSM = Conceptual Site Model
PA = Preliminary Assessment
REIMS = Ravenna Environmental Information Management System
RI = Remedial Investigation
RVAAP = Ravenna Army Ammunition Plant
SI = Site Inspection
VOC = Volatile Organic Compound

QAPP Worksheets #14 and #16 – Project Tasks & Schedule

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s)	Deliverable Due Date
Field Schedule Coordination	Leidos/Army	3/5/2024	4/3/2024	N/A	N/A
Field Mobilization	Leidos	4/4/2024	4/5/2024	N/A	N/A
Vapor Intrusion Seasonal Event 1					
Field Sampling	Leidos	4/6/2024	4/12/2024	Field Notes Field Scoping Session Summaries VI Study Appendix to FS Report	3/5/2025
Laboratory Analysis	WWA	4/13/2024	5/12/2024	Laboratory EDDs	3/5/2025
Data Validation	Leidos	5/13/2024	6/1/2024	REIMS Data Submittal	6/1/2024
Data Usability	Leidos	5/13/2024	6/1/2024	Data Usability Reports VI Study Appendix to FS Report	3/5/2025
Vapor Intrusion Seasonal Event 2					
Field Sampling	Leidos	10/10/2024	10/16/2024	Field Notes Field Scoping Session Summaries VI Study Appendix to FS Report	3/5/2025
Laboratory Analysis	WWA	10/17/2024	11/15/2024	Laboratory EDDs	3/5/2025
Data Validation	Leidos	11/16/2024	12/5/2024	REIMS Data Submittal	12/5/2024
Data Usability	Leidos	11/16/2024	12/5/2024	Data Usability Reports VI Study Appendix to FS Report	3/5/2025
Groundwater Sampling					
Sample Collection	Leidos	4/6/2024	4/12/2024	Field Notes Field Scoping Session Summaries VI Study Appendix to FS Report	3/5/2025
Laboratory Analysis	WWA	4/13/2024	5/12/2024	Laboratory EDDs	3/5/2025
Data Validation	Leidos	5/13/2024	6/1/2024	REIMS Data Submittal	6/1/2024
Data Usability	Leidos	5/13/2024	6/1/2024	Data Usability Reports VI Study Appendix to FS Report	3/5/2025

EDD = Electronic Data Deliverable
FS = Feasibility Study
N/A = Not Applicable
REIMS = Ravenna Environmental Information Management System
VI = Vapor Intrusion
WWA = White Water Associates

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QAPP Worksheet #15 – Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

15.1 VOCs IN GASEOUS MATRIX

Analyte	CAS Number	Indoor Air SL (mg/m^3)	Sub-Slab and Near Source SL (mg/m^3)	Achievable Laboratory Limits (mg/m^3)		
				DL	LOD	LOQ
1,1,1-Trichloroethane	71-55-6	0.521	17.4	0.00051	0.0014	0.0027
1,1,2,2-Tetrachloroethane	79-34-5	0.0000484	0.002	***0.00063***	***0.0026***	***0.0034***
1,1,2-Trichloroethane	79-00-5	0.0000209	0.001	***0.0004***	***0.002***	***0.0027***
1,1-Dichloroethane	75-34-3	0.00175	0.059	0.00042	0.001	***0.002***
1,1-Dichloroethene	75-35-4	0.0209	0.695	0.0005	0.0015	0.002
1,2-Dibromoethane (EDB)	106-93-4	0.00000468	0.0002	***0.00088***	***0.0029***	***0.0038***
1,2-Dichloroethane	107-06-2	0.000108	0.004	***0.00047***	***0.0015***	***0.002***
1,2-Dichloropropane	78-87-5	0.000417	0.014	***0.00045***	***0.0017***	***0.0023***
2-Butanone	78-93-3	0.521	17	0.00051	0.0053	0.0059
2-Hexanone	591-78-6	0.00313	0.104	0.0029	***0.0074***	***0.0082***
4-Methyl-2-pentanone	108-10-1	0.313	10	0.0012	0.0015	0.002
Acetone	67-64-1	N/A	N/A	0.0044	0.0059	0.012
Benzene	71-43-2	0.00036	0.012	0.00035	***0.0012***	***0.0016***
Bromobenzene	108-86-1	0.00626	0.209	N/A	N/A	***0.013***
Bromodichloromethane	75-27-4	0.0000759	0.003	***0.0006***	***0.0017***	***0.0034***
Bromoform	75-25-2	0.00255	0.085	0.0013	***0.0039***	***0.0052***
Bromomethane	74-83-9	0.000521	0.017	***0.0058***	***0.007***	***0.019***
Carbon Disulfide	75-15-0	0.073	2.4	0.0048	0.0056	0.0062
Carbon Tetrachloride	56-23-5	0.000468	0.016	***0.00058***	***0.0024***	***0.0031***
Chlorobenzene	108-90-7	0.00521	0.174	0.00035	0.0012	0.0023
Chlorobromomethane	74-97-5	0.00417	0.139	NA	NA	NA
Chloroethane	75-00-3	0.417	14	0.0017	0.0047	0.0053
Chloroform	67-66-3	0.000122	0.004	***0.00038***	***0.0012***	***0.0024***
Chloromethane	74-87-3	0.00939	0.313	0.0016	0.0037	***0.01***
cis-1,2-Dichloroethene	156-59-2	0.00417	0.139	0.00044	0.0015	0.002
cis-1,3-Dichloropropene	10061-01-5	0.000702[a]	0.023[a]	0.00057	***0.0017***	***0.0023***
Dibromochloromethane	124-48-1	N/A	N/A	0.00089	0.0032	0.0043
Ethylbenzene	100-41-4	0.00112	0.037	0.00049	***0.0016***	***0.0022***
Methylene Chloride	75-09-2	0.0626	2.1	0.0012	0.0059	0.017
m,p-Xylene	179601-23-1	0.0104[b]	0.348[b]	0.00076	0.0016	0.0022

15.1 VOCs IN GASEOUS MATRIX (Continued)

Analyte	CAS Number	Indoor Air SL (mg/m^3)	Sub-Slab and Near Source SL (mg/m^3)	Achievable Laboratory Limits (mg/m^3)		
				DL	**LOD**	**LOQ**
o-Xylene	95-47-6	0.0104	0.348	0.0004	0.0016	0.0022
Styrene	100-42-5	0.104	3.5	0.00043	0.0016	0.0021
Tetrachloroethene	127-18-4	0.00417	0.139	0.00064	0.0025	0.0034
Toluene	108-88-3	0.521	17	0.00049	0.0014	0.0019
trans-1,2-Dichloroethene	156-60-5	0.00417	N/A	0.00045	0.0015	0.002
trans-1,3-Dichloropropene	10061-02-6	0.000702[a]	0.023[a]	0.0004	***0.0017***	***0.0023***
Trichloroethene	79-01-6	0.000209	0.007	***0.00059***	***0.002***	***0.0027***
Vinyl Chloride	75-01-4	0.000168	0.006	***0.0003***	***0.00096***	***0.0013***
Xylenes, Total	1330-20-7	0.0104	0.348	0.00076	0.0016	0.00076

Screening levels are for indoor air and sub-slab soil samples.

The screening levels were calculated by USEPA's *Vapor Intrusion Screening Level Calculator*, https://epa-visl.ornl.gov/cgi-bin/visl_search accessed in May 2023, based on an HQ = 0.1 and ILCR = 1 × 10^{-6}.

Achievable laboratory limit exceeds indoor air screening level.

Achievable laboratory limit exceeds sub-slab and near-source screening level.

[a] 1,3-Dichloropropene used as surrogate.

[b] m-Xylene used as a surrogate.

CAS = Chemical Abstracts Service
DL = Detection Limit
HQ = Hazard Quotient
LCR = Incremental Lifetime Cancer Risk
LOD = Limit of Detection
LOQ = Limit of Quantitation
mg/m^3 = Milligrams per Cubic Meter
N/A = Screening level not available for this analyte.
SL = Screening Level
VOC = Volatile Organic Compound

15.2 VOCs IN AQUEOUS MATRIX

Analyte	CAS Number	Screening Level (µg/L)	Achievable Laboratory Limits (µg/L)		
			DL	LOD	LOQ
1,1,1-Trichloroethane	71-55-6	742	0.300	0.600	1.00
1,1,2,2-Tetrachloroethane	79-34-5	3.23	0.300	0.600	1.00
1,1,2-Trichloroethane	79-00-5	0.619	0.300	0.600	***1.00***
1,1-Dichloroethane	75-34-3	7.64	0.300	0.600	1.00
1,1-Dichloroethene	75-35-4	19.5	0.300	0.600	1.00
1,2-Dibromoethane (EDB)	106-93-4	0.176	***0.200***	***0.500***	***1.00***
1,2-Dichloroethane	107-06-2	2.24	0.300	0.600	1.00
1,2-Dichloropropane	78-87-5	3.62	0.300	0.600	1.00
2-Butanone	78-93-3	224000	0.500	1.00	10.0
2-Hexanone	591-78-6	821	0.850	1.70	10.0
4-Methyl-2-pentanone	108-10-1	55500	0.500	1.00	10.0
Acetone	67-64-1	N/A	0.700	2.00	20.0
Benzene	71-43-2	1.59	0.300	0.600	1.00
Bromobenzene	108-86-1	62	0.300	0.600	5.00
Bromodichloromethane	75-27-4	0.876	0.200	0.500	***1.00***
Bromoform	75-25-2	117	1.00	2.00	4.00
Bromomethane	74-83-9	1.74	0.300	0.600	1.00
Carbon Disulfide	75-15-0	124	0.300	0.600	5.00
Carbon Tetrachloride	56-23-5	0.415	0.300	***0.600***	***1.00***
Chlorobenzene	108-90-7	41	0.300	0.600	1.00
Chlorobromomethane	74-97-5	69.9	0.200	0.500	5.00
Chloroethane	75-00-3	919	0.200	0.500	1.00
Chloroform	67-66-3	0.814	0.300	0.600	***1.00***
Chloromethane	74-87-3	26	0.550	1.10	2.00
cis-1,2-Dichloroethene	156-59-2	25	0.30	0.60	1.0
cis-1,3-Dichloropropene	10061-01-5	4.84[a]	0.200	0.500	1.00
Dibromochloromethane	124-48-1	N/A	0.200	0.500	1.00
Ethylbenzene	100-41-4	3.49	0.400	0.800	1.00
Methylene Chloride	75-09-2	471	0.300	0.600	1.00
m,p-Xylene	179601-23-1	35.5[b]	0.400	0.800	1.00
o-Xylene	95-47-6	49.2	0.200	0.400	0.50
Styrene	100-42-5	928	0.300	0.600	5.00
Tetrachloroethene	127-18-4	5.76	0.300	0.600	1.00
Toluene	108-88-3	1920	0.200	0.500	1.00

15. 2 VOCs IN AQUEOUS MATRIX (Continued)

Analyte	CAS Number	Screening Level (µg/L)	Achievable Laboratory Limits (µg/L)		
			DL	LOD	LOQ
trans-1,2-Dichloroethene	156-60-5	10.9	0.70	1.4	2.0
trans-1,3-Dichloropropene	10061-02-6	4.84[a]	0.200	0.500	1.00
Trichloroethene	79-01-6	0.518	0.300	***0.600***	***1.00***
Vinyl Chloride	75-01-4	0.147	***0.200***	***0.500***	***1.00***
Xylenes, Total	1330-20-7	38.5	0.400	0.800	1.00

Screening levels are for groundwater samples.
The screening levels were calculated by the *Vapor Intrusion Screening Level Calculator* (USEPA 2023) based on an HQ = 0.1 and ILCR = 1 × 10^{-6}.
Achievable laboratory limit exceeds Target Groundwater Concentration Screening Level.
[a] 1,3-Dichloropropane used as surrogate.
[b] m-Xylene used as a surrogate.

CAS = Chemical Abstracts Service
DL = Detection Limit
HQ = Hazard Quotient
ILCR = Incremental Lifetime Cancer Risk
LOD = Limit of Detection
LOQ = Limit of Quantitation
N/A = Screening level not available for this analyte.
VOC = Volatile Organic Compound

QAPP Worksheet #17 − Sampling Design and Rationale

17.1 INTRODUCTION

This worksheet provides a detailed summary of the investigation design and includes the rationale used to develop the approach. The soil vapor and groundwater sampling will investigate areas listed on Worksheet #10. All samples will be analyzed for the VOCs specified on Worksheet #15.

17.2 SAMPLING AREAS AND RATIONALE

The sampling design and rationale were developed to characterize the indoor air, the sub-slab soil vapor beneath the foundation of Building 1037, and the groundwater at and downgradient from CC RVAAP-69 Building 1048 Fire Station. The sampling design is intended to satisfy the DQOs presented in UFP-QAPP Worksheet #11.

Indoor air and sub-slab soil vapor samples are planned to be collected within Building 1037 during a single sampling event. A second seasonal sampling event will be conducted to assess temporal and spatial variations at the site for any VOC constituents that are detected during the first event. The specific locations of each environmental sample are presented for Building 1037 in Figure 17-1. The sample locations are based on guidance presented in Ohio EPA's *Sample Collection and Evaluation of Vapor Intrusion to Indoor Air for Remedial Response, Resource Conservation and Recovery Act and Voluntary Action Programs* (Ohio EPA 2020a). Specific samples and justification for the proposed sampling locations are presented in Table 17-1.

Table 17-1. Building 1037 Proposed Sample Design and Rationale

Sample Area	Location	Rationale
Building 1037 Sub-slab (Quantity 5 presented in Figure 17-1)	Sub-slab soil vapor sample locations proposed to provide data to determine if any VOC constituents are present and if so, identify any potential VI pathways. Building 1037 is less than 5,000 ft^2; therefore, per Ohio EPA guidance, biased sample locations are not necessary (Ohio EPA 2020a).	• Sample 069vp-001 proposed to determine the presence of any VOC vapors beneath the building. • Sample 069vp-002 proposed to determine the presence of any VOC vapors beneath the building. • Sample 069vp-003 proposed to determine the presence of any VOC vapors beneath the building. • Sample 069vp-004 proposed to determine the presence of any VOC vapors beneath the building. • Sample 069vp-005 proposed to determine the presence of any VOC vapors beneath the building. • Prior to sub-slab vapor point installation, preferential pathways, such as floor drains, sumps, and utility corridors, identified during utility clearance procedures, will be used to guide the final selection of the exact sub-slab vapor point location.

Table 17-1. Building 1037 Proposed Sample Design and Rationale (Continued)

Sample Area	Location	Rationale
Indoor Air (Quantity 1)	Indoor air collected inside Building 1037.	• Sample location 069vp-006 proposed to characterize indoor background air inside the building where the sub-slab samples are being collected.
Ambient Air (Quantity 1)	Ambient air collected upgradient of Building 1037.	• Sample location 069vp-007 proposed to characterize atmospheric/upgradient background air outside the buildings where the indoor air and sub-slab samples are being collected. Ohio EPA requires that ambient air samples be collected when collecting indoor air samples (Ohio EPA 2020a).

Ohio EPA = Ohio Environmental Protection Agency
VI = Vapor Intrusion
VOC = Volatile Organic Compound

One round of groundwater samples will be collected from the 14 existing monitoring wells associated with CC RVAAP-69 Building 1048 Fire Station. The CC RVAAP-74 Building 1034 Motor Pool Hydraulic Lift AOC is approximately 500 feet southeast of and downgradient from the CC RVAAP-69 Building 1048 Fire Station AOC. According, one round of groundwater samples will be collected at the three existing monitoring wells associated with the CC RVAAP-74 Building 1034 Motor Pool Hydraulic Lift AOC, and the samples will be analyzed for VOCs. The specific locations of the monitoring wells are shown in Figures 17-2 and 17-3.

17.3 SAMPLING OVERVIEW

The following sections detail the sample naming conventions, sample locations, and types of samples planned for the CC RVAAP-69 Building 1048 Fire Station VI study at Building 1037 and groundwater sampling event. Table 17-2 summarizes the proposed samples and rationale for VI and groundwater sampling. Each sample collected during the field effort will be analyzed for the VOCs specified on Worksheet #15 and will receive a unique sample number, as listed on Worksheet #18. The number for each groundwater and VI sample will be in the pattern 0##ZZ-LOC-####-YY.

Where:

- 0## = Three-digit REIMS identification code and site number (e.g., 069 = RVAAP-069, 074=RVAAP-074)
- ZZ = Sample collection method
  - mw = Monitoring well
  - vp = Vapor point
- LOC = Three-digit sequential location ID
- #### = Sequence number for the sample at the location
- YY = Sample matrix type
  - GW = Groundwater sample
  - SG = Soil vapor sample
  - AA = Ambient air (outdoor) sample

  - IA = Indoor ambient air sample
  - Soil vapor is planned to be sampled during two separate seasonal events
  - Duplicate (vapor split) samples will include a 'D' following the sequence (i.e., -001D)
  - MS/MSD samples will include 'MS' or 'MSD' following the sequence number (e.g., 001MSD).
- Example: 069vp-002-0001-SG
  - 069 = Sample collected from AOC: RVAAP-069
  - vp = Sample was collected from a vapor point
  - 002 = Vapor point location 002 within the AOC
  - 0001 = First vapor sample collected from the location
  - SG = Sample collected to analyze soil vapors.
  - AOC = Area of Concern

DQO = Data Quality Objective
ID = Identifier
MS = Matrix Spike
MSD = Matrix Spike Duplicate
Ohio EPA = Ohio Environmental Protection Agency
REIMS = Ravenna Environmental Information Management System
UFP-QAPP = Uniform Federal Policy-Quality Assurance Project Plan
VI = Vapor Intrusion
VOC = Volatile Organic Compound

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Table 17-2. Summary of Proposed Sampling in Each Medium

RVAAP AOC	Site Name	Existing Groundwater Wells	New Vapor Sampling			Samples to Be Collected Twice	Rationale
			New Vapor Points	Indoor Ambient	Outdoor Ambient		
N/A	Building 1037	N/A	5	1	1	7	Proposed to determine the presence of any VOC vapors beneath Building 1037
CC RVAAP-69	Building 1048 Fire Station	14	N/A	N/A	N/A	N/A	Proposed as due diligence to determine the presence of groundwater concentrations exceeding VISLs that would cause a concern for potential VOC vapors
CC RVAAP-74	Building 1034 Motor Pool Hydraulic Lift	3	N/A	N/A	N/A	N/A	Proposed as due diligence to determine the presence of groundwater concentrations exceeding VISLs that would cause a concern for potential VOC vapors

Notes:
This table does not include QA/QC samples.
Groundwater will be analyzed once.
Vapor points will be sampled during two seasonal events.

N/A = Not Applicable
QA = Quality Assurance
QC = Quality Control
VISL = Vapor Intrusion Screening Level
VOC = Volatile Organic Compound

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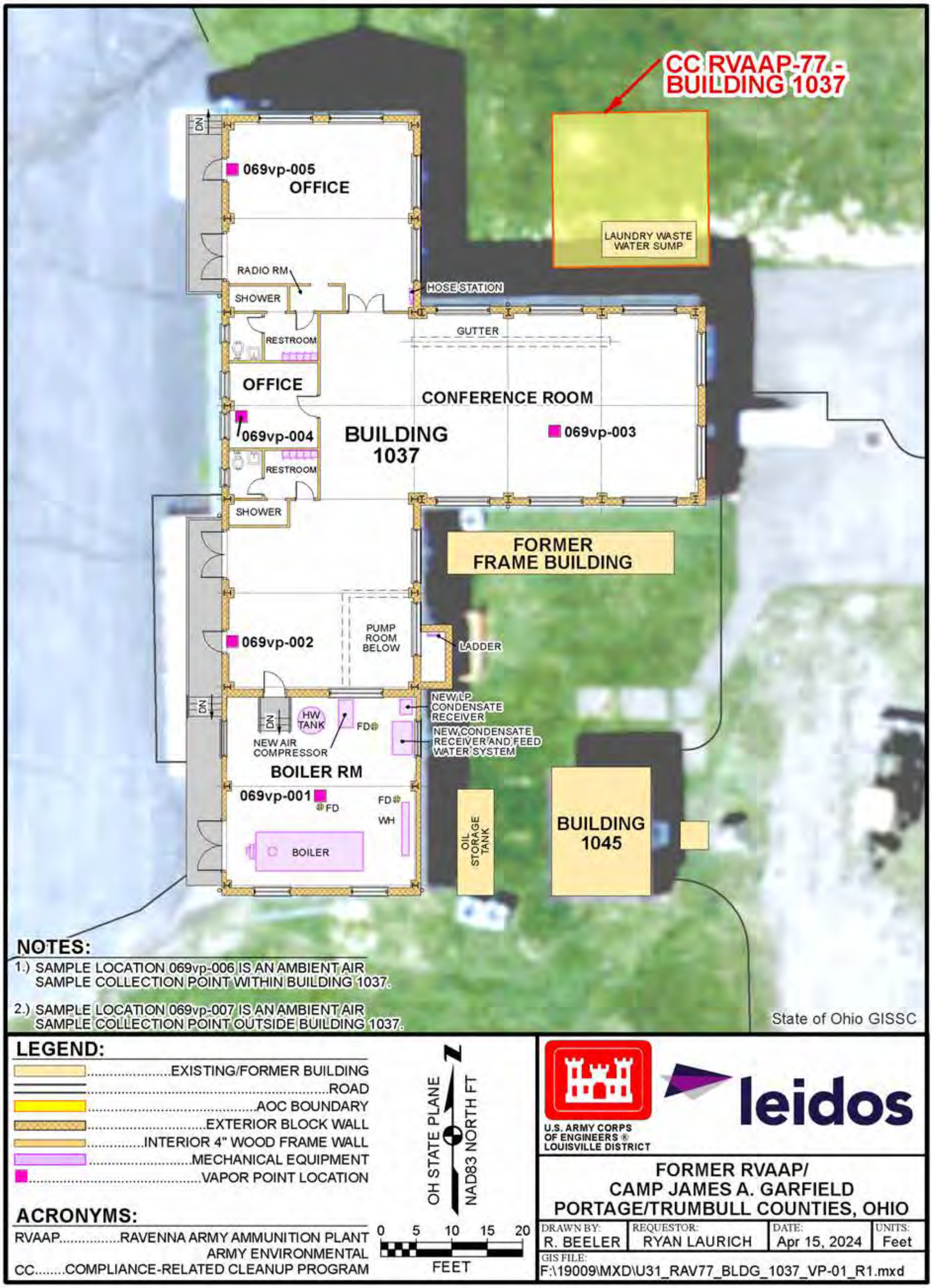

Figure 17-1. Building 1037 Vapor Point Sample Locations

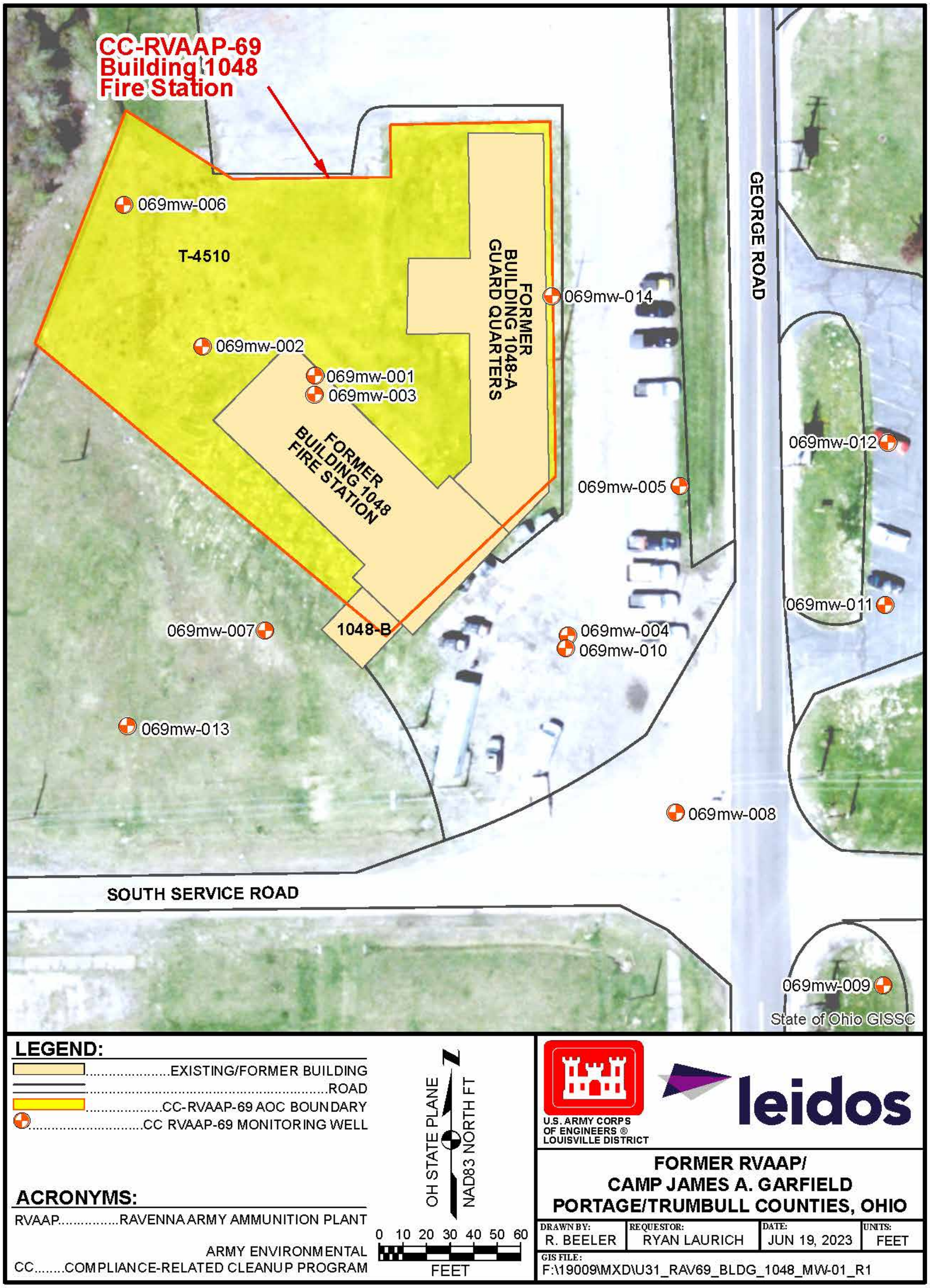

Figure 17-2. CC RVAAP-69 Building 1048 Fire Station – Groundwater Sampling Locations

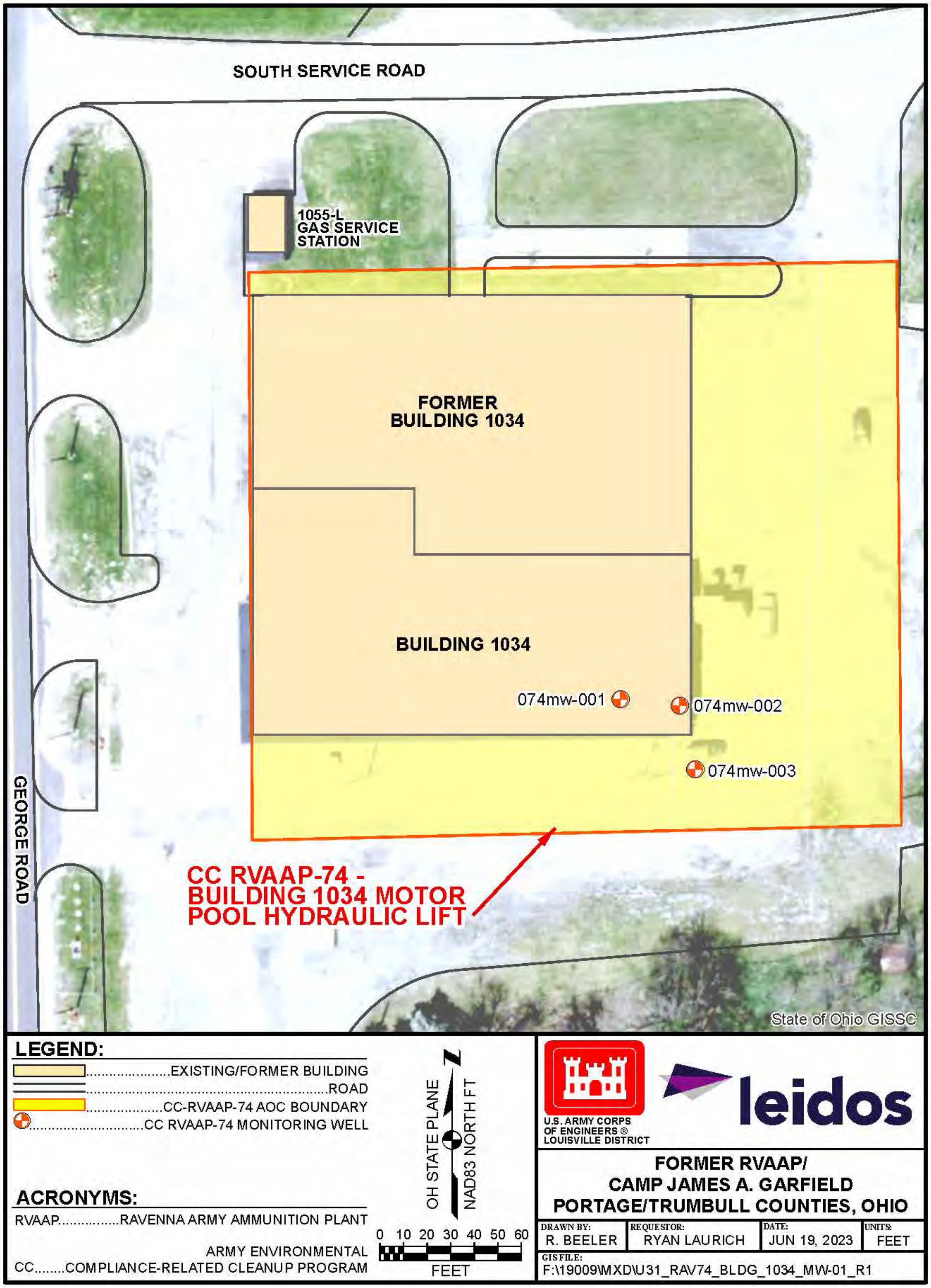

Figure 17-3. CC RVAAP-74 Building 1034 Motor Pool Hydraulic Lift – Groundwater Sampling Locations

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QAPP Worksheet #18 − Sample Locations and Methods

18.1 INTRODUCTION

This worksheet provides the sample location names and investigative methods. Sample locations are presented and discussed on Worksheet #17. Investigative methods are summarized and SOPs are presented after Tables 18-1 through 18-3. Samples will be analyzed for VOCs in accordance with the guidance provided on Worksheets #11, #12, #15, #19, #20, and #30.

18.2 SAMPLE LOCATION NUMBERS AND SAMPLE IDs

This section presents the location numbers for each sample location and sample IDs for all samples proposed, as presented in Tables 18-1 through 18-3. Proposed sample IDs are provided for existing wells; however, a review of previously used sample IDs will be performed in advance of the field mobilization to ensure sample IDs are not duplicated.

18.3 INVESTIGATIVE METHODS

The following sections provide a general overview of the investigative methods and procedures to conduct this investigation. In general, sampling methods are consistent with the *Facility-Wide Sampling and Analysis Plan for Environmental Investigation* (SAIC 2011b).

18.3.1 Access and Coordination

Leidos’ employees are or will become familiar with and obey the regulations of the facility, including emergency, traffic, spill response, environmental, safety, and security regulations, while on the facility. All Leidos field personnel will be HAZWOPER-trained and will provide current certifications to ARNG/OHARNG and the USACE, Louisville District COR. Leidos employees will always carry Government-issued photographic identification and will ensure compliance with all regulations and orders of the facility that may affect performance.

Leidos’ employees will not enter restricted areas unless work activities require entry and only with prior written approval from the CJAG Environmental Office. Leidos will take part in and document any necessary briefings regarding land use controls at a site.

Prior to field activities, Leidos will coordinate with Range Control and UTES maintenance personnel in Building 1034. Leidos will coordinate with Range Control daily during field activities. This coordination includes notifying Range Control when field staff enter and exit CJAG. Leidos will also provide any necessary project schedules and maps to Range Control.

Leidos will conduct fieldwork within the core work hours for contractors. These core work hours are Monday to Friday from 7:30 a.m. to 4:00 p.m., not including Federal holidays. Leidos must request (72 hours in advance) and obtain approval from the CJAG Environmental Office and Range Control for any work at CJAG performed outside these core work hours.

Leidos will coordinate with the ARNG Restoration Program Manager and OHARNG Environmental Specialist for access to the facility and to available infrastructure (e.g., buildings, roadways, other facilities). Leidos will provide sanitary facilities for its employees.

Leidos' work areas will always be kept clean and orderly. Debris and waste material will be cleaned up daily and at the end of the project. The contractor is responsible for containerizing all wastes and trash. Leidos will have spill kits with appropriate absorbents, plastic bags, drums, shovels, and other supplies and equipment suitable to clean up any releases or spills from work activities.

18.3.2 Sub-Slab Soil Vapor

Sub-slab soil vapor sampling will be conducted at Building 1037. Sample locations and IDs are presented in Table 18-1. Soil vapor sample collection will include two seasonal events. An initial sampling event will be conducted immediately following sub-slab monitoring point installation and a second seasonal sampling event also will be conducted. The following sections describe the installation and sampling of sub-slab soil vapor monitoring points.

18.3.2.1 Installation of Sub-Slab Soil Vapor Monitoring Points

The field team will review available drawings and the site to ensure concrete coring and drilling will not impact any building drains. Sub-slab soil vapor point installation will be completed in accordance with Ohio EPA's *Sample Collection and Evaluation of Vapor Intrusion to Indoor Air for Remedial Response, Resource Conservation and Recovery Act, and Voluntary Action Programs* (Ohio EPA 2020a).

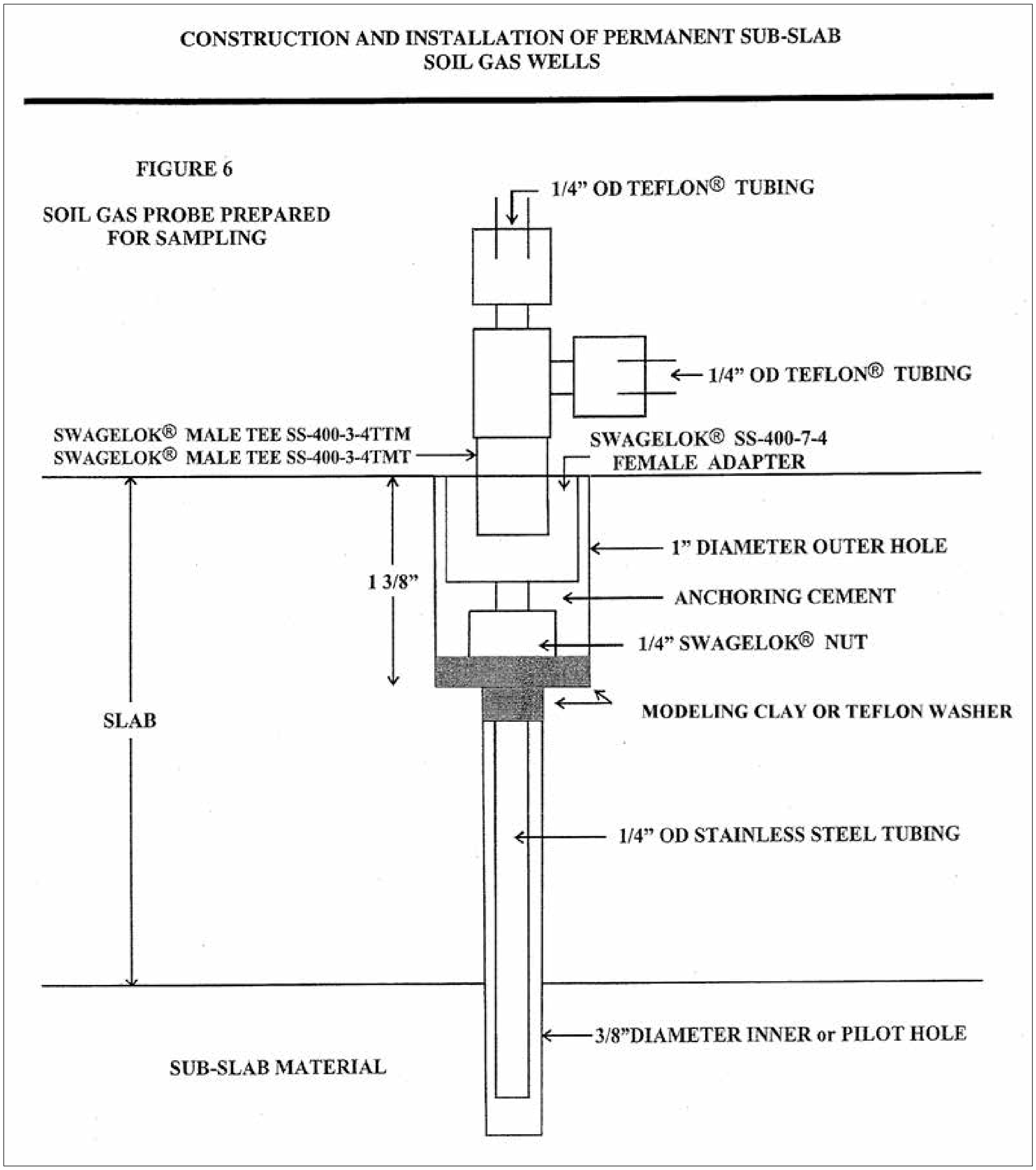
Concrete coring within the building will be accomplished using an electric hammer drill or rotary hammer. Using the hammer drill, a 3/8-inch-diameter pilot hole will be advanced through the concrete slab. A 1-inch-diameter outer hole will be installed to approximately 2 inches below the top of the slab. Carpet or rugs will be moved prior to drilling. If finished flooring (i.e., engineered wood, tile, or polyurethane) is present, it will be carefully removed if possible or drilled through. Sub-slab soil vapor monitoring ports will be assembled using ¼-inch outer diameter stainless steel tubing and Swagelok® connectors, as described in Ohio EPA SOP 2.5.2 (Construction and Installation of Permanent Sub-Slab Soil Gas Ports) (Ohio EPA 2020a). The ports will be installed into the pilot holes, ensuring that the stainless-steel tubing will not be in contact with the sub-slab material, as shown in Figure 18-1. Anchoring cement/grout will be placed around the sample port, and the port will be placed into the pilot boring. Any cement/grout that discharged from the hole will be cleaned and flattened flush with the slab. Cement/grout will be allowed to cure according to the manufacturer's instructions. Installed sub-slab vapor points will be sealed with a stainless steel plug and a plastic cap or a threaded-in stainless steel protective cover. The cover will remain in place after installation and between sampling events.

Water will be used to suppress dust during the concrete coring. Consequently, a small amount of concrete slurry is expected to be generated during the installation. The concrete slurry will be disposed of as municipal waste.

18.3.2.2 Sub-Slab Soil Vapor Sampling

Sampling will be completed a minimum of 24 hours after installation of the sample port to allow for proper curing of the cement/grout.

New Teflon tubing and stainless steel Swagelok® fittings will be used to connect the soil vapor monitoring point to the sampling assembly. All connections between the soil gas probe tubing, sampling assembly, and Summa canister will be inspected to ensure tightness prior to sampling. All vapor points will be sampled within the same 24-hour period. Sampling will not occur after a significant precipitation event (i.e., more than 0.50 inches of rain within 24 hours prior to sampling).



Source: Ohio EPA 2020a

Figure 18-1. Soil Vapor Probe Prepared for Sampling

An example of a soil vapor sampling setup is shown in Figure 18-2. Prior to sampling, vapor points will be purged using a portable vapor purge unit (Gillian Air Plus or similar). Purging will occur for a minimum of three vapor tubing volumes concurrently with helium leak detection. If leaks are not detected using the helium detection method, samples will be collected in a laboratory-supplied Summa canister (VOCs) at a flow rate of approximately 200 mL/min per the laboratory-supplied regulator. Purging conditions, including any concentrations measured, volume purged, and weather conditions, will be documented in the field logbook and/or field logs.

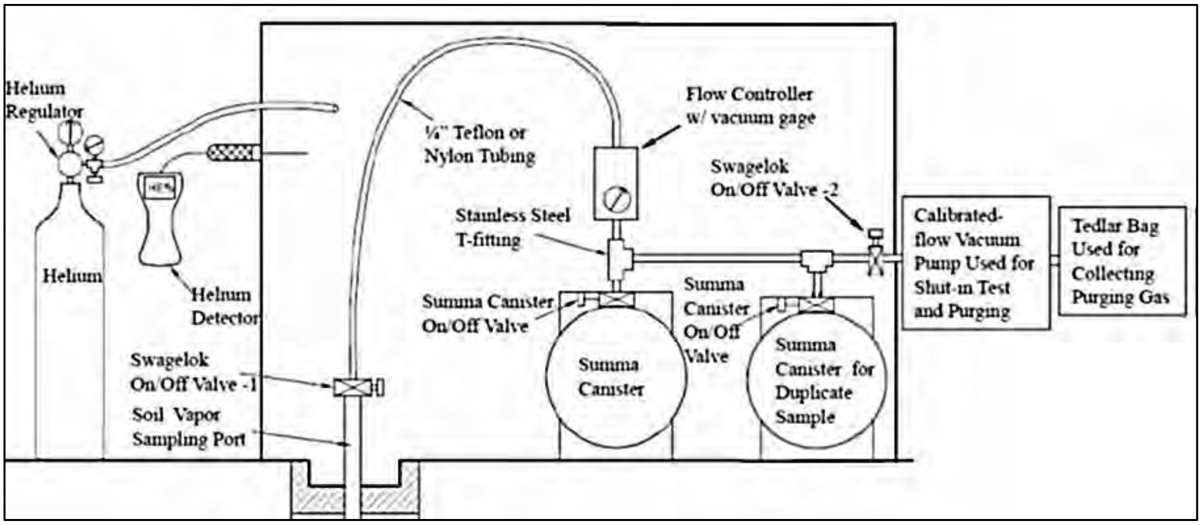


Figure 18-2. Typical Soil Vapor Sampling Setup

18.3.2.3 Sub-Slab Sample Port Abandonment

Upon determination that the sub-slab soil vapor ports are no longer required for investigative or monitoring purposes, the ports will be abandoned by first removing all materials and cement grouting. Removal will be completed with hand tools (i.e., hammer, chisel, and pliers). The pilot hole then will be backfilled with concrete/grout and smoothed flush with the top of the slab.

18.3.3 Ambient Air and Indoor Air

Sub-slab soil vapor and indoor air sampling will be performed in Building 1037. Soil vapor sample collection will include two seasonal events. Ohio EPA recommends that both indoor air and an ambient air sample be paired with sub-slab vapor samples to aid in VI assessment and data interpretation and conclusions (Ohio EPA 2020a).

An indoor ambient air sample will be collected concurrently with sub-slab soil vapor sampling. Indoor air samples will be collected over 8 hours to correspond with an 8-hour workday. A laboratory-supplied Summa canister (VOCs) with a laboratory-supplied regulator. Prior to indoor air sampling, a pre-sampling worker questionnaire will be completed for personnel who work near or around the sample locations to recognize and eliminate potential interferences to the sample collection process.

One ambient air sample will be collected at the same time, and for the approximate same duration (8 hours) as the indoor air samples, per Ohio EPA guidance (Ohio EPA 2020a). A laboratory-supplied

Summa canister (VOCs) will be used for collecting the ambient air sample with a laboratory-supplied regulator. The ambient air sample location will have unrestricted airflow and will be placed upgradient of the site, avoiding areas that will potentially have a negative effect on the sample collection activities.

Purging conditions, including any helium QC concentrations measured, volume purged, and weather conditions, will be documented in the field logbook and/or field logs. A site sketch will be recorded to map the area, sample location, intake height, and any other pertinent information related to site setting.

18.3.4 Groundwater Sampling

Groundwater sampling will be conducted using low-flow techniques in accordance with Chapter 10 of Ohio EPA's *Technical Guidance Manual for Hydrogeologic Investigations and Ground Water Monitoring* (Ohio EPA 2020b) and as specified in this UFP-QAPP. Required sampling equipment includes dedicated bladder pumps or stainless steel portable bladder pump; bladder pump compressor and controller; polypropylene tubing; flow-through cell; and water quality meter capable of monitoring pH, temperature, specific conductivity, DO, ORP, and turbidity.

Groundwater sampling is planned concurrently with one of the VI sampling events. Leidos will perform low-flow groundwater sampling of 17 permanent monitoring wells listed in Tables 18-2 and 18-3; these wells are located adjacent to Buildings 1048, 1037, and 1034. All wells will be sampled for VOCs only, and only one round of sampling will be completed. The locations of the wells are shown in Figures 17-2 and 17-3.

Prior to beginning groundwater sampling, depth to water measurements will be collected from each well within 24 hours. These measurements will be recorded in the field logs to the nearest 0.01 and 0.1 inch, respectively.

Groundwater samples will be collected by micro-purging with dedicated bladder pumps. If dedicated pumps are not installed or a problem with a dedicated pump arises, a portable stainless steel bladder pump will be deployed prior to sampling. If new pumps are installed, they must sit a minimum of 48 hours prior to sampling. The procedure for micro-purge sampling is provided below:

1. Connect all applicable hoses at the surface.
2. Turn the pump on and begin purging any stagnant water in the pump and tubing. (This purging does not represent a parameter for sampling.) For micro-purging, the pumping rate will not exceed 100 mL/min, unless it can be shown that higher purge rates (maximum of 500 mL/min) will not result in a drawdown greater than 0.3 feet. The pump rate is established once drawdown has been stabilized.
3. Begin recording water quality parameters every 3 to 5 minutes on the Groundwater Sample Form.
4. Continue purging for a minimum of 30 minutes and water quality parameters have stabilized. Stabilization is defined as three consecutive readings of:

Water Quality Parameter	Stabilization Requirement
pH	± 0.1
Conductivity	± 3 percent

Temperature	± 5°C
DO	± 0.3 mg/L
Turbidity	<10 NTU
ORP	± 10 mV or 10 percent

5. If the turbidity cannot be reduced to less than 10 NTUs after 2 hours of purging, ARNG/OHARNG will be informed, and if all other parameters are stable, the well will be sampled.

Purge water and decontamination water generated during the groundwater sampling event will be managed in accordance with Appendix B.

18.4 FIELD FORMS AND DOCUMENTATION

A sub-slab soil vapor, indoor air, or ambient air sampling log will be prepared for each sample collected and will contain the following information:

- Project
- Date and time
- Station (monitoring point) number
- Condition of the sub-slab vapor point, if applicable
- Geologist/scientist
- Purge volumes
- Field measurements (i.e., helium QC measurements)
- Sample number
- Sample depth (from, to), if applicable
- General remarks.

Following completion of purging of each station, samples will be collected in laboratory-supplied containers using clean, disposable nitrile gloves. Sample container requirements are detailed in Worksheets #19 and #30. Nitrile gloves will be changed between the collection of each sample. Sampling containers will be labeled, and the labels will provide the following information, if applicable:

- Site name
- Sample identification
- Date and time of sample collection
- Name of sampler
- Canister start/end pressures
- Type of analysis.

18.5 LOCATION SURVEYS

Sub-slab soil vapor sample locations will be hand measured from notable site features located within the building and mapped using site sketches and ArcGIS mapping applications during data evaluation and reporting.

Environmental sample locations and notable site features will be located and mapped using a portable Trimble (or similar) GPS unit capable of achieving ±3 feet accurate results. GPS data will be transferred for use in ArcGIS mapping applications during data evaluation and reporting.

18.6 FIELD SCREENING

VI investigation activities will include field screening for organic vapors. Field screening will be conducted during ambient air sampling, indoor air sampling, and installation of sub-slab soil vapor sample locations. A ppm PID will be calibrated daily and used to obtain low enough detection limits for detecting low-level soil vapors. The meter will be used during installation of sub-slab soil vapor sample locations to monitor the top of the borehole and breathing zone of the vapor point installation team per the project HASP. The results will be recorded on the soil boring log.

18.7 EQUIPMENT DECONTAMINATION

Non-dedicated equipment used to measure static water levels, develop and purge monitoring wells, and collect groundwater samples during the AOC-specific investigations will be decontaminated within a temporary decontamination area. The decontamination area will be designed so that all decontamination liquids are segregated in containers by type, contained from the surrounding environment, and can be recovered for disposal as IDW. Non-dedicated equipment will be decontaminated after each well is developed and again after each well is purged and sampled. The decontamination procedure will follow current guidance provided in Chapter 10 of the *Technical Guidance Manual for Hydrogeologic Investigations and Ground Water Monitoring* (Ohio EPA 2020b). Solvent and acid rinses may be necessary only if high concentrations of contamination are expected. Further procedures will be defined in investigation-specific addenda. Individual dedicated containers should be used for each step of the decontamination process. Gloves should be changed between various stages of decontamination. The procedure for equipment decontamination is as follows:

1. Wash with approved water and phosphate-free detergent using various types of brushes required to remove particulate matter and surface films.
2. Rinse thoroughly with approved potable water.
3. If analyzing for metals and expecting high levels of contamination, rinse thoroughly with hydrochloric acid (2 percent solution) or nitric acid (10 percent solution).
4. Rinse thoroughly with ASTM Type I or equivalent deionized/distilled water with analytical certification.
5. If analyzing for organics and expecting high levels of contamination, rinse thoroughly with solvent-pesticide grade isopropanol, acetone, or methanol, depending on analytes of interest.
6. Rinse thoroughly with ASTM Type I or equivalent deionized/distilled water with analytical certification.
7. Allow equipment to air dry as long as possible.
8. Place equipment on clean, dry plastic if it is to be used immediately or wrap in aluminum foil to prevent contamination if storage is required.

In addition to the well development and sampling equipment, field measurement instruments will be decontaminated between monitoring well locations. Only those portions of each instrument that encounter potentially contaminated environmental media will be decontaminated. Due to the delicate nature of these instruments, the decontamination procedure will involve only initial rinsing of the instruments with approved water, followed by a final rinse using ASTM Type I or equivalent water. Field measurement instruments will be rinsed with source water at the next sampling location. All solutions used in steps 3 through 6 should be dispensed from Teflon® spray bottles or dispensers.

18.8 HAZARDOUS MATERIALS MANAGEMENT

During field activities, it is anticipated that hazardous materials may be used to support sampling. Source containers of decontamination solutions will be stored at Building 1036, with isopropanol being stored in the flammable cabinet and nitric acid being stored in the corrosive cabinet. Decontamination of sampling equipment will be conducted at Building 1036 using plastic containers for cleaning and larger plastic tubs for secondary containment. Spill kits will be kept at Building 1036 in the event of a potential spill. Field activities will follow the OHARNG Environmental Procedures and spill reporting protocols presented in Appendix C.

AOC = Area of Concern
ArcGIS = Aeronautical Reconnaissance Coverage Geographic Information System
ARNG = Army National Guard
ASTM = ASTM International
CJAG = Camp James A. Garfield
COR = Contracting Officer’s Representative
DO = Dissolved Oxygen
GPS = Global Positioning System
HASP = Health and Safety Plan
HAZWOPER = Hazardous Waste Operations and Emergency Response
ID = Identifier
IDW = Investigation-Derived Waste
mg/L = Milligrams per Liter
mL/min = Milliliters per Minute
mV = Millivolt
NTU = Nephelometric Turbidity Unit
OHARNG = Ohio Army National Guard
Ohio EPA = Ohio Environmental Protection Agency
ORP = Oxidation-Reduction Potential
PID = Photoionization Detector
PPE = Personal Protective Equipment
ppm = Parts per Million
QC = Quality Control
SOP = Standard Operating Procedure
UFP-QAPP = Uniform Federal Policy-Quality Assurance Project Plan
USACE = U.S. Army Corps of Engineers
UTES = Unit Training Equipment Site
VI = Vapor Intrusion
VOC = Volatile Organic Compound

Table 18-1. Sample Location Numbers and IDs for CC RVAAP-69 Building 1048 Fire Station VI Study at Building 1037

Sample Location Number	Location Type	Sample IDs	Sample Type	Purpose
069vp-001	Sub-Slab Vapor Point	069vp-001-0001-SG 069vp-001-0002-SG	Soil Gas	Determine the presence of VOCs in soil gas in Building 1037.
069vp-002	Sub-Slab Vapor Point	069vp-002-0001-SG 069vp-002-0002-SG	Soil Gas	Determine the presence of VOCs in soil gas in Building 1037.
069vp-003	Sub-Slab Vapor Point	069vp-003-0001-SG 069vp-003-0002-SG	Soil Gas	Determine the presence of VOCs in soil gas in Building 1037.
069vp-004	Sub-Slab Vapor Point	069vp-004-0001-SG 069vp-004-0002-SG	Soil Gas	Determine the presence of VOCs in soil gas in Building 1037.
069vp-005	Sub-Slab Vapor Point	069vp-005-0001-SG 069vp-005-0002-SG	Soil Gas	Determine the presence of VOCs in soil gas in Building 1037.
069vp-006	Inside Building	069vp-006-0001-IA 069vp-006-0002-IA	Indoor Ambient Air	Determine the presence of VOCs in soil gas in Building 1037.
069vp-007	Outside Building	069vp-007-0001-AA 069vp-007-0002-AA	Outdoor Ambient Air	Determine the presence of VOCs in soil gas in Building 1037.

AA = Outdoor Ambient Air
IA = Indoor Ambient Air
ID = Identifier
SG = Soil Gas
VI = Vapor Intrusion
VOC = Volatile Organic Compound
vp = Vapor Point

Table 18-2. Sample Location Numbers and IDs for CC RVAAP-69 Building 1048 Fire Station Groundwater Study

Sample Location Number	Location Type	Sample ID	Sample Type	Purpose
069mw-001	Monitoring Well	069mw-001-0008-GW	Groundwater	Determine the presence of VOCs in groundwater at CC RVAAP-69.
069mw-002	Monitoring Well	069mw-002-0008-GW	Groundwater	Determine the presence of VOCs in groundwater at CC RVAAP-69.
069mw-003	Monitoring Well	069mw-003-0008-GW	Groundwater	Determine the presence of VOCs in groundwater at CC RVAAP-69.
069mw-004	Monitoring Well	069mw-004-0008-GW	Groundwater	Determine the presence of VOCs in groundwater at CC RVAAP-69.
069mw-005	Monitoring Well	069mw-005-0008-GW	Groundwater	Determine the presence of VOCs in groundwater at CC RVAAP-69.
069mw-006	Monitoring Well	069mw-006-0006-GW	Groundwater	Determine the presence of VOCs in groundwater at CC RVAAP-69.
069mw-007	Monitoring Well	069mw-007-0006-GW	Groundwater	Determine the presence of VOCs in groundwater at CC RVAAP-69.
069mw-008	Monitoring Well	069mw-008-0006-GW	Groundwater	Determine the presence of VOCs in groundwater at CC RVAAP-69.
069mw-009	Monitoring Well	069mw-009-0006-GW	Groundwater	Determine the presence of VOCs in groundwater at CC RVAAP-69.
069mw-010	Monitoring Well	069mw-010-0005-GW	Groundwater	Determine the presence of VOCs in groundwater at CC RVAAP-69.
069mw-011	Monitoring Well	069mw-011-0005-GW	Groundwater	Determine the presence of VOCs in groundwater at CC RVAAP-69.
069mw-012	Monitoring Well	069mw-012-0005-GW	Groundwater	Determine the presence of VOCs in groundwater at CC RVAAP-69.
069mw-013	Monitoring Well	069mw-013-0005-GW	Groundwater	Determine the presence of VOCs in groundwater at CC RVAAP-69.
069mw-014	Monitoring Well	069mw-014-0005-GW	Groundwater	Determine the presence of VOCs in groundwater at CC RVAAP-69.

ID = Identifier
GW = Groundwater
mw = Monitoring Well
VOC = Volatile Organic Compound

Table 18-3. Sample Location Numbers and IDs for RVAAP-74 Motor Pool Hydraulic Lift Groundwater Study

Sample Location Number	Location Type	Sample ID	Sample Type	Purpose
074mw-001	Monitoring Well	074mw-001-0005-GW	Groundwater	Determine the presence of VOCs in groundwater at CC RVAAP-74, as it is downgradient from CC RVAAP-69.
074mw-002	Monitoring Well	074mw-002-0005-GW	Groundwater	Determine the presence of VOCs in groundwater at RVAAP-74, as it is downgradient from CC RVAAP-69.
074mw-003	Monitoring Well	074mw-003-0005-GW	Groundwater	Determine the presence of VOCs in groundwater at CC RVAAP-74, as it is downgradient from CC RVAAP-69.

ID = Identifier
GW = Groundwater
mw = Monitoring Well
VOC = Volatile Organic Compound

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QAPP Worksheets #19 and #30 – Sample Containers, Preservation, and Hold Times

Laboratory Name: White Water Associates (WWA)/Eurofins Lancaster Laboratories Environment Testing, LLC (ELLE)/Eurofins Air Toxics
Laboratory Address (ELLE): 2425 New Holland Pike Lancaster, PA 17601
Point of Contact: Vanessa Badman
Email and Telephone Number: Vanessa.Badman@ET.EurofinsUS.com (717) 556-9762
Laboratory Address (Air Toxics): 180 Blue Ravine Road, Suite B, Folsom, CA 95630
Point of Contact: Jade White
Email and Telephone Number: Jade.White@et.eurofinsus.com 916-201-2144
Accreditation and Expiration Date (WWA): DoD ELAP/PJLA L22-129-R1; expiration March 31, 2024
Accreditation and Expiration Date (ELLE): DoD ELAP/A2LA 0.0001.01; expiration November 30, 2024
Accreditation and Expiration Date (Air Toxics): DoD ELAP/ANAB ADE-1451; expiration April 27, 2024
Sample Delivery Method: FedEx or United Parcel Service

Analyte	Matrix	Method/SOP	Container(s) (Number, Size, and Type per Sample)	Sample Volume for Analysis	Preservation	Sample Holding Time	Laboratory Data Package Turnaround
VOCs	Soil Vapor, Ambient and Indoor Air	TO-15/SOP-6 TO-15 (Low Level)/SOP-83 TO-15 SIM SOP-38	6-L Summa canisters	6 L	None, ambient temperature	30 days	Air Toxics 15 business days (Level 4 data)
	Water	SW-846 8260C/D WI8194	3 × 40-mL vials	120 mL	HCl to pH <2, 0-6°C	14 days preserved; (7 days not preserved)	ELLE 15 business days (Level 4 data)
TCLP VOCs	Aqueous IDW	SW 1311/8260D	1-L amber glass	200 mL	Cool, <6°C	14 days	ELLE 15 business days (Level 2 data)
TCLP SVOCs	Aqueous IDW	SW 1311/8270E	1-L amber glass	500 mL	Cool, <6°C	7 days to extraction; 40 days from extraction to analysis	ELLE 15 business days (Level 2 data)
TCLP Pesticides	Aqueous IDW	SW 1311/8081B	1-L amber glass	500 mL	Cool, <6°C	7 days to extraction; 40 days from extraction to analysis	ELLE 15 business days (Level 2 data)

QAPP Worksheets #19 and #30 – Sample Containers, Preservation, and Hold Times (Continued)

Analyte	Matrix	Method/SOP	Container(s) (Number, Size, and Type per Sample)	Sample Volume for Analysis	Preservation	Sample Holding Time	Laboratory Data Package Turnaround
TCLP Herbicides	Aqueous IDW	SW 1311/8151A	1-L amber glass	500 mL	Cool, <6ºC	7 days to extraction; 40 days from extraction to analysis	ELLE 15 business days (Level 2 data)
TCLP Metals	Aqueous IDW	SW 1311/6010D/7470A	1-L amber glass	500 mL	Cool, < 6ºC	Mercury: 28 days; 180 days other metals	ELLE 15 business days (Level 2 data)
PCBs (total)	Aqueous IDW	SW8082	2 × 1-L amber glass	1,000 mL	Cool 0-6ºC	7 days to extraction; 40 days from extraction to analysis	ELLE 15 business days (Level 2 data)
Flashpoint	Aqueous IDW	SW 1010A	250-mL plastic	200 mL	Cool, <6ºC	None	ELLE 15 business days (Level 2 data)
pH	Aqueous IDW	SW 9040C	250-mL plastic	100 mL	Cool, <6ºC	None	ELLE 15 business days (Level 2 data)

DoD = U.S. Department of Defense
ELAP = Environmental Laboratory Accreditation Program
ELLE = Eurofins Lancaster Laboratories Environmental, LLC
HCl = Hydrochloric Acid
IDW = Investigation-Derived Waste
PCB = Polychlorinated Biphenyl
SIM = Selected Ion Monitoring
SOP = Standard Operating Procedure
SVOC = Semivolatile Organic Compound
TCLP = Toxicity Characteristic Leaching Procedure
VOC = Volatile Organic Compound
WWA = White Water Associates, Inc.

QAPP Worksheet #20 − Field Quality Control Summary

VOC Analysis by TO-15 for Soil Vapor and 8260B for Groundwater[a]

Matrix/Event	Number of Field Samples	Field Duplicate Samples[b]	Field Blanks[c]	Equipment Rinsate Blanks[d]	MS	MSD	Total Analyses
Soil vapor (Event 1)	7	1	N/A	N/A	N/A	N/A	8
Soil vapor (Event 2)	7	1	N/A	N/A	N/A	N/A	8
Groundwater (1 Event)	17	2	N/A	N/A	1	1	21

[a] See Worksheet #23 for laboratory SOP number.

[b] The minimum number of field duplicate samples required for each round of sampling is 1 for every 10 samples. If there are fewer than 10 samples per matrix, 1 field duplicate per matrix will be submitted.

[c] Field blanks consists of the DI water used during the equipment decontamination process.

[d] Rinsate blanks will be collected at the rate of one per matrix per day when using non-disposable equipment for sample collection.

DI = Deionized
MS = Matrix Spike
MSD = Matrix Spike Duplicate
N/A = Not Applicable
SOP = Standard Operating Procedure
VOC = Volatile Organic Compound

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QAPP Worksheet #21 – Field Standard Operating Procedures

Reference Number	Title, Revision, Date and/or Number	Originating Organization	Equipment Type	Modified for Project Work?
EE FTP-180	GPS Data Collection, Revision 1, 12/31/20	Leidos	Varies	No
EE FTP-235	Soil Gas Sampling, Revision 1, 12/31/20	Leidos	Varies	No
EE FTP-400	Equipment decontamination, Revision 1, 12/31/20	Leidos	Varies	No
EE FTP-600	Groundwater Sampling from Wells, Revision 1, 12/31/20	Leidos	Varies	No
EE FTP-602	Water Level Measurements in Wells, Revision 1, 12/31/20	Leidos	Varies	No
EE FTP-625	Sample Chain of Custody, Revision 1.1, 12/31/20	Leidos	None	No
EE FTP-650	Labeling, Packing, and Shipping Environmental Samples, Revision 1, 12/31/20	Leidos	None	No
EE FTP-655	Analytical Method Selection for Environmental Samples, Revision 1, 12/31/20	Leidos	None	No
EE FTP-750	Field Measurement Procedures, Revision 1, 12/31/20	Leidos	PID	No
EE FTP-1215	Field Activity Documentation, Revision 4, 12/31/20	Leidos	None	No
EE FTP-1220	Documenting and Controlling Field Changes to Approved Work Plans, Revision 1, 12/31/20	Leidos	None	No
EE FTP-1225	Field Demobilization Checklist for Investigative Derived Waste, Revision 1, 12/31/20	Leidos	None	No
EHS 33.0	Subsurface Asset and Hazard Avoidance, 2/17	Leidos	Varies	No
None	Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells, Revision 4, 9/19/17[a,b]	USEPA Region I	Varies	No
None	Sample Collection and Evaluation of a Vapor Intrusion to Indoor Air for Remedial Response, Resource Conservation and Recovery Act, and Voluntary Action Programs, Revised March 2020	Ohio EPA	Varies	No

[a] Purging methods and stabilization criteria identified in the Ohio EPA Technical Guidance Manual for Hydrogeologic Investigations and Ground Water Monitoring will supersede those listed in GEO-TEC-012 and GEO-TEC-023.

[b] In accordance with Engineer Manual 1110-1-4000 and the contract, monitoring well development and core logging will be overseen by a qualified geologist or geological engineer.

EE = Energy and Environmental Division
EHS = Environmental Health and Safety
FTP = Field Technical Procedure
GPS = Global Positioning System
Ohio EPA = Ohio Environmental Protection Agency
PID = Photoionization Detector
USEPA = U.S. Environmental Protection Agency

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QAPP Worksheet #22 – Field Equipment Calibration, Maintenance, Testing, and Inspection

Field Equipment	Activity	SOP Reference	Title or Position of Responsible Person	Frequency	Acceptance Criteria	Corrective Action
Water level indicator	Testing audible and/or visible response	Water Level Measurements	Leidos Field Manager	Daily	Audible/visible response	Replace battery or replace equipment
PID	Screening during groundwater sampling activities	Manufacturer's Operating Manual Leidos EE FTP-750 Field Measurement Procedures	Leidos Field Manager	Daily	Calibration(s) within manufacturer's specifications	Recalibrate, perform maintenance activities
Water quality probes	Calibration of probes	Manufacturer's Operating Manual	Leidos Field Manager	Daily at a minimum, see Operating Manual for additional events that would require calibration	Calibration(s) within manufacturer's specifications	Recalibrate, perform maintenance activities, replace equipment, rinse out the flow-through cell, and decontaminate water level indicator after each monitoring well location

EE = Energy and Environmental Division
FTP = Field Technical Procedure
PID = Photoionization Detector
SOP = Standard Operating Procedure

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QAPP Worksheet #23 – Analytical Standard Operating Procedures

Laboratory SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?
WI8194	VOCs and GRO by GC/MS in Waters and Wastewaters by Method 8260C/D, Version 11, effective 5/11/2022	Definitive	Water GC/MS VOCs	GC/MS	ELLE	No
SOP-6	Analysis of Volatile Organic Compounds in Summa Polished Canisters by GC/MS, USEPA Method TO-15 and Modified USEPA Method TO-14A Rev. 45	Definitive	Air – VOCs	GC/MS	Eurofins Air Toxics	No

ELLE = Eurofins Lancaster Laboratories Environmental, LLC
GC/MS = Gas Chromatography Mass Spectrometry
GRO = Gasoline Range Organics
SOP = Standard Operating Procedure
USEPA = U.S. Environmental Protection Agency
VOC = Volatile Organic Compound

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QAPP Worksheet #24 – Analytical Instrument Calibration

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	Standard Operating Procedure Reference
GC/MS – SW846 8260 (water)	Tune check Check of mass spectral ion intensities using BFB	Prior to ICAL and at the beginning of each 12-hour period.	Per ion abundance criteria in SW-846 method.	Retune, injection port maintenance, clean the source, and/or change the column.	Analyst/Section Supervisor	WI8194/SOP-6
	ICAL Minimum five-point initial calibration for target analytes, lowest concentration standard at or near the reporting limit	ICAL prior to sample analysis.	Each analyte must meet one of the three options below: Option 1: RSD for each analyte ≤15 percent Option 2: Linear least squares regression for each analyte: $r^2 \geq 0.99$ Option 3: Non-linear least squares regression (quadratic) for each analyte: $r^2 \geq 0.99$. Six levels required.	Verify standard solutions still valid, perform instrument maintenance as needed, then repeat the ICAL.	Analyst/Section Supervisor	WI8194/SOP-6, SOP-83, SOP-38 (Eurofins Air Toxics)
	Second source ICV	Second source standard once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes within ± 20 percent of true value.	Correct problem and verify second source standard. Rerun verification. If still fails, repeat initial calibration.	Analyst/Section Supervisor	WI8194/SOP-6, SOP-83, SOP-38 (Eurofins Air Toxics)
	Retention time window position establishment	Once per ICAL, and at the beginning of the analytical sequence for each analyte and surrogate.	Set position using the mid-point standard of the ICAL when ICAL is performed. On days when ICAL is not performed, use initial CCV.	N/A	Analyst/Section Supervisor	WI8194/SOP-6, SOP-83, SOP-38 (Eurofins Air Toxics)
	CCV	Daily, prior to sample analysis and after every 12 hours of analysis time, and at the end of the analytical batch.	Opening CCV: All reported analytes and surrogates within ±20 percent of true value. If analyte identified as a poor performer per laboratory SOP, use criteria of ±30 percent of true value. Closing CCV: All reported analytes (except poor performers) and surrogates within ±50 percent for end of analytical batch CCV.	Evaluate failure and impact on samples. If samples are non-detect for analytes that have a high bias, report non-detect results with case narrative comment. For closing CCVs, if compounds are not identified as critical compounds of concern, report results with qualifiers. For closing CCVs, if the compound is identified as a critical COC, then recalibrate, and reanalyze all affected samples since the last in control CCV. *or* Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and recalibrate; then reanalyze all affected samples since the last in control CCV.	Analyst/Section Supervisor	WI8194/SOP-6
	IS	During acquisition of calibration standard.	Retention time within ± 30 seconds from retention time of the midpoint standard in the ICAL. EICP area within -50 to +100 percent of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.	Analyst/Section Supervisor	WI8194/SOP-6

QAPP Worksheet #24 – Analytical Instrument Calibration (Continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	Standard Operating Procedure Reference
GC/MS – TO-15 (Air)	Tune check Check of mass spectral ion intensities using BFB	Prior to ICAL and at the beginning of each 24-hour period.	Per ion abundance criteria in SW-846 method.	Retune, injection port maintenance, clean the source, and/or change the column.	Analyst/Section Supervisor	WI8194/SOP-6
	ICAL Minimum five-point initial calibration for target analytes, lowest concentration standard at or near the reporting limit	ICAL prior to sample analysis.	Each analyte must meet one of the three options below: Option 1: RSD for each analyte ≤30 percent Option 2: Linear least squares regression for each analyte: r^2 ≥0.99 Option 3: Non-linear least squares regression (quadratic) for each analyte: r^2 ≥0.99. Six levels required.	Verify standard solutions still valid, perform instrument maintenance as needed, then repeat the ICAL.	Analyst/Section Supervisor	WI8194/SOP-6
	Second source ICV	Second source standard once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes within ±30 percent of true value.	Correct problem and verify second source standard. Rerun verification. If still fails, repeat initial calibration.	Analyst/Section Supervisor	WI8194 SOP-6
	Retention time window position establishment	Once per ICAL, and at the beginning of the analytical sequence for each analyte and surrogate.	Set position using the mid-point standard of the ICAL when ICAL is performed. On days when ICAL is not performed, use initial CCV.	N/A	Analyst/Section Supervisor	WI8194/SOP-6
	CCV	Daily, prior to sample analysis; after every 24 hours of analysis time, and at the end of the analytical batch.	Opening CCV: All reported analytes and surrogates within ±30 percent of true value.	Evaluate failure and impact on samples. If samples are non-detect for analytes that have a high bias, report non-detect results with case narrative comment. For closing CCVs, if compounds are not identified as critical compounds of concern, report results with qualifiers. For closing CCVs, if the compound is identified as a critical COC, then recalibrate, and reanalyze all affected samples since the last in control CCV. *or* Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and recalibrate; then reanalyze all affected samples since the last in control CCV.	Analyst/Section Supervisor	WI8194/SOP-6
	IS	During acquisition of calibration standard.	ICAL Standards: The area response for each internal standard must be within 40 percent of the mean area response of the calibration standards for each internal standard. The retention time shift for each IS at each calibration level must be within 20 seconds of the mean retention time of the calibration standards for each IS. Field samples, blanks and QC samples: Retention time of each IS must be within +/-0.33 minutes of the most recent ICAL.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.	Analyst/Section Supervisor	WI8194/SOP-6

BFB = Bromofluorobenzene
CCV = Continuing Calibration Verification
COC = Chemical of Concern
EICP = Extracted Ion Current Profile
GC/MS = Gas Chromatography Mass Spectrometry
ICAL = Initial Calibration
ICV = Initial Calibration Verification

IS = Internal Standard
N/A = Not Applicable
QC = Quality Control
r^2 = Coefficient of Determination
RSD = Relative Standard Deviation
SOP = Standard Operating Procedure

QAPP Worksheet #25 – Analytical Instrument and Equipment Maintenance, Testing, and Inspection

Instrument/Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC/MS (Volatiles – aqueous)	Change septum, clean injection port, change or clip column, install new liner, change trap	Detector signals and chromatogram review	Instrument performance and sensitivity	As needed	Tune and CCV pass criteria	Re-inspect injector port, cut additional column, reanalyze CCV, recalibrate instrument	Analyst	T-VOA-WI8194
GC/MS (Volatiles – gaseous)	Preventative maintenance	Instrument performance checks	Ion source, injector liner, column, column flow, purge lines, purge flow, trap	Varies from daily to every 6 months and as needed	See Worksheet #24	Correct the problem and repeat calibration or calibration verification	Analyst	SOP-6

CCV = Continuing Calibration Verification
GC/MS = Gas Chromatography/Mass Spectrometry
SOP = Standard Operating Procedure

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QAPP Worksheets #26 and #27 – Sample Handling, Custody, and Disposal

Sampling Organization: Leidos
Laboratories: Eurofins/TestAmerica Knoxville, TN (fixed-base laboratory)
Method of Sample Delivery (Shipper/Carrier): FedEx or United Parcel Service (fixed-base laboratory)
Number of Days from Reporting until Sample Disposal: 90 days

Activity	Organization and Title or Position of Person Responsible for the Activity	SOP Reference
Sample labeling	Leidos field personnel	FTP-650: Labeling, Packaging, and Shipping Environmental Samples
Chain-of-custody form completion	Leidos field personnel	FTP-625: Labeling, Packaging, and Shipping Environmental Samples
Packaging	Leidos field personnel	FTP-650: Labeling, Packaging, and Shipping Environmental Samples
Shipping coordination	Leidos field personnel	FTP-650: Labeling, Packaging, and Shipping Environmental Samples
Sample receipt, inspection, and log-in	Laboratory Sample Custodian	SOP SW-QA-0003/WS-QA-005
Sample custody and storage	Laboratory personnel	SOP SW-QA-0003/WS-QA-005
Sample disposal	Laboratory responsible for disposal of samples 90 days after analysis	SOP WS-EHS-001
Nonconformances and Corrective Actions	Laboratory analyzing samples	ELLE Quality Policy Manual

FIELD SAMPLE CUSTODY PROCEDURES (SAMPLE COLLECTION, PACKAGING, SHIPMENT, AND DELIVERY TO LABORATORY)

Packaging will be performed according to the guidelines in the Sample Tracking and Handling Guidance SOP in Appendix A (FTP-650). To maintain a record of sample collection transfer between field personnel, shipment, and receipt by the laboratory, the applicable sample CoC paperwork is completed for each shipment (i.e., cooler or set of coolers) of packed sample bottles. The team member performing the sampling is personally responsible for the care and custody of the samples collected until they are transferred to the commercial carrier. The Leidos Field Manager will review all field sampling activities to confirm that proper custody procedures are followed during the fieldwork.

All courier receipts and/or paperwork associated with the shipment of the samples will serve as a custody record for the samples while they are in transit from the field to the laboratory. Custody seals on all coolers should remain intact during this transfer.

When samples are shipped via a commercial carrier, coolers will be secured with tape. The tape will seal any drain plug to prevent accidental leakage as the ice pack melts during transport. The tape also will be wrapped around the entire cooler on both ends. Custody seals will be placed across the cooler openings. As custody forms are sealed inside the sample cooler and custody seals remain intact, commercial carriers are not required to sign the CoC.

When samples are delivered to the laboratory, signatures of the laboratory personnel receiving the samples and the date and time of receipt will be completed in the appropriate spaces on the CoC record. This will complete the sample transfer.

SAMPLE IDENTIFICATION PROCEDURES

A coding system will be used to identify each sample collected during the field operations of the project (Worksheet #17). This coding system will provide a traceable record to allow retrieval of the information about a particular sample and ensure that each sample is uniquely identified. Each sample will be identified by a unique code that indicates the sample type, sample number, and (in some cases) sample depth.

CHAIN-OF-CUSTODY PROCEDURES

Sample custody and CoC procedures are outlined in the Sample Chain of Custody SOP (FTP-625). Sample receipt, handling, and check in are outlined in the Laboratory SOPs.

CoC = Chain-of-Custody
ELLE = Eurofins Lancaster Laboratories Environmental, LLC
FTP = Field Technical Procedure
SOP = Standard Operating Procedure
UFP-QAPP = Uniform Federal Policy-Quality Assurance Project Plan

QAPP Worksheet #28 – Analytical Laboratory Quality Control and Corrective Action

Matrix: Gaseous
Analytical Group: Volatiles
Concentration Level: Low to High
Analytical Method/SOP Reference: TO-15/SOP-6
Analytical Organization: Eurofins Air Toxics

QC Sample	Frequency/Number	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Method Blank	After analysis of standards and prior to sample analysis, or when contamination is present	See Worksheet #12	Inspect the system and reanalyze the blank.	Analyst	See Worksheet #12
LCS	One per analytical batch	See Worksheet #12.	Check the system and reanalyze the standard. Re-prepare the standard if necessary to determine the source of error. Recalibrate the instrument if the primary standard is found to be in error.	Analyst	See Worksheet #12
LCSD; Initial and Closing CCV can serve as the LCS/LCSD	One per analytical batch	See Worksheet #12.	Investigate the cause and perform maintenance as required. If instrument maintenance is required, calibrate as needed.	Analyst	See Worksheet #12
IS	All standards, blanks, and samples	Retention time for blanks and samples must be within ±0.33 minutes of the retention time in the CCV and within ±40 percent of the area counts of the daily CCV internal standards.	For blanks: inspect the system and reanalyze the blank. For samples: reanalyze the sample. If the ISs are within limits in the reanalysis, report the second analysis. If ISs are out-of-limits a second time, dilute the sample until ISs are within acceptance limits and narrate.	Analyst	See Worksheet #12

QAPP Worksheet #28 – Analytical Laboratory Quality Control and Corrective Action (Continued)

QC Sample	Frequency/Number	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Surrogates	All standards, blanks, and samples	In-house generated QC limits; While surrogate compounds routinely demonstrate tight recoveries, there are times where the surrogate recoveries in the samples are wider than the historical acceptance limits but within +/-30 of 100 percent for USEPA method TO-15. In this case, the laboratory will default to the SOP surrogate control limits of 70-130 %R.	For blanks: inspect the system and reanalyze the blank. For samples: reanalyze the sample unless obvious matrix interference is documented. If the %R is within limits in the reanalysis, report the second analysis. If %R is out-of-limits a second time, then narrate results.	Analyst	See Worksheet #12

%R = Percent Recovery
CCV = Continuing Calibration Verification
IS = Internal Standard
LCS = Laboratory Control Sample
LCSD = Laboratory Control Sample Duplicate
QC = Quality Control
SOP = Standard Operating Procedure
USEPA = U.S. Environmental Protection Agency

QAPP Worksheet #28 – Analytical Laboratory Quality Control and Corrective Action (Continued)

Matrix: Aqueous
Analytical Group: Volatiles
Concentration Level: Low to High
Analytical Method/Standard Operating Procedure Reference: VOCs and GRO by GC/MS in Waters and Wastewaters by USEPA 8260C/D, WI8194
Analytical Organization: Eurofins Lancaster Laboratories Environment Testing, LLC

QC Sample	Frequency/Number	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Field Duplicate	One per 10 samples. If there are fewer than 10 samples per matrix, 1 field duplicate per matrix will be submitted.	See Worksheet #12	No corrective action is taken on field duplicate data alone. Assess data and determine if resampling is required.	Leidos Chemist	See Worksheet #12
Method Blank	One per prep batch of 20 or fewer samples of similar matrix; or one per day, whichever comes first.	See Worksheet #12	If sufficient sample is available, reprep and reanalyze samples. Qualify data as needed.	Analyst/Supervisor	See Worksheet #12
Equipment Blank	One per day.	See Worksheet #12	Qualify data as appropriate.	Leidos QA Officer	See Worksheet #12
Field Blanks (source DI)	One per 10 samples.	See Worksheet #12	Qualify data as appropriate.	Leidos QA Officer	See Worksheet #12
Surrogate	Every field and QC sample.	See Worksheet #12	Evaluate data, if samples non-detect and surrogate recovery is above upper limits, report with case narrative comment. If obvious chromatographic interference is present, report with narrative comment. Otherwise, reanalyze.	Analyst	See Worksheet #12
LCS	One per prep batch of 20 or fewer samples of similar matrix.	See Worksheet #12	Reanalyze LCS once. If in control, report. Otherwise, if exceedance is not a critical COC as identified by the project team, evaluate for SME. If in control, report with case narrative comment. If not in control for SME, evaluate samples for detections, and LCS for high bias.	Analyst/Supervisor	See Worksheet #12

QAPP Worksheet #28 – Analytical Laboratory Quality Control and Corrective Action (Continued)

QC Sample	Frequency/Number	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
			If LCS has high bias and samples are non-detect, report with case narrative comment. If LCS has low bias, or if there are detections for critical COCs, evaluate and reprep and reanalyze the LCS and all samples in the associated prep batch for failed analytes, if sufficient sample material is available.		

COC = Chemical of Concern
DI = Deionized
GC/MS = Gas Chromatography/Mass Spectrometry
GRO = Gasoline Range Organics
LCS = Laboratory Control Sample
QA = Quality Assurance
QC = Quality Control
SME = Sporadic Marginal Exceedance
USEPA = U.S. Environmental Protection Agency
VOC = Volatile Organic Compound

QAPP Worksheet #29 – Project Documents and Records

Record Type	Generation	Verification	Storage Location/Archival
Readiness Review Checklist	Leidos Task Manager	Leidos Project Manager	Projects Drive*
Readiness Review Action Item Memorandum	Leidos QA/QC Officer	Leidos Project Manager	Projects Drive*
Planning Documents (e.g., UFP-QAPP, HASP)	Leidos Deputy Project Manager	Leidos Project Manager	Projects Drive*
Field Logbook or Field Logs	Leidos Field Manager	Leidos Project Manager	Projects Drive*
Sample Coordinates	Leidos Field Manager	Leidos Project Manager	Projects Drive*
Identification of Field and QC Samples, Sample Labels	Leidos Sample Manager	Leidos Task Manager and Project Chemist	Projects Drive*
Variance Request Forms, Field Change Requests	Leidos Field Manager	Leidos Project Manager	Projects Drive*
Chain-of-Custody Records	Leidos Sample Manager	Leidos Field Manager	Projects Drive*
Sample Shipping Records	Leidos Sample Manager	Leidos Field Manager	Projects Drive*
Digital Photographs	Leidos Field Manager	Leidos Project Manager	Projects Drive*
Field Calibration Logs	Leidos Field Manager	Leidos Project Manager	Projects Drive*
Equipment Inspection Forms	Leidos Field Manager	Leidos Project Manager	Projects Drive*
Laboratory Sample Receipt Forms	Laboratory	Leidos Project Chemist	Projects Drive*
Laboratory Analytical Records and Reports (Full Level IV Data Package, see Worksheet #35)	Laboratory	Leidos Project Chemist	Projects Drive*
Equipment Maintenance Records, if required	Laboratory	Leidos Project Chemist	Projects Drive*
Source Documentation on Standards, if required	Laboratory	Leidos Project Chemist	Projects Drive*
QA/QC Records (e.g., control charts), if required	Laboratory	Leidos Project Chemist	Projects Drive*
Laboratory EDDs (ADR.net, excel)	Laboratory	Leidos Data Manager	Projects Drive*
REIMS Error Logs and Submittal Documentation	Leidos Data Manager	Leidos Project Manager	Projects Drive*
Nonconformance and Corrective Action Reports	Leidos QA/QC Officer	Leidos Project Manager	Projects Drive*
Data Verification Report	Leidos Data Validation Staff	Leidos Project Manager	Projects Drive*
DUA Report	Leidos Project Chemist	Leidos Project Manager	Projects Drive*
Technical Reports	Leidos Deputy Project Manager	Leidos Project Manager	Projects Drive*
Document Review Records	Leidos Independent Technical Reviewer	Leidos Report Writer, Leidos Project Manager	Projects Drive*

*The ‘projects drive’ is a Leidos secure network data storage server that is a maintained and secure designated location for storing records, data, reports, and Leidos internal protocols. The project drives undergo regular backup to a secure location and records are designated for lifetime storage.

DUA = Data Usability Assessment
EDD = Electronic Data Deliverable
HASP = Health and Safety Plan
QA = Quality Assurance
QC = Quality Control
UFP-QAPP = Uniform Federal Policy-Quality Assurance Project Plan

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QAPP Worksheets #31, #32, and #33 – Assessments and Corrective Actions

Assessments:

Assessment Type	Responsible Party and Organization	Number/Frequency	Estimated Dates	Assessment Deliverable	Deliverable Due Date
FPPRR	Leidos Task Order Manager	One assessment 1 week prior to mobilization	At least 2 weeks prior to field activities	FPPRR Checklist	24 hours following assessment
Field Logbook and Field Logs Review	Leidos Field Manager	Daily during field activities	TBD	Signed logbook pages	None
Health and Safety Surveillance	Leidos Site Safety and Health Manager	Once during field activities, if warranted	TBD	Surveillance report	1 week following assessment
Quality Management Surveillance	Division QA Officer or designee	At least once during contract duration, if required	TBD	Surveillance report	1 week following assessment
Field Quality Surveillance	Leidos trained surveillance staff	Once during field activities, if warranted	TBD	Surveillance report	1 week following assessment
Laboratory Internal QA and Assessment Program	Technical personnel in appropriate departments	Per Laboratory QA Program	TBD	Assessment report	Per laboratory policy
Laboratory External Accreditation Program	Accreditation bodies	Per accreditation bodies	TBD	Audit report	Per accreditation bodies
Verification and Validation of Laboratory Data	Leidos Data Validation Staff	One per analytical data package received	As needed	Validated data in Excel format and worksheets documenting verification/validation of the data	60 days after sample collection
DUA	Leidos Project Chemist or designee	Once per each phase of the project	As needed	DUA Report	Written report due with Phase I RI report; data usability will be assessed as data validation progresses

DUA = Data Usability Assessment
FPPRR = Field Project Planning Readiness Review
QA = Quality Assurance
RI = Remedial Investigation
TBD = To Be Determined

QAPP Worksheets #31, #32, and #33 – Assessments and Corrective Actions (Continued)

Assessment Response and Corrective Action:

Assessment Type	Responsibility for Responding to Assessment Findings	Assessment Response Documentation	Time Frame for Response	Responsibility for Implementing Corrective Action	Responsible for Monitoring Corrective Action Implementation
FPPRR	Leidos Task Order Manager	FPPRR Corrective Action Response	24 hours from checklist review	As directed by the Project Manager	Division H&S and QA Managers
H&S Surveillance	Field Manager	Written response to any critical findings	Within 24 hours of report	As directed by the Field Manager	Leidos SSHO
Field Logbook and Field Log Review	Field staff	Revised, initialed documentation	ASAP when noted	As directed by the Field Manager	Leidos Field Manager
Quality Management Surveillance	Project Manager	Written response to findings	Within 24 hours of report	As directed by the Project Manager	Division QA Officer or designee
Field Quality Surveillance	Independent Field Manager or Geologist	Once during field activities, if warranted	TBD	Surveillance report	1 week following assessment
Corrective Action Reports	Leidos Task Order Manager	Corrective Action Plan	1 week from receipt of Corrective Action Report	As directed by the Corrective Action Plan	Leidos Project Manager
Laboratory Internal QA and Assessment Program	Technical personnel in appropriate departments	Per Laboratory QA Program	Per Laboratory QA Program	Technical personnel in appropriate departments	Laboratory QA Manager
Laboratory External Accreditation Program	Laboratory QA Manager	Per accreditation bodies	Per accreditation bodies	Technical personnel in appropriate departments	Laboratory QA Manager or per accreditation bodies

ASAP = As Soon As Possible
H&S = Health & Safety
FPPRR = Field Project Planning Readiness Review
QA = Quality Assurance
SSHO = Site Safety Health Officer
TBD = To Be Determined

QAPP Worksheet #34 – Data Verification and Validation Inputs

Item	Description	Verification (completeness)	Validation (conformance to specifications)
	Planning Documents/Records		
1	Approved UFP-QAPP	**X**	
2	Approved UFP-QAPP and Appendices	**X**	
3	Laboratory contract	**X**	
4	Field SOPs	**X**	
5	Laboratory SOPs	**X**	
6	Leidos administrative and data management SOPs (if applicable)*	**X**	
	Field Records		
7	Field logbooks and field logs	**X**	**X**
8	Equipment calibration records	**X**	**X**
9	CoC forms	**X**	**X**
10	Drilling logs	**X**	**X**
11	Field change requests (if required)	**X**	
12	Nonconformance Reports/Corrective Action Reports (if applicable)	**X**	
13	Field QA surveillance (if applicable)		
	Analytical Data Package		
14	Cover sheet with identifying information	**X**	
15	Case narrative	**X**	
16	Sample receipt information and CoC	**X**	
17	Sample results	**X**	**X**
18	Method blank and instrument blank summaries	**X**	**X**
19	MS/MSD summaries	**X**	**X**
20	Sample dilution reanalysis (if applicable)	**X**	**X**
21	Post spike sample results (if applicable)	**X**	**X**
22	EIS recoveries	**X**	**X**
23	LCS/LCSD summaries, as applicable	**X**	**X**
24	Instrument mass calibration	**X**	**X**
25	Initial and continuing calibration summaries, including ISC	**X**	**X**
26	Sample prep and run logs	**X**	**X**
27	Analytical raw data	**X**	
28	Required laboratory signatures	**X**	

QAPP Worksheet #34 – Data Verification and Validation Inputs (Continued)

Item	Description	Verification (completeness)	Validation (conformance to specifications)
Other			
29	Laboratory QA surveillance findings (if applicable)	**X**	**X**

Notes: Leidos, ELLE, and Air Toxic SOPs are located in Appendix A.

*Leidos will evaluate the laboratory data using criteria taken from the DoD Validation Guidelines Module 3 (DoD 2020).

CoC = Chain-of-Custody
DoD = U.S. Department of Defense
EIS = Extraction Internal Standard
ELLE = Eurofins Lancaster Laboratories Environmental, LLC
ISC = Instrument Sensitivity Check
LCS = Laboratory Control Sample
LCSD = Laboratory Control Sample Duplicate
MS = Matrix Spike
MSD = Matrix Spike Duplicate
QA = Quality Assurance
SOP = Standard Operating Procedure
UFP-QAPP = Uniform Federal Policy-Quality Assurance Project Plan

QAPP Worksheet #35 – Data Verification Procedures

Records Reviewed	Requirement Document(s)	Process Description	Responsible Person, Organization
Field logbook and field logs	Leidos FTP-1215 Field Activity Documentation	Verify that records are present and complete for each day of field activities. Verify that all planned samples, including field QC samples, have been collected and that sample collection locations are documented. Verify that meteorological data have been provided for each day of field activities. Verify that changes/exceptions are documented and have been reported in accordance with requirements. Verify that any required field monitoring has been performed and results are documented.	Daily – Leidos Field Manager or designee Post-sampling – Leidos Project Manager or designee
CoC forms and sample receipt	Leidos FTP-625 Sample Chain of Custody	CoC forms will be reviewed for accuracy and completeness against the samples packed in the specific cooler(s) prior to shipment and upon receipt by the laboratory. Verify sample receipt confirmation against CoC forms for accuracy and completeness. Verify that sufficient sample volume has been collected for analysis and QC purposes (e.g., MS/MSD). Verify that appropriate type and number of field QC blanks and field duplicates have been collected.	Prior to shipment – Leidos Field Manager or designee Upon receipt by laboratory – Eurofins Project Manager or designee Upon receipt of Laboratory Sample Receipt Confirmation – Leidos Data Validation Staff
Laboratory data package	UFP-QAPP Eurofins SOPs See Worksheet #23 Leidos SOPs: Analytical; Laboratory Data Collection and Tracking for Environmental Projects; Leidos DM-04, Revision 1; December 31, 2020 Data Verification and Validation Leidos DM-05, Revision 1; December 31, 2020	Verify data package for completeness, as defined in this UFP-QAPP, for the following: • Cover sheet with identifying information • Case narrative • Sample receipt information and CoC • Sample results • Method blank and instrument blank summaries • MS/MSD summaries • Sample dilution reanalysis (if applicable) • LCS/LCSD summaries, as applicable • Instrument • Initial and continuing calibration summaries, including ISC • Ion ratio summaries • Sample prep and run logs • Analytical raw data • Required laboratory signatures.	Before release from laboratory – Laboratory QA Manager of designee Upon receipt of data package – Leidos Data Validation Staff

QAPP Worksheet #35 – Data Verification Procedures (Continued)

Records Reviewed	Requirement Document(s)	Process Description	Responsible Person, Organization
Nonconformance Reports/Corrective Action Reports (if applicable)	Eurofins Quality Manual Leidos SOPs: Control of Nonconforming Items; Leidos A15.1; Revision 1; December 31, 2020 Nonconformance and Corrective Action; Leidos A16.1; Revision 1; December 31, 2020	Verify that corrective action was implemented according to plan.	Leidos Project Chemist or designee Leidos QA/QC Officer or designee Eurofins Project Manager or designee

Note: Leidos, ELLE and Air Toxics SOPs are located in Appendix A.

CoC = Chain-of-Custody
FTP = Field Technical Procedure
ISC = Instrument Sensitivity Check
LCS = Laboratory Control Sample
LCSD = Laboratory Control Sample Duplicate
MS = Matrix Spike
MSD = Matrix Spike Duplicate
QA = Quality Assurance
QC = Quality Control
SOP = Standard Operating Procedure
UFP-QAPP = Uniform Federal Policy-Quality Assurance Project Plan

QAPP Worksheet #36 – Data Validation Procedures

Data Validator	Leidos
Analytical group/method	VOC – SW8260B VOC TO-15
Data deliverable requirements	ADR.net files. Excel spreadsheet with sample results. The laboratory may use their basic EDD format, which should include, at a minimum, sample identifiers, analytical method, dilution factor, analyte, results, units, result qualifier, DL, LOD, LOQ, dilution factor, and sample type (e.g., reanalysis, dilution). Level IV data package in searchable PDF format (includes all QA/QC and calibration summaries as well as raw data).
Analytical specifications/measurement performance criteria	UFP-QAPP Worksheets #12, #15, #19 and #30, #24, and #28
Measurement performance criteria	UFP-QAPP Worksheet #12
Percent of data packages to be validated	100 percent will undergo Stage 2B validation, and 10 percent will undergo Stage 4 validation by a third-party contractor.
Percent of raw data reviewed	10 percent.
Percent of results to be recalculated	10 percent of sample results will be calculated from the raw data.
Validation procedure	The Leidos Data Validation Staff will validate analytical data packages using Leidos procedures EE DM-04 (Rev 1) and EE DM-05 (Rev 1). These packages are generated by a subcontracted commercial laboratory. Leidos will evaluate the laboratory performance using objective criteria taken from the requirements of the project UFP-QAPP, USEPA methodology, DoD QSM Version 5.4, and DoD Data Validation Guidelines Module 3 (DoD 2020). This process is done independently from the end data users that prepare the RI Report. The findings of this evaluation are summarized in the DUA. Stage 4 validation reports generated by the third-party validation firm will be included as an appendix to the DUA All data validation and DUA documentation will undergo a technical review by a qualified/Leidos chemist.

Note: The following data validation qualifiers will be assigned to results when QC requirements are not met during the data validation process:

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample. These results are considered estimates.
J+ = The result is estimated, potentially biased high
J- = The result is estimated, potentially biased low
X = Associated value may be unusable and requires further evaluation.
U = The analyte was analyzed for, but was not detected above, the associated numerical value.
UJ = The analyte was not detected above the associated numerical value. However, the reported quantitation limit is an estimate.

DL = Detection Limit
DoD = U.S. Department of Defense
DUA = Data Usability Assessment
EDD = Electronic Data Deliverable
EE = Energy and Environmental Division
LOD = Limit of Detection
LOQ = Limit of Quantitation
PDF = Portable Document File
QA = Quality Assurance
QC = Quality Control
QSM = Quality Systems Manual
RI = Remedial Investigation
UFP-QAPP = Uniform Federal Policy-Quality Assurance Project Plan
USEPA = U.S. Environmental Protection Agency
VOC = Volatile Organic Compound

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QAPP Worksheet #37 – Data Usability Assessment

37.1 REVIEW OF THE PROJECT OBJECTIVES AND SAMPLING DESIGN

The DUA will be performed by the Leidos team with input from other project stakeholders, where appropriate. The Leidos Project Chemist will be responsible for information in the DUA. Note that the DUA will be conducted on verified/validated data. After the data usability assessment has been performed, data deemed appropriate for use then will be used to evaluate project objectives and support further recommendations. The results of the data usability assessment will be presented in the final DUA report.

37.2 DATA VERIFICATION/VALIDATION OUTPUTS

Precision – Results of all MS/MSD pairs, LCS/LCSD pairs, and field duplicates will be assessed against measurement performance criteria provided on Worksheet #12. The RPDs exceeding criteria will be identified in the DUA, and data qualified as a result of precision nonconformances will be identified. A discussion will follow summarizing the results of sampling and laboratory precision. Any conclusions about the precision of the analyses will be drawn, and any limitations on the use of the data will be described.

Accuracy/Bias Contamination – Results for all laboratory method blanks, instrument blanks, and field QC blanks will be assessed against measurement performance criteria provided on Worksheet #12. Results for analytes that exceed criteria will be identified in the DUA, and data qualified as a result of accuracy nonconformances will be identified. Any conclusions about the accuracy/bias of the analyses based on contamination will be drawn, and any limitations on the use of the data will be described in the DUA.

Overall Accuracy/Bias – The results for the LCS/LCSDs, MS/MSDs, post-digestion spikes (if applicable), and surrogate/internal standards will be assessed against measurement performance criteria provided on Worksheet #12. In addition, initial and continuing calibration data will be compared to the requirements provided on Worksheet #24. Data qualified as a result of accuracy nonconformances will be identified. A discussion will follow summarizing overall accuracy/bias. Any conclusions about the overall accuracy/bias of the analyses will be drawn, and any limitations on the use of the data will be described in the DUA.

Sensitivity – Results for all samples will be presented separately in tabular format for each analysis. The results for each analyte will be checked against the laboratory detection limits, limits of detection, limits of quantitation, and screening levels presented on Worksheet #15. Low-level calibration standards as well as the instrument sensitivity checks will be evaluated against method and UFP-QAPP criteria provided on Worksheets #12 and #24. A discussion will follow summarizing the results of the laboratory sensitivity. Any conclusions about the sensitivity of the analyses will be drawn, and any limitations on the use of the data will be described in the DUA.

Representativeness – Representativeness will be achieved by using standard sampling and analytical methodologies governing sample collection protocols, sample size, preservation and handling, and methodology. Holding times will be compared to the criteria on Worksheets #19 and #30 to evaluate whether the data reflect environmental conditions at the time and location the sample was collected; data qualified as a result of holding time nonconformances will be identified in the DUA. Field duplicate data will be reviewed to evaluate the potential for matrix heterogeneity. Representativeness will be assessed qualitatively by ensuring that sample collection, handling, and analysis methodologies were followed. A discussion will follow summarizing the results of the representativeness of the results. Any conclusions about the representativeness of the analyses will be drawn, and any limitations on the use of the data will be discussed in the DUA.

Comparability – Comparability will be achieved by using standard sampling and analysis procedures that can be reproduced in future sampling events. Analytical results also will be compared semi-qualitatively to historical data available for the site and field observations. A discussion will follow summarizing the analyses of the comparability of the results. Any conclusions about the comparability of the analyses will be drawn, and any limitations on the use of the data will be described in the DUA.

Completeness – A completeness check will be conducted on all data generated by the laboratory. Completeness criteria are presented on Worksheet #12. Completeness will be calculated as the number of valid data points (i.e., all data that are not rejected during the DUA process) divided by the total number of data points planned. Any conclusions about the completeness of the data for each analyte will be drawn, and any limitations on the use of the data will be described in the DUA.

Reconciliation – Each of the project quality objectives presented on Worksheet #11 will be examined to determine if the objective was met. This examination will include a combined overall assessment of the results of each analysis pertinent to an objective. Each analysis will first be evaluated separately in terms of the major impacts observed from the data validation, data quality indicators, and measurement performance criteria assessments. Based on the results of these assessments, the quality of the data will be determined. The usability of the data for each analysis will be determined and discussed in the DUA, which includes a tabulated summary of qualified data along with the reason for the qualification. The final report, which will include the DUA, will evaluate data quality indicator failures, discuss any trends and biases indicated by the QC analyses, and describe any limitations on the usability of any of the data. The final report will include a summary of all of the points that went into the reconciliation of each objective.

37.3 IDENTIFY THE PERSONNEL RESPONSIBLE FOR PERFORMING THE USABILITY ASSESSMENT

The Leidos Project Chemist, or designee, project management, and other stakeholders where necessary.

37.4 DESCRIBE HOW THE USABILITY ASSESSMENT WILL BE DOCUMENTED

The DUA report will be generated using outputs discussed in Section 37.2 and will include a summary of qualified data and a discussion on the limitations of data usability. Conclusions from the DUA will identify the limitations of the data and any effect qualified results have on the decisions being made and will be documented in the narrative of the report. It will be the Leidos Project Chemist's responsibility to provide the final DUA and to document and retain stakeholders' input through independent technical reviews, emails, or communication logs.

DUA = Data Usability Assessment
LCS = Laboratory Control Sample
LCSD = Laboratory Control Sample Duplicate
MS = Matrix Spike
MSD = Matrix Spike Duplicate
QC = Quality Control
RPD = Relative Percent Difference

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APPENDIX A

STANDARD OPERATING PROCEDURES

- A.1 – Leidos Standard Operating Procedures
- A.2 – Ohio EPA and USEPA Standard Operating Procedures
- A.3 – Laboratory Standard Operating Procedures

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A.1 – Leidos Standard Operating Procedures

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ENERGY & ENVIRONMENTAL DIVISION

STANDARD OPERATING PROCEDURE

GPS Data Collection

E&E FTP-180, Revision 1

Effective 31 Dec 2020

Approved By:

Michael D. Simms, P.E.
E&E Division Manager

Kimberly C. Murphree

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1. PURPOSE

This Standard Operating Procedure (SOP) establishes the minimum requirements for the collection of features and associated coordinates using a mapping grade Global Positioning Systems (GPS) unit in support of field based feature collection activities.

1.1 Scope and Limitations

These data acquisition and data logging procedures are integral to field activities performed by the Leidos Energy & Environmental (E&E) Division where accurate global positioning system (GPS) field data collection with Global Navigation Satellite System (GNSS)-based equipment is required. This procedure should be considered supplementary to instruction manuals provided with the specific GPS equipment utilized during the survey.

If more stringent contractual requirements governing the use and accuracy of GPS exist, those shall take precedence over this SOP.

This SOP is not intended for data acquisition with a mobile device that has not been augmented with a high quality external GNSS antenna. The use of mobile devices (e.g., smartphones, tablets) for GPS data collection is not prohibited, but is not currently addressed in this procedure. If mobile devices are used for spatial data collection, the requirements governing their use must be defined in a project-specific SOP to ensure that required processes and best practices are defined and all project-specific requirements for data accuracy are met.

This SOP is not intended for use by registered surveyors whose work is generally governed by a different set of standards.

1.2 Regulations or Standards

Although no regulation(s) or standard(s) are included here, it does not mean that none may exist for the activity defined in this SOP. It is the responsibility of the Project Manager to verify that applicable regulations and standards are implemented as necessary.

1.3 Definitions/Acronyms

Base Station – A fixed GNSS receiver established over a known point or benchmark and paired with a radio transmitter to calculate and broadcast differential corrections to a moving or roving GNSS receiver to be integrated into the positional solution in real-time in order to yield highly accurate positioning data in both the horizontal and vertical planes.

Benchmark – U.S. Geological Survey (USGS) monuments, or other feature with a known GPS location. Also referred to as control points.

Differential Correction – Real-time or post processed correction of GPS coordinates. Real-time corrections are typically from a satellite or beacon. Post-processed corrections are typically performed at the end of the day or the end of the project.

ESRI – Geographic information mapping software provided by the Environmental Systems Research Institute.

Global Navigation Satellite System (GNSS) – A constellation of Earth-orbiting satellites that broadcast a timing signal and a data message that includes their orbital parameters (ephemeris data). The core GNSS constellations include the United States Navigation Satellite Timing and Ranging (NAVSTAR) GPS and the Russian Global Navigation Satellite System (GLONASS).

Global Positioning System (GPS) – A satellite-based navigation and radio-positioning system created and operated by the United States Department of Defense. It includes a minimum of 24 operational satellites in 6 orbital paths. Objective is to have at least 4 satellites available at any time and any place. This abbreviation may also be used to refer to the receiver portion of the system only.

GLONASS – Global Navigation Satellite System (Russia)

ITRF – International Terrestrial Reference Frame

NAVSTAR – U.S. Navigation Satellite Timing and Ranging

North American Datum of 1983 (NAD 83) – Standardized horizontal (X and Y axes) control datum for the North American continent based on the Geodetic Reference System (GRS) 1980 ellipsoid. NAD 83 is tied to the North American tectonic plate to minimize changes to coordinate values over time.

North American Vertical Datum of 1988 (NAVD 88) – Standardized vertical (Z axis) control datum for the North American continent.

USGS – United States Geological Survey

World Geodetic System of 1984 (WGS 84) – Standardized worldwide horizontal (X and Y axes) control datum based on the WGS 84 ellipsoid. WGS 84 is tied to the International Terrestrial Reference Frame (ITRF).

2. QUALIFICATIONS AND RESPONSIBILITIES

2.1 Qualifications

Staff shall be trained to this procedure prior to conducting field activities and that training shall be documented.

2.2 Responsibilities

Project and/or Program Managers (PMs)

- Communicating general and project specific GPS data collection requirements to the field staff.
- Verifying that personnel performing the activity described herein are trained to this procedure as well as other applicable Federal, State or local requirements, and that the training is documented.
- Making provisions for appropriate and adequate instrumentation and verifying it is available to meet technical requirements of the project.
- Providing a process for QC review of data collection records within a reasonable period following the field activity consistent with Section 6, Quality Assurance / Quality Control, of this procedure.

Site Safety and Health Officer

- Providing health and safety information regarding GPS activities.

Field Manager

- Verifying that field team members are trained and capable of collecting field data according to the project specifications.
- Using the appropriate planning tools (e.g., see Mission Planning Tool referenced in Section 8) to support successful collection of needed data.
- Verifying GPS equipment meets project requirements for reference datum, horizontal and vertical accuracy, data entry, durability, battery life, and data storage.
- Performing daily evaluations of system performance relative to specified accuracies and repeatability by examining the system verification findings as described in Section 5.0 of this document.
- Verifying that personnel perform their assigned duties in accordance with this procedure when it is applicable.
- Verifying compliance with the Sampling and Analysis Plan (SAP), as applicable.
- Overall management of field activities.

Field Staff

- Verifying that the GPS equipment is in working order prior to use in the field, with fully charged batteries and sufficient GPS data storage space to meet project requirements.
- Performing the majority of the hands-on operations including mounting, interface with computer systems and verification procedures.
- Verifying that the requirement to log data on the GPS unit is met and that data are downloaded and archived as required (see Section 7).
- Performing assigned tasks in a safe and effective manner according to established operating procedures.
- Attending required training and understanding tasks assigned.
- Using required personal protective equipment.
- Inspecting equipment prior to use for condition and function.
- Reporting unsafe or questionable conditions to a supervisor.

3. HEALTH AND SAFETY

Implement stop work authority (EHS-48) any time an activity potentially poses an uncontrolled risk to human health or the environment. Proper personal protective equipment shall be worn at all times when performing field work.

Refer to the site- or project-specific Health and Safety Plan for relevant health and safety requirements. Contact the Site Safety and Health Officer and/or the Field Manager with health or safety related questions.

4. EQUIPMENT AND SUPPLIES

The following are general comments regarding GPS equipment:

- The accuracy and repeatability obtained from the GPS system will be critical to obtaining defensible data from field surveys.
- The Leidos approach includes the use of mapping grade equipment and real-time or post-process corrections in order to minimize the uncertainty in the position. Modern GPS units with differential corrections are capable of sub-foot accuracy or better.
- When collecting a GPS position for a single point, it is recommended to collect a minimum of 30 individual position fixes. The coordinates from each position fix are averaged to calculate the coordinates recorded for a single position. Averaging 30 or more position fixes helps to improve the overall accuracy of a single position. GPS position fixes are typically collected at a rate of 1 fix per second.
- GPS error is primarily affected by multipath, atmosphere and the number of positions collected at a single location. PDOP (Position Dilution of Precision) is an indicator of GPS quality, with a value of 6 or less considered sufficient.
- When feasible, the multi-channel receiver will utilize data from GPS and GLONASS, increasing the position resolution over GPS alone and ultimately the accuracy of the raw positional information. The raw satellite data captured by the GNSS receiver generally provides positions with an uncertainty value of 15 feet. (5 meters), but accuracy and repeatability of those positions are greatly enhanced when paired with a source of differential corrections.
- Real-time GPS correction will provide the highest level of accuracy and should be utilized when available. The most common (free) real-time correction is Wide Area Augmentation System (WAAS). Some other real-time correction options are OmniSTAR (subscription fee), US Coast Guard Beacon, and Trimble VRS subscription (subscription fee).
- Accuracy in the horizontal and vertical planes can be improved by connecting an additional antenna. Some newer GPS models can also improve accuracy by integrating highly accurate horizontal and vertical differential correctors to a GPS receiver in real-time by establishing a wireless connection to a commercial or public base station (fee based).

5. PROCEDURE

5.1 Overview

Refer to the manufacturer's instructions for specific details regarding the operation of your GPS equipment.

5.2 Details

5.2.1 Calibration

- Modern GPS equipment generally requires no on-site calibration prior to use.

- In order to verify that the performance and geodetic accuracy of navigation equipment is within expectations, verification exercises will be completed twice daily; at the start and end of each field mapping day (see calibration verification below).
- If significant differences, as defined below, in horizontal position or vertical height are detected during the verification procedure, a full review of the data collected that day will be performed immediately to examine data validity.
- Any data obtained while the system was operating outside of the performance specifications will be isolated from the primary data set and reacquired once the positioning problem has been resolved.

5.2.2 Equipment Setup

- Choose precision GPS equipment that is consistent with investigative requirements.
- Operate the instruments as per manufacturer’s instructions and note in the field logbook the make, model and serial number of survey equipment. In the absence of project-specific requirements, the elevation mask should be set to 15 degrees above the horizon.
- Clearly document in the field logbook (see FTP-1215 “Field Activity Documentation”) the horizontal reference datum and the vertical reference datum (if applicable) that were used during the survey. If the GPS equipment allows for user selection of a reference datum, verify that the datum selected is consistent with project requirements. If the survey involves navigation to a pre-defined set of waypoints, verify that the reference datum and units selected for the GPS equipment matches the reference datum and units that were used to generate the waypoints.

5.2.3 Point Offsets

- There are occasions when GPS equipment will not be able to provide an accurate position due to factors that are beyond the control of the field team member (e.g., the station is located in a narrow space between two buildings). On these occasions, positions should be captured by determining accurate coordinates for a reference GPS position and the distance and bearing from the reference position to the actual feature location.
- Reference positions should be within the direct line-of-sight to the actual feature location.
- All bearings should be made relative to the GPS antenna and bearings should be measured from both the offset location and from the actual feature location to improve the accuracy of the value.
- Compasses are affected by natural and man-made attractions and efforts should be made to prevent these sources of magnetic distortion from influencing bearing readings.

- The accuracy of distance measurements will directly affect the overall accuracy of the offset position. Distances measured on an incline must be adjusted from slope to horizontal distance.
- Positions located within the interior of a structure, where direct line-of-sight to an accurate GPS fix may not be possible, should be referenced to permanent features of the structure itself that would be visible on an aerial photo (e.g. exterior wall, exterior corner, or chimney).

5.2.4 Calibration Verification

The procedures described below are meant only as a general check to verify that the GPS equipment is working properly. Project specific guidelines will need to be followed in order to meet project accuracy requirements; this may require more detailed calibration procedures with different accuracy criteria.

- Prior to commencing field GPS operations, hold static over a pre-existing benchmark (free of overhead obstructions) of first-order horizontal and vertical (if available) control and collect a minimum of 30 positional fixes in the project survey datum.
- Move the system 50 to 100 feet away from the benchmark for a minimum of 30 seconds.
- Return to the benchmark position and collect a minimum of 30 new positional fixes.
- Compare the two observed positions to the known position of the survey benchmark to verify that differences between the sets of coordinates remain within 15 feet, in the horizontal plane. If the difference between the sets of coordinates exceed 15 feet, then survey operations should be suspended until the reason for this difference is identified and corrected.
- Repeat this verification procedure at the conclusion of daily operations, to confirm continued, normal system operation.
- In the absence of a pre-existing benchmark, calibration verification should be performed by re-observation of a minimum of 10% of representative survey points. These data points should be collected a minimum of one hour after the original readings and by a different individual to maximize the independence. Re-observation may be completed with the same GPS receiver, or one capable of higher accuracy. Use of a higher accuracy receiver is preferred if available. Verify that the same critical settings are used for re-observations. Each re-observed position must be based on a minimum of 30 positional fixes and must not differ from the original position recorded more than 15 feet in the horizontal plane. Survey operations should be suspended until the reason for differences greater than 15 feet are identified and corrected.

6. QUALITY ASSURANCE / QUALITY CONTROL

- Post-processing of GPS data should be performed by a person experienced in appropriate GPS post-processing software. A backup copy of original raw data files should be created prior to post-processing of the data.
- Data shall be reviewed for compliance to contractual requirements, specified guidelines or standards (i.e. positional accuracy, content accuracy, completeness, data format adherence, and data integrity assurance).
- All raw data files, originally corrected and interpreted (originally corrected with edits) GPS data and base station sampling files must be archived in accordance with E&E A17.1 “Project Records Management”. Files must be archived both in the manufacturer’s original, proprietary format and in a standard format such as Excel or delimited text file. Be aware that these standard formats do not necessarily include all file information. It may be necessary to use an ESRI shapefile (or similar) format to capture required data. The goal is to record the information in a non-proprietary, or less proprietary, format that may be accessed without the GPS software.

7. RECORDS

- During the GPS data collection itself, positional data obtained by the GPS is logged in the handheld unit. Data should be downloaded daily using applicable software in the standard manufacturer format.
- An additional backup file should also be made at the conclusion of each day survey data is collected and kept separately on another storage device, such as a Memory Card (when available).
- A new GPS file should be created each day, per project, on the GPS device. A new GPS file should also be created if there is any potential for data file corruption, such as a power failure or the need for a system reset without proper file shutdown.
- At the conclusion of the field activity, after post-processing is complete, data must be transferred to the project files in accordance with E&E A17.1 “Project Records Management”.

8. REFERENCES

- E&E FTP-1215, Field Activity Documentation
- E&E A17.1, Project Records Management
- EHS-48, Stop Work Authority
- GPS Mission Planning (Trimble): http://www.trimble.com/GNSSPlanningOnline

Refer to https://apps.prism.leidos.com/eiapps/qa for the current version of E&E referenced procedures and forms.

Current Environmental Health and Safety (EHS) procedures are maintained at https://prism.leidos.com/command_media/command_media_folders/leidos_ehs_manual pdf.

9. ATTACHMENTS

Not Applicable.

10. DOCUMENT CHANGE RECORD

- Revision 0, dated 31 Jan 2015, is the original version of this procedure issued under Leidos.
- Revision 1, dated 31 Dec 2020, is a major revision to the procedure. Revisions included the following:
    - Updated organization name from ESE Operation to E&E Division.
    - Revised signature line titles for clarity/consistency.
    - Changed web addresses to reflect current location.
    - Editorial changes to be consistent with other procedures.
    - Section 1.1 – Added statement about accuracy requirements. Added statement about data collection with mobile devices.
    - Section 1.2 – Added statement to implement required regulations/standards.
    - Section 3 – Included stop work authority information.
    - Section 5 – Reformatted using 3rd level headers.
    - Section 5.2.2 – Added statement regarding waypoint datum.
    - Section 5.2.4 – Added statement regarding accuracy requirements.
    - Section 7 – Updated backup requirements. Added statement about creating a new data file if there is a potential for file corruption.
    - Section 8 – Updated references.

ENERGY & ENVIRONMENTAL DIVISION

STANDARD OPERATING PROCEDURE

Soil Gas Sampling

E&E FTP-235, Revision 1

Effective 31 Dec 2020

Approved By: ____________________

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E&E Division Manager

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1. PURPOSE

This Standard Operating Procedure (SOP) establishes the requirements and responsibilities for obtaining soil gas samples at known or suspected hazardous waste sites. Soil gas sampling and analysis is primarily conducted to measure concentration and distribution of volatile chemical compounds in the vadose zone as an indirect indicator of VOC contamination in soil or groundwater.

1.1 Scope and Limitations

This SOP, which applies to soil gas sampling and analysis, can be used as a rapid field screening technique for health and safety evaluation prior to the excavation of potentially contaminated soil, to aid in the placement of monitoring wells, to determine the areal extent of soil contamination or delineate a plume of contaminated groundwater, and to estimate the effectiveness of remedial measures. The guidance in this SOP does not apply when soil gas sampling is being performed as part of a Vapor Intrusion study. The mention of trade names or commercial products in this procedure does not constitute an endorsement or recommendation for its exclusive use.

This SOP applies to applicable work performed or directed by the Leidos Energy & Environmental (E&E) Division.

1.2 Regulations or Standards

The regulation(s) or standard(s) included below may not be a complete list of regulations or standards applicable to the activity described in this SOP. It is the responsibility of the Project Manager to verify that applicable regulations and standards are implemented as necessary.

- ASTM D7758-17, *Standard Practice for Passive Soil Gas Sampling in the Vadose Zone for Source Identification, Spatial Variability Assessment, Monitoring, and Vapor Intrusion Evaluations*
- ASTM D7648 / D7648M-18, *Standard Practice for Active Soil Gas Sampling for Direct Push or Manual-Driven Hand-Sampling Equipment*
- DoD *Environmental Field Sampling Handbook*, Revision 1.0, April 2013

1.3 Definitions/Acronyms

<u>*Flame Ionization Detector (FID)*</u> – A detector that uses hydrogen flame to combust, ionize, and measure the presence of volatile chemicals in air.

<u>*Photoionization Detector (PID)*</u> – A detector that uses an ultraviolet light to ionize molecules and measure the presence of volatile chemicals in air.

<u>*Sampling and Analysis Plan (SAP)*</u> – A plan that documents the procedural and analytical requirements for a project that involves the collection of samples to characterize potential areas of contamination. This may be a stand-alone plan or included as a section in another site- or project-specific plan.

<u>*Soil Gas*</u> – Subsurface gas that may be generated by biological, chemical, and physical decomposition.

Vadose (unsaturated) zone – The part of earth between the land surface and the top of the groundwater table where water has a pressure head less than atmospheric pressure.

Vapor Probe – That portion of an instrument inserted into soil to collect a gas when conducting soil gas analysis.

2. QUALIFICATIONS AND RESPONSIBILITIES

2.1 Qualifications

Staff shall be trained in this procedure and familiar with work plan goals and manufacturer requirements prior to conducting applicable field activities and training shall be documented.

2.2 Responsibilities

Project and/or Program Managers (PMs)

- Communicating general and project-specific sample collection requirements to the Field Manager.
- Verifying that personnel performing the activity described herein are trained to this procedure as well as other applicable Federal, State or local requirements, and that the training is documented.
- Securing appropriate subcontractor support (as needed) to complete field sampling and analysis.

Site Safety and Health Officer

- Providing guidance on health and safety requirements pertaining to the work.

Field Manager

- Overall management of field activities related to soil gas sampling.
- Verifying compliance with Sampling and Analysis Plan (SAP) and Health and Safety plan.
- Verifying personnel perform their assigned duties in accordance with this procedure when it is applicable.
- Training inexperienced field personnel in equipment setup, data collection, data management, and test results verification.
- Correctly identifying and verifying locations to be sampled.
- Communicating health and safety protocols to field staff.
- Communicating client or project specific requirements, general and project-specific goals and locations to the field staff.
- Identifying and acquiring appropriate test equipment and related sampling materials (containers, labels, packing materials, and shipping containers) to perform work.
- Verifying equipment decontamination and investigation-derived waste protocols are in place and communicated to field staff.

Field Staff

- Obtaining available information for locations to be sampled including sample depth and depth to groundwater below ground surface.

- Reviewing manufacturers' instructions for equipment operation and calibration.
- Verifying equipment is operational and calibrated and batteries are charged.
- Correctly locating sample points in field.
- Performing assigned tasks in a safe and effective manner according to established operating procedures.
- Attending required training and understanding tasks assigned.
- Using required personal protective equipment.
- Inspecting equipment prior to use for condition and function.
- Reporting unsafe or questionable conditions to a supervisor.
- Completely documenting field testing including problems encountered, timing and sequence of events.
- When applicable, labelling and shipping environmental samples in accordance with the SAP and E&E FTP-650 "Labeling, Packaging and Shipping Environmental Field Samples".

3. HEALTH AND SAFETY

Proper personal protective equipment shall be worn at all times when performing field work. Implement stop work authority (EHS-48) any time an activity potentially poses an uncontrolled risk to human health or the environment.

Refer to the site- or project-specific Health and Safety Plan for relevant health and safety requirements. Questions, comments or concerns should be directed to the Field Manager and/or Site Safety and Health Officer.

4. EQUIPMENT AND SUPPLIES

Equipment and supply requirements are contingent on the nature of the soil gas sampling effort (e.g., active/intrusive soil gas sampling or passive sampling). The following list includes some of the more common requirements:

- Shovels, spades
- Boring device (auger, slide hammer, etc.)
- Vapor probe
- Inert, impenetrable sealant material (e.g., pottery clay, sand pack)
- Direct read instrument (e.g., PID, FID, gas chromatograph)
- Vacuum pump
- Field logbooks / field forms (see E&E FTP-1215 "Field Activity Documentation")
- Writing implements (indelible ink, black preferred)
- Sample containers (e.g., non-intrusive, surface-placed flux chamber and sorbent sampler, Gore sorber®, Tedlar® bags, syringes, Summa® canisters)
- Sorbent tubes or samplers (e.g., charcoal, tenax or polyurethane foam)
- Sample labels
- Chain of Custody forms (see E&E FTP-625 "Sample Chain of Custody")
- Personal protective equipment (Refer to the site- or project-specific Health and Safety Plan for relevant requirements.)

5. PROCEDURE

5.1 Overview

Soil gas sampling strategies must be developed within the framework of a comprehensive site characterization as documented in the project planning documents (e.g., Sampling and Analysis Plan or Quality Assurance Project Plan). The overall effectiveness of a soil gas sampling protocol must account for:

- soil permeability,
- the presence of underground obstacles or other features affecting sampling pathways,
- the nature and concentration of contamination and the presence of interfering chemical compounds,
- site physical constraints,
- soil types and stratigraphy, and
- the depth to the groundwater table.

Multiple depth sampling should be considered when complex geologic settings are encountered. Sample locations must account for a variety of physical properties of the soil, including grain size, cohesiveness, organic matter, moisture content, geographic fractures, and overall soil permeability. In addition, the properties of the chemical contaminants must also be considered, including volatility, solubility or immiscibility in water, and degradation potential. Soil gas sampling technology is most effective in mapping low-molecular-weight, halogenated, or aromatic hydrocarbons that possess high vapor pressures and low aqueous solubilities (e.g., benzene, toluene, trichloroethylene, vinyl chloride, etc.). (*DoD Sampling Handbook, Chapter 4, see References*)

Soil gas sampling must be accompanied by a program of borings or wells to obtain soil, waste, or groundwater samples (or all three) to correlate the soil gas analytical data with the delineated extent of environmental contamination. Interpretation of soil gas data is qualitative, even though the results are quantitative based on the following limitations:

- Primarily volatile organic compounds with low molecular weights can be detected through soil gas sampling.
- Soil gas release is affected by soil mineralogy (certain clays absorb organics), by the temperature of the soil and the contaminant plume (if any), by barometric pressure (high pressure suppresses soil gases), by precipitation (infiltrating rainfall will suppress soil gas or cause it to go into solution), or by rising and falling water tables. Information relative to these variables is recorded at the time of sampling.
- Soil gas is not homogenous, varying with both time and distance from a contaminant source. Because soil gas can travel significant distances through interstitial pores, fissures and cracks, burrows or root holes, or abandoned or poorly constructed boreholes or wells, interpretation of soil gas data must consider such conditions relative to the movement and variability of the soil gas data.
- The type(s) of collecting devices and analytical techniques used contribute to the uncertainties of interpreting soil gas data.

- Appropriate manufacturer's calibration and maintenance instructions should be attached to the equipment.

Soil gas samples are obtained in conjunction with active or passive sampling systems. Active soil gas sampling involves the vacuum extraction of bulk soil gas from the vadose zone to a collection device through a subsurface probe or similar apparatus. Active soil gas sampling with on-site analysis provides a flexible field investigation tool where sampling can be directed by virtually real-time analytical results. Alternatively, passive soil gas sampling is commonly conducted over pre-determined spatial grids or sampling locations over an area of concern with sampling achieved by adsorption onto surface or subsurface collection media. The collection medium is dependent on the system that is implemented and the contaminant being collected, and is typically activated charcoal, silica gel, activated alumina, various porous polymers, or molecular sieve adsorbents. Because of reliance on extended field exposure of adsorbents and laboratory extraction and analysis, passive soil gas sampling does not provide the capability for real-time adjustment of sample locations in the field. Passive sampling does provide the capability for non-intrusive or minimally intrusive gas sampling, sampling results integrated over extended time periods, and sampling in the space above the water table in gas vent wells.

5.2 Preparation for Soil Gas Sampling

Selection of an appropriate soil gas sampling approach for a given project is paramount for obtaining useful analytical results. The following steps are to be used when performing soil gas sampling, unless superseded by more stringent requirements in the project planning document (Statement of Work, Work Plan, Sampling and Analysis Plan, etc.). Deviations from specified requirements will be justified to and authorized by the Project Manager and will be sufficiently documented on the appropriate field change forms to allow re-creation of the modified process.

- Establish sample locations over the area of concern using pin flags. Each sample location should have unique designation as specified in the SAP.
- Sampling tools and equipment are protected from sources of contamination prior to sampling and decontaminated prior to and between sampling locations as specified in FTP-400 "Equipment Decontamination".
- Clear the locale to be sampled of grass, leaves, or debris. Be careful not to walk or drive over the area.
- (The following is not necessary for flux-type, non-intrusive passive soil gas sampling). Using a decontaminated steel drive bar, bucket auger, or slide hammer, make a hole in the ground to the desired sample depth (usually 3 feet). If refusal occurs significantly before the sampling depth is reached, remove and decontaminate the drive bar and backfill the hole. Clear another sampling point within 1 foot of the first point and make a second hole in the ground to the desired sample depth. If refusal occurs, eliminate the area within ten square feet as a sampling point. The initial size of the hole must be kept to a minimum to reduce excessive purge volumes.

- Once the sampling depth is reached, make a logbook entry of the depth, time, location, etc.

5.3 Active Soil Gas Sampling

Active sample collection methods involve the vacuum extraction of a subsurface gas sample through a temporary or permanent probe to a collection or analytical device. Samples are then either transported to a laboratory for analysis or analyzed on-site so real time data can be obtained and used for directing the investigation. Active sample collection gives a “snap shot” of the soil gas conditions at a particular time and depth. This method allows for rapid soil-gas sample collection and analysis from target depths.

- Once the sampling hole is prepared, the probe is placed into the hole and the annular space at the surface is sealed with an inert, impermeable material (such as pottery clay or a sand pack). Once sealed, the probe is evacuated and a sample is withdrawn for analysis.
- Alternatively, other types of ground probes are installed to the targeted depth by direct push rig, slide, electric or hydraulic hammer. Ground probes consist of a tube, which has a removable or retractable drive tip. Once at the targeted depth, the drive rods are pulled back to “open” the probe. The drive ground probe may have a removable or retractable tip which allows for sample collection. In this type of system, the annular seal is maintained by the pressure of the soil against the probe rods.
- Permanent soil gas probes are installed so that soil gas samples can be obtained from the same location during multiple sampling events over time. The location and depth of permanent soil gas probes is based on the objective of the monitoring program and the method of installation and construction of permanent soil gas probes can vary. Probe holes can be advanced with hand or power augers, soil cores, hollow or solid stem augers and direct push methods. The probes can be constructed of various size PVC pipe with predrilled small diameter holes or commercially available soil gas well points manufactured by companies specializing in soil gas equipment. Permanent soil gas probes are of similar construction to a monitoring well, only above the water table.
- Since subsurface conditions are disturbed during augering/drilling and probe placement, the subsurface must be allowed to equilibrate before proceeding with soil gas sampling. The equilibration time is generally a minimum of 2 hours and may be as long as 48 hours depending upon the type of installation method used. The equilibration time must be specified in the SAP or other project-specific document.
- Purging of the soil gas probe is best performed with a small vacuum pump. The pump should have a flow meter and an in-line vacuum gage so vacuum establishment and changes in the flow rate and vacuum can be monitored.
- It may be preferable to employ the use of direct reading instruments for the analysis of vapor samples in a soil gas survey. Onsite gas chromatography or direct reading instruments, such as a photoionization detector (PID) or flame ionization detector

(FID), can be connected directly to the soil gas probe for analysis or can be used for direct injection of samples.

- The equipment used for sample analysis and the results of onsite analysis and quality control sampling are documented in a field logbook for each collected sample.
- Soil gas samples may be collected in various sample containers, as specified in the SAP. This may include Tedlar® bags, syringes (limited to direct injection into an analytical instrument for on-site analysis), or Summa® canisters.
- Samples not analyzed on site are sent offsite for analysis, following requirements in E&E FTP-650 “Labeling, Packaging and Shipping Environmental Samples” and E&E FTP-625 “Sample Chain of Custody”.

5.4 Passive Soil Gas Sampling

Passive soil gas sample collection includes two general sample collection techniques. These techniques include the passive collection of contaminants onto sorbent material placed in the vadose zone and a whole-air passive collection technique for collecting vapors emissions from the soil surface using an emission isolation flux chamber. This procedure does not specifically address use of an emission isolation flux chamber. If that technique is utilized, project-specific documents or SOPs must address proper techniques and requirements.

Passive sorbent sample collection utilizes diffusion and adsorption for soil gas collection onto a sorbent collection device over time. Depending upon the sorbents, they can be used to sample both VOCs and semi-volatiles. The upward movement of contaminant vapors creates a concentration gradient in the vadose zone. The passive sorbent collection method uses this to collect long-term non-disruptive samples of VOCs, SVOCs and biogenic gases. The principal of passive sorbent sample collection relies on the sorbent reducing the concentration of contaminants around the sampler over time. This creates a concentration gradient that decreases toward the sampler. This concentration gradient sustains the movement of vapors toward the sampler.

- The sorbents are placed in small diameter holes (made with simple hand tools) that vary in depth from a few inches to 5 foot deep. They are left in the ground for a few days or weeks depending upon the application and site conditions. The characteristics of the vadose zone and the chemical and physical properties of the contaminant will control migration of the contaminants.
- Passive sorbent samplers provide an integrated sample that compensates for short-term fluxes in soil gas concentrations. This method is recommended when the ground water contaminants are not known and concentration is low.
- Sorbent samplers should be exposed to the soil gas vapors for about 3 to 14 days depending on the type of sampler, soil characteristics, contaminant concentrations and the compounds of interest. Exposure time must be specified in the SAP or other project-specific document.

- The sorbent samplers are removed and sent to an offsite laboratory for analysis via thermal desorption or solvent extraction followed by an appropriate analytical technique. Samples are shipped to the laboratory in accordance with E&E FTP-650 "Labeling, Packaging and Shipping Environmental Samples" and E&E FTP-625 "Sample Chain of Custody".

6. QUALITY ASSURANCE / QUALITY CONTROL

Appropriate quality assurance/quality control (QA/QC) samples will be specified in the SAP or other project planning document. Field blanks may be required to identify ambient conditions that may interfere with analytical results and data interpretation. Field duplicates may be collected using proper flow splitters where applicable and specified in the SAP.

7. RECORDS

Records generated as a result of this procedure shall be submitted to the designated electronic record system in accordance with E&E A17.1 "Project Records Management".

8. REFERENCES

- E&E A17.1, Project Records Management
- E&E FTP-400, Equipment Decontamination
- E&E FTP-625, Sample Chain of Custody
- E&E FTP-650, Labeling, Packaging and Shipping Environmental Field Samples
- E&E FTP-1215, Field Activity Documentation
- EHS-48, Stop Work Authority
- United States Environmental Protection Agency 1998, Office of Research and Development, EPA/600/R-98/095, Environmental Technology Verification Report, Soil Gas Sampling Technology, W. L. Gore & Associates, Inc., GORE-SORBER Screening Survey, August 1998.

Refer to https://apps.prism.leidos.com/eiapps/qa for the current version of E&E referenced procedures and forms.

Current Environmental Health and Safety (EHS) procedures are maintained at https://prism.leidos.com/command_media/command_media_folders/leidos_ehs_manual pdf.

9. ATTACHMENTS

Not Applicable.

10. DOCUMENT CHANGE RECORD

- Revision 0, dated 31 Jan 2015, is the original version of this procedure issued under Leidos.
- Revision 1, dated 31 Dec 2020, is a minor revision to the procedure. Revisions included the following:

- Updated organization name from ESE Operation to E&E Division.
- Revised signature line titles for clarity/consistency.
- Changed web addresses to reflect current location.
- Editorial changes to be consistent with other procedures.
- Section 1.2 – Added statement to implement required regulations/standards.
- Section 3 – Included stop work authority information.
- Section 8 – Updated references.

ENERGY & ENVIRONMENTAL DIVISION

STANDARD OPERATING PROCEDURE

Equipment Decontamination

E&E FTP-400, Revision 1

Effective 31 Dec 2020

Approved By: ______________________________

Michael D. Simms, P.E.
E&E Division Manager

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Kimberly C. Murphree, P.E.
E&E Division Quality Assurance Manager

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ATTACHMENT(S)

1. PURPOSE

This Standard Operating Procedure (SOP) establishes the requirements for the decontamination of equipment during field sampling activities. The objective of decontamination is to:

- Remove physical, chemical and radiological contamination from surfaces;
- Minimize the spread of contamination to uncontaminated surfaces;
- Avoid cross-contamination of samples; and,
- Minimize personnel exposures.

The intent is to accomplish the required level of decontamination while minimizing the generation of additional solid and liquid waste.

1.1 Scope and Limitations

This SOP describes general decontamination requirements to be followed by Leidos Energy & Environmental (E&E) Division employees and subcontractors when field decontaminating sampling equipment (e.g., vehicles, drilling equipment, sampling equipment, well materials) for both reuse in the field as well as final decontamination prior to equipment storage or leaving the site. This procedure does not apply to health and safety equipment and personal protective equipment. The mention of trade names or commercial products in this procedure does not constitute an endorsement or recommendation for its exclusive use.

Decontamination procedures may be subject to Federal, State, or local regulations and/or client specific requirements. If a determination is made that the procedures described herein are inappropriate, inadequate or impractical and that other procedures must be used to decontaminate sampling equipment at a particular site, the variant process shall be authorized by the Project Manager (with concurrence from other appropriate personnel such as the Site Safety and Health Officer). Deviations identified before fieldwork begins shall be clearly documented in the Sampling and Analysis Plan (SAP) or other appropriate project-specific document. Deviations identified during fieldwork shall be documented in the field logbook with a description of the circumstance requiring its use.

1.2 Regulations or Standards

Although no regulation(s) or standard(s) are included here, it does not mean that none may exist for the activity defined in this SOP. It is the responsibility of the Project Manager to verify that applicable regulations and standards are implemented as necessary.

1.3 Definitions/Acronyms

Decontamination – Removal of substances from skin, clothing, or equipment to the extent necessary to preclude the occurrence of foreseeable health effects, environmental effects, or sampling and testing effects.

Deionized Water (DI Water) – Tap water that has been treated to remove ions. Generally, the term “DI Water” is used to refer to water that has been purified in some method to remove contaminants that may interfere with sample analysis. Essentially, water used for the final rinse step in decontamination procedures must not contain contaminants at a concentration high enough to introduce a false positive into the analytical results of a sample. Field and Rinsate Blanks can be used to provide verification.

Equipment – Those items (variously referred to as “field equipment” or “sampling equipment”) necessary for sampling activities.

Field Blank – A sample of DI Water poured into a sample container in the field, preserved and shipped to the laboratory with field samples. Field blanks are used to assess contamination (vehicle exhaust, airborne contaminants, etc.) from field conditions during sampling.

Laboratory Detergent – A standard brand of phosphate-free laboratory detergent, such as Liquinox®, or equivalent.

Organic-Free Water – Tap water that has been purified specifically to remove organic compounds. One of the most common treatment methods is to filter the water through activated carbon. Similar to the DI Water definition, organic-free water is required in situations where organic contaminants in the water may introduce false positives into the analytical results when analyzing for organics.

Rinsate Blank – A sample of DI Water poured over or through decontaminated field sampling equipment prior to the collection of environmental samples. The rinsate water is collected and placed into appropriate sample containers, preserved, and shipped to the lab for analysis as part of the field sampling program. Rinsate blanks are used to assess the adequacy of the decontamination process. Rinsate blanks are sometimes referred to as equipment blanks.

Sampling and Analysis Plan (SAP) – A plan that documents the procedural and analytical requirements for a project that involves the collection of samples to characterize potential areas of contamination. This may be a stand-alone plan or included as a section in another site- or project-specific plan.

Solvent – Pesticide-grade isopropanol is the standard solvent used for decontamination in most instances. The use of other solvents must be justified and approved by the Project Manager and documented in the field logbook.

Tap Water – Water from a potable, municipal water system.

Trip Blank – A clean sample of a matrix that is taken from the laboratory to the sampling site and transported back to the laboratory without being exposed to sampling procedures. Trip blanks are typically only analyzed for volatile compounds, and are used to assess contamination introduced during shipping and field handling procedures.

2. QUALIFICATIONS AND RESPONSIBILITIES

2.1 Qualifications

Staff shall be trained to this procedure prior to conducting applicable activities and that training shall be documented.

2.2 Responsibilities

Project and/or Program Managers (PMs)

- Verifying that personnel performing the activity described herein are trained to this procedure as well as other applicable Federal, State or local requirements, and that the training is documented.
- Approving deviations from this procedure, in coordination with the Site Safety and Health Officer, and verifying deviations are properly documented.

Field Manager (FM)

- Verifying that personnel, including subcontractors, perform their assigned duties in accordance with this procedure when it is applicable.
- Verifying compliance with the SAP during fieldwork.
- Selecting, in coordination with the Site Safety and Health Officer, the appropriate decontamination method that complies with SAP guidelines and regulatory requirements (if applicable).
- Verifying that equipment decontamination is performed in accordance with requirements and that the decontamination method selected is appropriate for the contaminant present as well as the surface and/or material to be decontaminated.
- Managing fieldwork.

Site Safety and Health Officer

- Assisting the Field Manager in determining appropriate decontamination methods to be used.
- Providing guidance on and answering questions about health and safety requirements.
- Assisting the Project Manager in approving required deviations from this procedure on a project-by-project basis.

Field Staff

- Performing decontamination activities in accordance with this procedure and requirements identified in the SAP or other site- or project-specific document.
- Reporting unsafe or questionable conditions and communicating issues encountered to the Field Manager and Project Manager.
- Attending required training and understanding tasks assigned.
- Using required personal protective equipment.
- Inspecting equipment prior to use for condition and function.

3. HEALTH AND SAFETY

Proper safety precautions must be observed when field cleaning or decontaminating field equipment. Decontamination procedures may involve exposure to impacted surface waters or soils via routes of dermal contact and inhalation. At a minimum, the following precautions shall be taken during decontaminating operations:

- Safety glasses or goggles, and nitrile (or equivalent) gloves will be worn while decontaminating equipment.

- No eating, smoking, drinking, chewing, or hand to mouth contact will be permitted during decontamination activities.

Implement stop work authority (EHS-48) any time an activity potentially poses an uncontrolled risk to human health or the environment.

Refer to the site- or project-specific Health and Safety Plan for specific guidance on safety precautions. Questions and/or comments regarding health and safety will be directed to the Site Safety and Health Officer and/or the Field Manager.

4. EQUIPMENT AND SUPPLIES

Required decontamination supplies and equipment are dependent upon the nature of the contaminant and the decontamination method used. The list below includes typical equipment and supplies necessary for general decontamination activities. Refer to the project SAP for specific details regarding required equipment and supplies for project-specific decontamination activities.

- Aluminum Foil
- Brushes
- Chains of Custody (for rinsate/equipment blanks) (see E&E FTP-625 “Sample Chain of Custody)
- Coolers (for storage and shipment)
- DI Water
- Drums
- Emery cloth
- Field Logbook / Field Forms (See E&E FTP-1215 “Field Activity Documentation”)
- High-pressure washer
- Laboratory Grade Detergent (non-phosphate)
- Labels
- Organic-free water
- Paper towels
- Plastic bags
- Plastic Sheeting
- Personal protective equipment (Check project-specific Health and Safety Plan for details; however, PPE generally includes, but is not limited to, eye, hand, foot, hearing, and head protection.)
- Sample containers for rinsate/equipment blanks
- Sand-blaster
- Sawhorses/racks (not wood)
- Solvent(s)
- Solvent squeeze bottle/dispenser
- Spray Bottles
- Steam Machine
- Table (not wood)
- Tap water

- Tape
- Trash bags
- Trash container(s)
- Tubs or buckets
- Writing Utensils (indelible blue or black ink, black ink preferred)

5. PROCEDURE

5.1 Overview

A decontamination plan should be developed and sufficiently scoped to address the expected types and levels of contaminants at a site and the methods used to investigate them. The decontamination plan is typically included in the SAP. Until proven otherwise, the decontamination plan should assume that personnel and equipment exiting the area of potential contamination are contaminated and, therefore, comprehensive decontamination procedures must be implemented. The plan should address the number, locations, and layout of decontamination stations; which decontamination apparatus is required; appropriate decontamination methods; and methods for disposal of contaminated equipment and waste liquids. The level of effort required for decontamination of equipment should be determined prior to beginning fieldwork.

Reusable equipment employed in the collection of environmental samples shall be cleaned prior to use to minimize the possibility of introducing contaminants with the potential to bias sample analysis. Sampling activities must be conducted with the utmost care because field contamination has the potential to significantly bias analytical results. Reusable equipment must also be decontaminated between samples to prevent cross-contamination.

Cleaning techniques shall be commensurate with the type of equipment in use, generally consisting of washing with a laboratory grade detergent followed by subsequent rinses of tap water and DI Water. Equipment used to collect samples that will be analyzed for metals may require a nitric acid rinse followed by a DI Water rinse. Sampling equipment to be used to collect samples for organic compounds shall also be rinsed with an appropriate organic solvent. Note that pesticide-grade isopropanol is the standard solvent used for decontamination in most instances. The use of other solvents must be justified and approved by the Project Manager and documented in the field logbook.

When equipment is used to collect samples that contain oil, grease, or other hard to remove materials, it may be necessary to rinse the equipment several times with an approved solvent (one which meets the requirements of the SAP) before initiating decontamination. Extreme cases may require more aggressive methods (e.g., steam clean, wire brush, or sandblasting). If the equipment cannot be adequately cleaned utilizing these means, it will be properly discarded.

For a specific decontamination method used, the substitution of higher-grade water is permitted (e.g., the use of organic-free water in place of DI Water). However, it must be noted that DI Water and organic-free water are less effective than tap water in rinsing away the detergent film during the initial rinse.

If an item has not been successfully decontaminated or cannot be monitored due to its shape (such as inside of a pipe), a decision as to further decontamination measures is made by the Field Manager.

Deviations from the requirements specified in this procedure must be justified to and authorized by the Project Manager. Deviations must be sufficiently documented in the field logbook to allow recreation of the modified process.

The following information is intended only as a general guideline for understanding the relevant concerns pertaining to field equipment and sample device decontamination. The actual selection of decontamination methods and schedules must be based on requirements within the site- or project-specific SAP.

5.2 Determining Appropriate Decontamination Methods

Each decontamination task must be individually assessed based on the characteristics and use of the equipment to be cleaned, including:

- Surfaces and materials of the equipment
- Size of equipment
- Fragility of equipment
- Equipment purpose/use

Assessment will also be based on characteristics of the media to be removed by contamination (e.g., oily sludge, heavy clay, etc.). The assessment must consider potential contaminants of concern (e.g., radioactive vs. chemical contaminants), levels of contamination, sensitivity of sample analysis, and related health and safety issues.

The FM, in coordination with the Site Safety and Health Officer if necessary, selects the decontamination method (as defined herein or in the SAP) deemed most appropriate for a particular task. If results are unsatisfactory, proceed step-by-step in selecting a more extensive method to successfully complete the decontamination. Deviation from plans will be documented in the field logbook and by a field change process if appropriate.

5.2.1 Equipment Categories

It is helpful to discriminate among three categories of field equipment when making decisions regarding decontamination requirements. These three categories of equipment are distinguished by the degree to which they may encounter contaminated media and their potential to indirectly affect sample integrity. Consequently, each of these three categories will usually require different consideration in terms of decontamination schedules and methods used. The table below identifies the three categories and indicates appropriate decontamination methods.

Category	Definition	Type of Decon	Example(s)
1	• Equipment that will not contact the sample • Should not affect sample integrity • Need not contact the contaminated media	Avoid decontamination by keeping clean equipment away from incidental contact with contaminated media (e.g., placing equipment on clean plastic drop cloths, baggies, etc.).	• Ambient air thermometers • Emergency equipment • Field support equipment

Category	Definition	Type of Decon	Example(s)
2	- Equipment that will not contact the sample - Should not affect sample integrity - Will contact the contaminated media	Decontamination between sample locations and decontaminated or packaged before being removed from the site.	- Flow meter used in conjunction with surface water sampling
3	- Equipment that may have an impact on sample integrity due to its function in close proximity to the sample before and during sample collection	Usually decontaminated prior to arrival on site, between sample locations, and most often between samples to avoid cross-contamination (e.g. drilling and digging through area of possible or known contamination.	- Drill rig - Drill rod - Augers - Flights - Sampling tools

Other factors influencing the selection of decontamination procedures and schedules include:

- Consideration of the effect of various decontamination solutions on the equipment and sampling device materials(s). Before selecting a cleaning method for specific field equipment, consult the manufacturer’s instructions to avoid the possibility of damage to instrument components. The FM is responsible for verifying that the decontamination method selected is appropriate for the contaminant present and the surface and/or material being decontaminated.
- A distinction should be made between requirements for decontamination in the field between sample locations and the requirements for decontamination prior to storage.

5.2.2 Chemical Contamination

Equipment that contacts known or suspected chemical contaminants is considered chemically contaminated. The item is typically released for unrestricted use if, after decontamination, it is free of visible contamination. If organic contamination is a concern, the equipment and/or sampling device will be scanned with appropriate instruments (e.g., Photo Ionization Detector or Flame Ionization Detector) before release in accordance with pre-defined site- or project-specific criteria. Refer to the SAP or other site- or project-specific plans for specific criteria for decontaminating chemically contaminated equipment and release requirements.

5.2.3 Radioactive Contamination

The method for decontamination of equipment and the exterior of sample containers that have been exposed to radioactive material is based on the material contaminated, the sample medium, the radiation levels, and the specific radionuclides to be removed.

Criteria for releasing decontaminated equipment for unrestricted use will be defined in site- or project-specific documents, typically the SAP. Release criteria shall be approved by the site/project Radiation Safety Officer.

Porous materials (e.g., wood, hollow concrete block, rubberized coatings, etc.) and equipment with surfaces inaccessible for a survey (e.g., electric motors, small diameter pipes, etc.) and items with surface coatings that could bind or cover the contamination are considered on a case-by-case basis and released by authorized personnel in accordance with SAP or other site- or project-specific criteria.

5.3 Precautions for Storage and Handling

5.3.1 Handling Practices and Containers for Cleaning Solutions

Improperly handled cleaning solutions may easily become contaminated. Storage and application containers must be constructed of the proper materials to ensure their integrity. Containers must be properly labeled with the contents. Safety Data Sheets must be available for solutions or solvents used or stored. Following are acceptable materials used for containing the specified cleaning solutions:

- Laboratory detergent must be kept in clean plastic, metal, or glass containers until used. It should be poured directly from the container during use.
- Tap water may be kept in tanks, hand pressure sprayers, squeeze bottles, or applied directly from a hose.
- Deionized water must be stored in clean glass or plastic containers that can be closed when not in use. It can be applied from plastic squeeze bottles.
- Organic-free water must be stored in clean glass or Teflon® containers prior to use. It may be applied using Teflon® squeeze bottles.
- Solvents must be stored out of direct sunlight in the unopened original containers until used. They may be applied using Teflon® squeeze bottles.

Hand pump sprayers are generally not acceptable storage or application containers for the materials defined above (with the exception of tap water). This also applies to stainless steel sprayers. Hand sprayers typically have internal oil coated gaskets and black rubber seals that may contaminate the solutions.

Solvents, laboratory detergent, and rinse water used to clean equipment shall not be reused during field decontamination.

5.3.2 Disposal of Cleaning Solutions

Procedures for the safe handling and disposition of investigative derived waste, including wash water and rinse water, are in the EHS-46 “Management of Waste Generated at Project Sites” procedure. The SAP, and/or the project-specific Waste Management Plan may also include information for proper handling and disposal of these materials.

5.3.3 Handling Decontaminated Equipment

After decontamination, equipment shall be handled only by personnel wearing clean gloves to prevent re-contamination. In addition, the equipment shall be moved away (preferably upwind) from the decontamination area to prevent re-contamination. If the equipment is not to be immediately reused it should be covered with plastic sheeting, wrapped in aluminum foil, or bagged to prevent re-contamination. The area where equipment is stored for reuse must be free of contaminants.

5.4 Pre-Sampling Requirements

5.4.1 Specifications for Designated Decontamination Area

Sufficient decontaminated equipment should be transported to the field so that daily work can be conducted without the need for field decontamination. When equipment must be decontaminated in the field, the following procedures are to be utilized for establishing a designated decontamination area.

The designated decontamination area shall be downwind of the location where clean equipment, clean sample devices, and samples containers are stored. This area shall also be in an area free of direct exposure to airborne and radiological surface contaminants.

Decontamination pads constructed for field cleaning of equipment should meet the following minimum requirements:

- The decontamination pad shall be constructed in an area known or believed to be free of surface contamination.
- The pad shall not leak. If the decontamination pad is found to be leaking at any time, the FM and PM shall be notified immediately.
- If possible, the pad should be constructed on a level, paved surface and should facilitate the removal of wastewater. This may be accomplished by either constructing the pad with one corner lower than the rest, or by creating a sump or pit in one corner or along one side. The sump or pit should also be lined.
- Sawhorses or racks constructed to hold equipment while being cleaned should be high enough above ground to prevent equipment from being splashed. These sawhorses/racks should not be constructed of wood.
- Decontamination water shall be removed from the decontamination pad frequently.
- A temporary pad should be lined with a water impermeable material with no seams within the pad. This material should be easily replaced (disposable) or repairable.
- At the completion of site activities, the decontamination pad should be deactivated. The pit or sump should be backfilled with the appropriate material, but only after waste/rinse water has been pumped into containers for disposal. See EHS-46 “Management of Waste Generated at Project Sites”, the SAP, and/or the project-specific Waste Management Plan for proper handling and disposal of these materials.

On small projects, a decontamination pad may not be necessary. Where only “hand” sampling or other small equipment work is being conducted, several small washtubs may be sufficient for decontamination.

5.4.2 Preliminary Cleaning Requirements

Sampling equipment, including drill rigs, should be clean of contaminants that may have been transported from off-site to minimize the potential for cross-contamination. Sampling equipment brought on-site shall meet these minimum requirements:

- Downhole augering, drilling, and sampling equipment should be sandblasted before use if painted, and/or there is a buildup of rust, hard or caked matter, etc., that cannot be removed by steam cleaning or wire brushing. Sandblasting should be performed prior to arrival on site, or well away from the decontamination and sampling areas.
- Portion of the drilling equipment that are over the borehole (kelly bar, mast, buckets, platform, hoist, spindles, cathead, etc.) shall be steam cleaned and wire brushed to remove rust, soil, and other material that may have come from other areas before being brought on site.
- Painting and/or writing on well casing, tremie tubing, etc., should be removed before use. Emery cloth or sand paper can be used to remove printing and/or writing. Most well material suppliers can provide materials without printing and/or writing if requested when ordered. Items that cannot be cleaned are not acceptable and should not be used.
- The drill rig and equipment associated with the drilling and sampling activities must be inspected to verify that oils, greases, hydraulic fluids, etc., on the surface of the equipment have been removed, and seals and gaskets are intact with no fluid leaks. This inspection must be documented (field logbook, inspection log, maintenance log, etc.).
- PVC or plastic materials shall be inspected. Reusable Items that cannot be cleaned are not acceptable and should not be used.

5.5 Drilling Equipment Decontamination

The following procedures are presented as a function of the level of contaminant concentration and are intended as general guidelines. Appropriate requirements should be established based on the individual site characteristics and type of investigation performed.

- Low to Moderate Contaminant Concentration
  - Steam or water rinse with tap water to remove mud or dirt.
  - Steam or hot water wash with a mixture of non-phosphate detergent and tap water or other type of decontamination solution.
  - Steam or hot water rinse with clean, tap water.
  - Air dry on a clean, plastic- or aluminum foil-lined surface.
- High Contaminant Concentration
  - Steam rinse with tap water to remove mud or dirt.
  - Rinse critical pieces of sampling or drilling equipment with an organic solvent and/or acid solution.
  - Steam wash with a mixture of non-phosphate detergent and tap water or other type of decontamination solution.
  - Steam rinse with clean, tap water.
  - Air dry on a clean, plastic- or aluminum-lined surface.

During decontamination of drilling equipment and accessories, clean the inside of hollow-stem auger flights, drill rods and drill bits (particularly roller bits), as well as couplings and threads. Generally, decontamination can be limited to the back portion of the drill rig and those parts that come in direct contact with samples or casing, or drilling equipment that is placed into or over the borehole.

Mud pumps, kelly, swivel, kelly hoses, and suction hoses on rotary drill rigs shall be cleaned by circulating a sufficient volume of clean water and cleaning solution through the system followed by a clean water rinse through the system.

Water or grout pumps may be sufficiently decontaminated by flushing with water. However, if a high concentration of contaminants or visible product is known to exist, then disassembly and thorough cleaning of internal parts is required prior to removal of the equipment from the site.

Some items of drilling equipment cannot typically be decontaminated. These include wood materials, porous hoses, etc. These items should not be removed from the site until they are ready for disposal in an appropriate manner.

5.6 Sampling Equipment Decontamination

Reusable sampling equipment, which may contribute to the potential contamination of a sample, must be thoroughly decontaminated prior to its initial use (unless specific documentation exists that the sampling equipment has been pre-cleaned or decontaminated) and between uses while actively sampling.

Generally, sampling equipment can be cleaned by hand. The following procedure is provided as a typical sequence that may be modified appropriately to be consistent with site conditions:

- Scrub with tap water to remove mud and residue.
- Scrub with a non-phosphate detergent/tap water solution or other decontamination solution as appropriate using a hard bristle brush.
- Rinse with clean tap water.
- Rinse with DI Water
- If required by the SAP, rinse equipment being used for sampling metals with an approved acid solution (e.g., 10% nitric acid) followed by another DI rinse.
- If required by the SAP, rinse equipment being used for sampling organic parameters with an approved organic solvent. Note: Do not solvent rinse PVC or plastic items.
- Air dry on a clean, plastic- or aluminum foil-lined surface.
- Package and seal equipment in plastic bags or other appropriate containers to prevent recontamination.

Use of high-pressure steam or hot water may be substituted for hand scrubbing if it effectively removes contaminants and soil and can be done safely without burning or contaminating personnel. Racks should be used to hold equipment while high-pressure washing.

Split-spoon, split-barrel, and Shelby tube samplers are commonly used to obtain soil samples. Most samplers contain a ball-check valve above the sample barrel that shall be thoroughly decontaminated prior to use/reuse.

Steel tapes, water probes, transducers, thermometers and water quality meters shall be rinsed in deionized water (demonstrated analyte-free) or cleaned in a non-phosphate detergent solution and rinsed once in deionized water after each use.

5.7 Well Materials Decontamination

Well-casing, regardless of material, must be cleaned thoroughly before installation. The well casing supplier should provide documentation of cleanliness. In lieu of supplier documentation, the following decontamination procedure will generally be used or adapted as appropriate for site conditions:

- High-pressure hot water steam wash with a non-phosphate detergent and tap water solution, organic or acid rinses (if appropriate) or other types of decontamination solution.
- High-pressure hot water or steam rinse with clean tap water.
- Air dry on a clean, plastic- or aluminum foil-lined surface or wipe dry.
- Wrap with plastic to prevent contamination before use.

5.8 Miscellaneous Equipment Decontamination

Step-by-step decontamination procedures for other typical sampling equipment are provided in Attachment 1. This information provided in Attachment 1 is not intended to be an exhaustive list of the type of equipment that may be utilized or that may require decontamination. Additionally, if site conditions or contaminants dictate a more specific decontamination procedure than those listed in Attachment 1, those alternate procedures shall be used. Alternate or additional decontamination procedure must be documented and approved by the Project Manager.

6. QUALITY ASSURANCE / QUALITY CONTROL

Effectiveness of the decontamination procedures is monitored by submitting rinse water to the laboratory for low-level analysis of the parameters of interest. The rinsate blank provides information on the effectiveness of the decontamination process in the field. When used in conjunction with the field blanks and trip blanks, a rinsate blank can detect contamination during sample handling, storage, and sample transportation to the laboratory. A rinsate blank consists of a sample of analyte-free (i.e., deionized) water which is passed over and through a field decontaminated sampling device and placed in a clean sample container. Rinsate blanks should be analyzed for parameters of interest at a rate a frequency appropriate for the project. Especially in the case of sampling events that occurred over multiple days or longer, the analytical results for the rinsate blanks should be evaluated as soon as possible to confirm that the decontamination procedure is effective. This frequency should be defined in the SAP.

In the event that rinsate blanks indicate a potential problem with the decontamination procedure, the quality of the DI and organic-free water used may be verified by collecting samples in standard, pre-cleaned sample containers and submitting them to the laboratory for analysis. Organic-free water should be submitted for low-level pesticide, herbicide, extractable, or purgeable compounds analyses, as appropriate.

Samples sent to a laboratory shall comply with E&E FTP-650 “Labeling, Packaging and Shipping Environmental Field Samples” and E&E FTP-625 “Sample Chain of Custody.”

7. RECORDS

Records generated as a result of this procedure shall be submitted to the designated electronic record system in accordance with E&E A17.1 “Project Records Management”.

8. REFERENCES

- E&E A17.1, Project Records Management
- E&E FTP-625, Sample Chain of Custody
- E&E FTP-650, Labeling, Packaging and Shipping Environmental Samples
- E&E FTP-1215, Field Activity Documentation
- EHS-46, Management of Waste Generated at Project Sites
- EHS-48, Stop Work Authority

Refer to https://apps.prism.leidos.com/eiapps/qa for the current version of E&E referenced procedures and forms.

Current Environmental Health and Safety (EHS) procedures are maintained at https://prism.leidos.com/command_media/command_media_folders/leidos_ehs_manualpdf.

9. ATTACHMENTS

- Attachment 1. Miscellaneous Equipment Decontamination

10. DOCUMENT CHANGE RECORD

- Revision 0, dated 31 Jan 2015, is the original version of this procedure issued under Leidos.

- Revision 1, dated 31 Dec 2020, is a major revision to the procedure. Revisions included the following:
  - Updated organization name from ESE Operation to E&E Division.
  - Revised signature line titles for clarity/consistency.
  - Changed web addresses to reflect current location.
  - Editorial changes to be consistent with other procedures.
  - Section 1.2 – Added statement to implement required regulations/standards.
  - Section 3 – Included stop work authority information.
  - Section 5.2.3 – Removed reference to Attachment 1 and added Radiation Safety Officer responsibility.
  - Section 8 – Updated references.
  - Section 9 – Removed Attachment 1 from list.
  - Removed NRC Regulatory Guide 1.86 from the attachments since it has been withdrawn by the NRC.

ATTACHMENT 1

MISCELLANEOUS EQUIPMENT DECONTAMINATION

The following are guidelines for decontaminating typical equipment used for environmental field sampling. Not all sampling equipment is listed here. Additionally, if site conditions or contaminants dictate a more specific decontamination procedure than those listed here, those alternate procedures shall be used. Alternate decontamination procedure must be documented and approved by the Project Manager.

Well Sounders or Tapes

- Wash with laboratory detergent and tap water
- Rinse with tap water
- Rinse with DI Water
- Allow to air dry overnight (does not apply to field cleaning)
- Wrap equipment in aluminum foil with shiny side of the foil facing outward (with tab for easy removal), seal in plastic, and date.

Submersible Pumps and Hoses Used to Purge Ground Water Wells

This method applies whether this equipment is decontaminated in the field or in the field equipment warehouse.

- Pump a sufficient amount of soapy water through the hose to flush out residual purge water.
- Using a brush, scrub exterior of contaminated hose and pump with soapy water.
- Rinse soap from exterior of the hose with tap water, then rinse again with DI water.
- Pump a sufficient amount of tap water (approximately one gallon) through the hose to flush out the soapy water.
- Pump a sufficient amount of DI Water through the hose to flush out the tap water and then purge the pump in reverse mode.
- Rinse the outside of the pump housing and hose with DI Water (approximately ¼ gallon).
- Equipment will be placed in a polyethylene bag or wrapped with polyethylene film to prevent contamination during storage or transit. Ensure that a set of rotors, fuses, and cables are attached to each cleaned pump.

Engines for Portable Power Augers such as the Little Beaver

- The engine and power head will be cleaned with a power washer, steam jenny, or hand washed with a brush using detergent. Detergent does not have to be a laboratory detergent, but it should not be a degreaser. Remove oil, grease, and hydraulic fluid from the exterior of the unit.
- Rinse thoroughly with tap water.

ISCO Flow Meters, Field Analytical Equipment, and other Field Instrumentation

- Before selecting a cleaning method for specific field instruments, consult the manufacturer's instructions to avoid the possibility of damage to instrument components.
- Wash exterior of sealed, watertight equipment (such as ISCO Flow Meters) with a mild detergent (such as liquid dishwashing detergent).
- Rinse with tap water.
- Interiors of such equipment may be wiped with a damp cloth if necessary.
- Flow measuring equipment such as weirs, staff gages, and velocity meters may be cleaned with tap water after use between measuring locations.
- Other field instrumentation should be wiped with a clean, damp cloth. pH meter probes, conductivity probes, DO meter probes, etc., will be rinsed with DI Water before storage.
- The desiccant in flow meters and other equipment will be checked and replaced if necessary each time the equipment is cleaned.

Ice Chests and Reusable Shipping Containers

- Wash with laboratory detergent (interior and exterior).
- Rinse with tap water
- Air dry before storage

Drill Rigs and Associated Equipment

No oils or grease will be used to lubricate drill stem threads or other drilling equipment that is used over the borehole or in the borehole without documented prior approval from the client. If drill stems tend to tighten during drilling, Teflon® string can be used on the drill stem threads.

Portions of the drill rig, backhoe, etc., that are over the borehole should be steam-cleaned (detergent and high-pressure hot water) between boreholes.

In addition, downhole drilling and associated equipment that will come in contact with the downhole equipment and sample medium will be cleaned and decontaminated by the following methods:

- Clean with tap water and laboratory grade, phosphate-free detergent, using a brush if necessary, to remove particulate matter and surface films. Steam cleaning (high-pressure hot water with detergent) may be necessary to remove matter that is difficult to remove with a brush. Auger flights and drill rods that are used to drill down in preparation for sample collection must be decontaminated thoroughly both on the outside and inside, as applicable. The steam cleaner and/or high-pressure hot water washer will be capable of generating at least 2500 psi of pressure and 200 degrees Fahrenheit or greater water temperatures.

- Rinse thoroughly with tap water. Tap water may be applied with a pump sprayer. Other decontamination liquids (DI Water, organic-free water, and solvents) must be applied with non-interfering containers. These containers will be made of glass, Teflon®, or stainless steel. This aspect of the decontamination procedures used by the driller will be inspected by the Field Manager and/or other responsible person prior to beginning of operations. Remove from the decontamination area and cover with clean, unused plastic (minimum 6 mil thickness). If stored overnight, the plastic should be secured so it stays in place.

Sample Container Exteriors

Decontamination of sample container exteriors must occur before placing the sample container in the sample cooler or shipping container.

- Wipe the exterior surfaces of the sample container with disposable rags/towels or rinse with DI Water.
- After rinsing with DI Water, if applicable, dry the exterior of the sample container with disposable rags/towels.
- Visible dirt, droplets of liquid, or other extraneous materials must be removed.
- For containers used in controlled access areas, or where the sample media is difficult to remove (e.g., sludge), a more rigorous cleaning and/or radiation monitoring may be required. Refer to site- or project-specific plans for details.

Stainless Steel, Teflon®, or Metal Sampling Equipment (Trace Organic/Metal Samples)

The following procedure is for decontaminating stainless steel, Teflon®, or metal sampling equipment used to collect samples for trace organic compounds and/or metals analyses:

- Clean with tap water and laboratory detergent solution. Use phosphate-free detergent, such as Liquinox®, or equivalent. Use a brush to remove particulate matter and surface film.
- Rinse thoroughly with organic-free water.
- Rinse twice with solvent (pesticide-grade isopropanol).
- Allow to air dry for 24 hours, if possible.
- If it is not possible to air dry for 24 hours, then rinse twice with organic-free water and allow to air dry as long as possible.
- Wrap sampling equipment with aluminum foil (with shiny side facing outward). This is done to prevent contamination of sampling equipment during transport and storage.

Stainless Steel or Metal Sampling Equipment (Radioactive Samples)

- Clean with tap water and detergent solution. Use phosphate-free detergent, such as Liquinox® or equivalent. Use brush to remove particulate matter and surface film, as necessary.
- Rinse with tap water.

- Air dry before reuse, if possible.
- If not possible to air dry before reuse, rinse thoroughly with organic-free water and allow to dry for as long as possible before reuse.

Glass Sampling Equipment

The following describes the methods for decontaminating glass sampling equipment used to collect samples for trace organic compounds and/or metals analyses:

- Wash thoroughly with laboratory detergent and hot tap water using a brush to remove particulate matter or surface film.
- Rinse thoroughly with hot tap water.
- Rinse thoroughly with tap water.
- Rinse twice with an appropriate solvent and allow to air dry for at least 24 hours.
- Wrap with aluminum foil (with shiny side facing outward). This is to prevent contamination during storage and/or transport to the field.

Silastic Rubber Pump Tubing (used in Automatic Samplers and other Peristaltic Pumps)

New clean tubing must be used for each automatic sampler set-up. The silastic rubber pump tubing need not be replaced in peristaltic pumps where the sample does not contact the tubing or where the pump is being used for purging purposes (i.e., not being used to collect samples). New tubing (certified clean by the manufacturer or medical grade) may be used in lieu of cleaning. New tubing may be dedicated to a well or new tubing used for each sampling event or location.

- Flush tubing with hot tap water and phosphate-free laboratory detergent.
- Rinse tubing thoroughly with hot tap water.
- Rinse tubing with DI Water.

Teflon® Sample Tubing

Only new or dedicated Teflon® sample tubing, decontaminated as follows, may be used for collection of samples for organic compounds analyses:

- Teflon® tubing may be pre-cut in convenient lengths before cleaning to simplify handling.
- Rinse outside of tubing with an appropriate solvent.
- Flush interior of tubing with an appropriate solvent.
- Dry overnight using a drying oven, if applicable.
- Wrap tubing and cap ends with aluminum foil, or store in a plastic bag to prevent contamination during storage.

Polyvinyl Chloride (PVC) Sample Tubing

Only new PVC tubing shall be used and decontaminated as follows:

- Tubing will be stored in its original container and not removed from this container until needed.
- The tubing will be flushed immediately before use to remove residues from the manufacturing or extruding process.
- Discard tubing after use in sampling.

Stainless Steel Tubing

- Wash with laboratory detergent and water using a long, narrow, bottle brush. Use hot water, if available.
- Rinse thoroughly with tap water. Use hot water, if available.
- Rinse thoroughly with DI Water.
- Rinse twice with an appropriate solvent.
- Allow to air dry for 24 hours, if possible.
- If it is not possible to air dry for 24 hours, then rinse thoroughly with organic-free water and allow to dry for as long as possible.
- Wrap with aluminum foil (with the shiny side facing outward). This is done to prevent contamination of tubing during transport and storage.

Glass Tubing

Use only new glass tubing, decontaminated prior to use as follows:

- Rinse thoroughly with approved solvent.
- Air dry for at least 24 hours.
- Wrap with aluminum foil (with the shiny side facing outward) to prevent contamination during transport and storage.

Leidos Proprietary

ENERGY & ENVIRONMENTAL DIVISION

STANDARD OPERATING PROCEDURE

Groundwater Sampling from Wells

E&E FTP-600, Revision 1

Effective 31 Dec 2020

Approved By: ______________________________

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E&E Division Manager

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ATTACHMENTS

1. PURPOSE

This Standard Operating Procedure (SOP) establishes general and specific procedures, methods and considerations to be used and observed when collecting groundwater samples for field screening or laboratory analysis.

1.1 Scope and Limitations

The procedures described herein are to be used when collecting and handling groundwater samples in the field by Leidos Energy & Environmental (E&E) Division personnel and subcontractors. If personnel determine that the methods described herein are inappropriate, inadequate or impractical, variant methods will be identified and documented in the field logbook. A description of the circumstances requiring the variant method shall also be recorded in the field logbook. The mention of trade names or commercial products in this procedure does not constitute an endorsement or recommendation for its exclusive use.

This procedure does not address the installation of temporary or permanent wells, nor does it address the collection of groundwater samples by use of a Hydropunch sampler. Hydropunch sampling is addressed in E&E FTP-601 “Groundwater Sampling Using a Hydropunch”.

1.2 Regulations or Standards

The regulation(s) or standard(s) included below may not be a complete list of regulations or standards applicable to the activity described in this SOP. It is the responsibility of the Project Manager to verify that applicable regulations and standards are implemented as necessary.

- *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*, R.W. Puls and M.J. Barcelona. EPA Ground Water Issue, EPA/540/S-95/504 April 1996.

1.3 Definitions / Acronyms

Aliquot – Any representative portion of the sample.

Casing – The tubular pipe that is assembled and inserted into a bored or drilled well.

Decontamination – The process of cleaning dirty sampling equipment to the degree to which it can be reused in the field.

Dissolved Oxygen (DO) – The amount of oxygen dissolved in water.

Drawdown – Lowering the water level in a well.

Equipment Blank – A sample of analyte-free media that has been used to rinse the sampling equipment. It is collected after completion of decontamination and prior to sampling. This blank is useful in documenting adequate decontamination of sampling equipment.

Field Duplicate – Independent samples which are collected as close as possible to the same point in space and time. They are two separate samples taken from the same source, stored in separate containers, and analyzed independently. These duplicates are useful in documenting the precision of the sampling process.

Headspace – The volume left at the top of an almost filled container before sealing.

Matrix Spike – An aliquot of sample spiked with a known concentration of target analyte(s). The spiking occurs prior to sample preparation and analysis. A matrix spike is used to document the bias of a method in a given sample matrix.

Matrix Spike Duplicates – Intra-laboratory split samples spiked with identical concentrations of target analyte(s). The spiking occurs prior to sample preparation and analysis. They are used to document the precision and bias of a method in a given sample matrix.

Meniscus – The convex or concave upper surface of a column of liquid, the curvature of which is caused by surface tension

Oxidation-Reduction Potential (ORP) – A measure of the tendency of a solution to contribute or accept electrons.

Potential of Hydrogen (pH) – A measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. The pH scale commonly in use ranges from 0 to 14.

Sampling and Analysis Plan (SAP) – A plan that documents the procedural and analytical requirements for a project that involves the collection of samples to characterize potential areas of contamination. This may be a stand-alone plan or included as a section in another site- or project-specific plan.

Specific Electrical Conductance (SEC) – A measure of the ability of a given substance to conduct electric current, equal to the reciprocal of the resistance of the substance.

Temperature Blank – A vial of water that accompanies the samples that will be opened and tested upon arrival at the laboratory to verify that contents of the sampling shipping container was received at a temperature within the required parameters.

Trip Blank – A sample of analyte-free media transported with the sample bottles from the laboratory to the sampling site, then returned with the samples to the laboratory unopened. A trip blank is used to document contamination attributable to shipping and field handling procedures. This type of blank is useful in documenting contamination of volatile organics samples.

Turbidity – Cloudiness or haziness of a fluid caused by individual particles (total suspended or dissolved solids) that are generally invisible to the naked eye.

Volatile Organic Compound (VOC) – Volatile organic compounds are organic chemical compounds whose composition makes it possible for them to evaporate under normal indoor atmospheric conditions of temperature and pressure.

Water Level – The distance from a fixed reference point (typically the north side of the top of the casing) down to the water in the well. It is the "resting" level of water.

Well Volume – The volume of standing water in a well.

2. QUALIFICATIONS AND RESPONSIBILITIES

2.1 Qualifications

Staff shall be trained to this procedure prior to conducting field activities and that training shall be documented.

2.2 Responsibilities

Project and/or Program Managers (PMs)

- Communicating client- or project-specific requirements, general and project-specific goals, and locations to the Field Manager.
- Assigning appropriately experienced field personnel to conduct required testing.
- Verifying that personnel performing the activity described herein are trained to this procedure as well as other applicable Federal, State or local requirements, and that the training is documented.
- Verifying investigation-derived waste management protocols are in place. Communicate protocols to Field Manager as warranted by sampling to be conducted.

Field Manager

- Overall management of field activities related to groundwater sampling.
- Correctly identifying and verifying wells to be tested.
- Communicating, in coordination with the Site Safety and Health Officer, health and safety protocols to field staff.
- Communicating client- or project-specific requirements to the field staff.
- Identifying and acquiring appropriate sampling equipment (pumps, tubing, bottles, etc.) and materials to perform work.
- Verifying equipment decontamination and investigation-derived waste protocols are in place and communicated to field staff.

Site Safety and Health Officer

- Providing guidance on health and safety requirements.

Field Staff

- Obtaining available information for wells to be sampled including well depth, well inside diameter, well construction specifications, screen interval, depth to groundwater below top of casing, etc., as appropriate.
- Inspecting and controlling sampling equipment including pumps, hoses, tubing, analyzers, etc. Reviewing manufacturers' instructions for equipment operation and calibration.
- Verifying equipment is operational and calibrated.
- Correctly locating and verifying wells to be tested.
- Identifying wells with potential for hazardous waste discharge. Implementing equipment decontamination and investigation-derived waste protocols as required.
- Conducting sampling and shipping samples as per the SAP.
- Documenting field conditions including problems encountered, timing and sequence of events as per E&E FTP-1215 "Field Activity Documentation".

3. HEALTH AND SAFETY

Depending on the site-specific contaminants, various protective programs must be implemented prior to sampling the first well. Standard safe operating practices should be followed, such as minimizing contact with potential contaminants by using appropriate personal protective equipment.

Procedures for the safe handling and disposition of investigative derived waste, including purge water, wash water and rinse water, are in the EHS-46 “Management of Waste Generated at Project Sites” procedure. The SAP, and/or the project-specific Waste Management Plan may also include information for proper handling and disposal of these materials. In addition, E&E FTP-1225, “Field Demobilization Checklist for Investigative Derived Waste” should be implemented as appropriate.

Depending on the type of contaminants expected, the following safe work practices will be employed at a minimum:

- Avoid skin contact, and incidental ingestion of, purge water.
- Use protective gloves and splash protection.
- Avoid breathing constituents venting from the well.
- Pre-survey the well headspace with an appropriate device as specified in the Health and Safety Plan.
- Avoid skin contact with water from preserved sample bottles.
- Avoid inhaling fumes from preserved sample bottles.

Implement stop work authority (EHS-48) any time an activity potentially poses an uncontrolled risk to human health or the environment.

Refer to the site- or project-specific Health and Safety Plan for relevant health and safety requirements. Questions, comments or concerns should be directed to the Field Manager and/or Site Safety and Health Officer.

4. EQUIPMENT AND SUPPLIES

The following list includes typical equipment used during groundwater sampling events:

- Depth to water measuring device
- Sampling pump
- Tubing of appropriate material for the parameters being sampled (maximized thickness and diameter so that the loss of contaminants absorbed to and through the tubing walls may be reduced)
- Tubing cutters or scissors (Note: per Leidos H&S policy, the use of fixed open-blade knives is prohibited.)
- Power source
- Flow-measurement equipment (flow meter or graduated cylinder and a stop watch)
- Multi-parameter meter with flow-through cell
- Decontamination supplies

- Samples bottles/vialsCoolers
- Ice
- Chains of Custody (see E&E FTP-625 “Sample Chain of Custody”)
- Field Logbooks/Forms (see E&E FTP-1215 “Field Activity Documentation”)
- Well keys (if required)
- Filtration equipment (if required)
- Plastic sheeting
- Containers to collect purged water
- PPE as appropriate

Depending upon the parameters to be sampled, sampling equipment may need to be limited to stainless steel, Teflon®, glass, or other inert materials. This must be specified in the SAP.

5. PROCEDURE

5.1 Overview

Groundwater sampling may be conducted from temporary or permanent well locations. Procedures common to all groundwater sampling include checking and setting up the field sample equipment; installing sample equipment in the well; purging the well as needed; properly collecting, preserving and labeling samples; and safely delivering the samples to the laboratory. Additional steps are required for sampling of permanent wells as discussed below. Each step should be followed with care so that collected groundwater samples meet the objectives and data quality requirements of the project. Examples of forms that may be used to document groundwater purging and sampling are included as attachments to this procedure.

The following shall be performed when collecting groundwater samples:

- Whenever possible, sample from the least contaminated location to the most contaminated location (if known). This will minimize the opportunity for cross-contamination.

- Clean, new, non-powdered, disposable gloves will be worn each time a different location is sampled. Gloves should be donned immediately prior to sampling. The gloves should not come in contact with the media being sampled. Gloves should be changed immediately if they become dirty or wet while sampling.

- Clean plastic sheeting shall be placed on the ground at each sample location to prevent or minimize contaminating sampling equipment.

- Samplers must use new, verified or certified clean equipment when collecting samples for trace metals or organic compound analyses.

- Store samples in a secure location. Samples shall be custody sealed during storage or shipment (see E&E FTP-625 “Sample Chain of Custody”).

- Documentation of fieldwork shall be recorded in the field logbook (see E&E FTP-1215 “Field Activity Documentation”).

5.2 Special Sampling Considerations

5.2.1 Volatile Organic Compounds (VOC) Analysis

Groundwater samples for VOC analysis must be collected in 40 ml glass vials with Teflon® septa. The vial may be preserved with concentrated hydrochloric acid or unpreserved. Preserved samples have a two-week holding time, whereas unpreserved samples only have a seven-day holding time. The decision to use preserved versus unpreserved is often predicated on the holding time; however, certain groundwater attributes may require unpreserved samples (e.g., groundwater has high amount of dissolved limestone which will react with hydrochloric acid and render the sample unacceptable).

VOC samples should be collected with as little disturbance or agitation as possible. The vial should be filled so that there is a meniscus at the top of the vial and absolutely no bubbles or headspace should be present after the vial is capped. After the cap is secure, the vial should be inverted and tapped on the palm of the hand to see if previously undetected bubbles appear. If bubbles are present, the vial should be topped off using a minimal amount of sample to re-establish the meniscus. Care should be taken not to remove any of the preservative during this process. If bubbles still exist after topping off and recapping the vial, a new vial should be obtained and the sample recollected.

VOC samples must be collected using stainless steel, Teflon®, or Teflon®-lined equipment. Preferred techniques include low-flow sampling equipment (e.g., bladder pumps), bailers, or RediFlo2® submersible pumps (with Teflon® tubing). Based on the data quality objectives established for the project, peristaltic pump/vacuum jug assemblies (with Teflon® tubing) may be acceptable. The equipment to be used must be specified in the SAP or another project-specific document.

5.2.2 Sample Handling

Effort should be made to collect samples with minimal agitation.

During sampling, the pump discharge line or the bailer shall not contact the sample container.

Samples collected for VOC, acidity and alkalinity analysis must not have any headspace in the container. When filling preserved sample containers, avoid overfilling the container to avoid loss of preservative.

5.3 Purging

Purging is the process of removing stagnant water from a well immediately prior to sampling. Groundwater will replace the purged water in the well. Samplers should monitor, at a minimum, the pH, specific electrical conductance (SEC) and turbidity of the groundwater removed during purging, and, in the case of permanent monitoring wells, record the volume of water removed.

Purging is typically performed by removing multiple volumes of water from the well; however, there are other methods available. When the multiple volume purge method is not used, alternate purge methods are acceptable. Alternate purge methods must be clearly defined and documented in the SAP or another project-specific document.

5.3.1 Purge Volume and Stabilization Criteria

Prior to initiating a purge, the volume of standing water in the well (well riser and screen) should be determined, if possible. To calculate the water volume the diameter of the well, the total depth of the well, and the water level must be known (see E&E FTP-602 "Water Level Measurements in Wells"). Once this information is obtained, the volume of standing water (in gallons) can be determined using the following equation:

$$V = 0.041d^2h$$

Where:
h = depth of water in feet
d = diameter of well in inches
V = volume of water in gallons

Alternatively, the volume of standing water may be determined using the casing volume per foot for the appropriate diameter well. The table below provides information for one water column.

Casing Diameter (inches)	Gallons/foot (one water column)	Casing Diameter (inches)	Gallons/foot (one water column)
1	0.041	7	2.000
2	0.163	8	2.611
3	0.367	9	3.305
4	0.653	10	4.080
5	1.020	11	4.937
6	1.469	12	5.875

To determine the volume of standing water using the table above, multiply the length of the water column (total well depth minus the water level measurement) by the appropriate volume per foot factor for the diameter of the well. The field logbook should note calculations or determinations that are made regarding well volumes.

An adequate purge is typically achieved when three to five well volumes have been removed. With respect to groundwater chemistry, an adequate purge is achieved when the pH and SEC of the groundwater have stabilized and the turbidity has either stabilized (+/-10%) or is below 10 Nephelometric Turbidity Units (NTUs). Although 10 NTUs is the minimum goal for most groundwater sampling objectives, lower turbidity is easily achievable in most situations and reasonable attempts should be made to achieve lower levels.

Stabilization occurs when, for at least three consecutive measurements, the pH remains constant within 0.1 Standard Unit (SU) and specific conductance varies no more than approximately 3 percent. Other factors, such as dissolved oxygen (DO) and oxidation-reduction potential (ORP) may also be used as a purge adequacy parameter. Routine criteria for DO are +/- 0.3 mg/L or 10 percent saturation, whichever is greater. Routine criteria for ORP are +/- 10 millivolts.

If the well quality parameters have not stabilized according to the criteria above after three well volumes have been removed, additional well volumes (up to five) should be removed. If the parameters have not stabilized after five well volumes have been removed, the

Project Manager should be contacted to determine whether or not to collect a sample or to continue purging. The well quality parameters should be noted in the field logbook when sampling begins.

Wells should be sampled as soon as possible after purging. If adequate well volume is available upon completion of purging, the well should be sampled immediately. If not, sampling should occur as soon as adequate volume has recovered. If possible, sampling of wells with a slow recovery should be scheduled so they can be purged and sampled in the same day, after adequate volume has recovered.

5.3.2 Low-Flow Purge Method

The following describes step-by-step purging procedures for the Low-Flow/Minimal Drawdown method.

1. For a non-dedicated pump system, place the pump and support equipment at the wellhead and slowly lower the pump and tubing down into the monitoring well until the location of the pump intake is set at a pre-determined location within the screened interval. The placement of the pump intake should be positioned with a calibrated sampling pump hose, sounded with a weighted-tape, or using a pre-measured hose. Record the pump location in the field logbook or appropriate groundwater sampling form.
2. For a dedicated pump system, record the depth of the pump intake for the monitoring well in the field logbook or appropriate groundwater sampling form.
3. Measure the water level to the nearest 0.1 feet, and record that information in the field logbook or appropriate groundwater sampling form. Leave the water level indicator in the well.
4. Connect the discharge line from the pump to a flow-through cell. A “T” connection is needed prior to the flow-through cell to allow for the collection of water for the turbidity measurements. The discharge line from the flow-through cell must be directed to a container to contain purge water during the purging of the well.
5. Start pumping the well at a low flow rate (0.1 to 0.5 liters per minute) and slowly increase the speed. Check the water level. Maintain a steady flow rate while maintaining a drawdown of less than 0.33 feet. If drawdown is greater than 0.33 feet, lower the flow rate. (If the pump is to be turned off, a check valve is required.) It should be noted that this drawdown goal may be difficult to achieve under some circumstances due to geologic heterogeneities within the screened level, and may require adjustment based on site-specific conditions.
6. Measure the discharge rate of the pump with a flow meter or a graduated cylinder and a stopwatch. Also, measure the water level and record both the flow rate and the water level in the field logbook or appropriate groundwater sampling form. Monitor and record water level and pump rate every three to five minutes during purging. Pumping rates should be kept at minimal flow to ensure minimal drawdown in the monitoring well.

7. During the purging, a minimum of one well volume must be purged prior to recording the water quality indicator parameters. Then monitor and record the water quality indicator parameters every three to five minutes. The water quality indicator parameters are turbidity, dissolved oxygen, SEC, pH, ORP, and temperature. ORP may not always be an appropriate stabilization parameter, and will depend on site-specific conditions. The stabilization criterion is based on three consecutive readings of the water quality field parameters as discussed in Section 5.3.1 above, while maintaining drawdown of less than 0.33 ft. Once the criteria have been successfully met, sample collection can take place.

Purged water should be collected and screened in accordance with site- or project-specific plans. If purge water is suspected or determined to be hazardous it shall be contained and disposed of properly in accordance with site- or project-specific requirements. See E&E FTP-1225 “Field Demobilization Checklist for Investigative Derived Waste” and EHS-46 “Management of Waste Generated at Project Sites” for further information.

5.4 Sampling

The following describes step-by-step sampling procedures after adequate purging has been completed:

1. Maintain the same purging pumping rate or reduce slightly for sampling (0.1 to 0.5 liters per minute) in order to minimize disturbance of the water column.
2. Disconnect the pump’s tubing from the flow-through cell so that the samples are collected directly from the pump’s discharge port. For samples collected for dissolved gases or VOC analyses, the pump tubing needs to be completely full of groundwater to prevent the groundwater from being aerated as it flows through the tubing.
3. All sample containers should be filled with minimal turbulence by allowing the groundwater to flow from the tubing gently down the inside of the container. When filling VOC samples, a meniscus must be formed over the mouth of the vial to eliminate the formation of air bubbles and headspace prior to capping (see Section 5.2.1 above).
4. All sample collection must follow chain of custody requirements as prescribed in E&E FTP-625 “Sample Chain of Custody”. Field activities must be documented in accordance with E&E FTP-1215 “Field Activity Documentation”. Samples being shipped for off-site laboratory analyses must comply with the procedures in E&E FTP-650 “Labeling, Packaging, and Shipping of Environmental Field Samples” or E&E FTP-651 “Hazards Materials/Dangerous Goods Shipping” as appropriate.

In general, bailers should be avoided for well sampling in favor of pumps. If a pump cannot be used to sample because recovery rate of the well is low, and the volume of the water to be removed is minimal, then a Teflon® bailer with a double check valve and a bottom-emptying device with a control-flow check valve may be used to obtain samples. Bailers should not be used when sampling for VOCs because of the potential bias introduced during sampling. Bailers should also be avoided when sampling for metals because repeated bailer deployment has the potential to increase turbidity, which biases concentrations of inorganic constituents.

5.5 Decontamination Procedures

Decontamination of field equipment shall be performed as outlined in E&E FTP-400 “Equipment Decontamination” or the site- or project-specific Sampling and Analysis Plan if alternative decontamination procedures have been identified.

When purging/sampling equipment must be reused in other wells (non-dedicated equipment), it shall be decontaminated between wells.

6. QUALITY ASSURANCE / QUALITY CONTROL

Quality assurance/quality control for groundwater sampling requires that this SOP be followed as written unless project-specific deviations are detailed in the SAP or as authorized and documented by the Project Manager. In addition, samples must be collected in accordance with method requirements for the parameters of interest for sample volumes, containers and preservatives or as specified in the SAP.

Other quality assurance considerations for groundwater sampling are as follows:

- Verify that purging and sampling devices are made of materials and utilized in a manner that will not interact with or alter the analyses.
- Evaluate if the results generated by these procedures are reproducible by obtaining duplicate samples.
- Properly preserving, packaging, and shipping samples.

Field QC samples must be prepared the same as regular investigation samples with regard to sample volume, containers and preservation. The chain of custody procedures for the QC samples shall be identical to the field groundwater samples. The following QC samples should be collected as part of a routine groundwater sampling program:

- Field duplicates – 1 per 20 samples
- Matrix spike – 1 per 20 samples
- Matrix spike duplicate – 1 per 20 samples
- Equipment blank – 1 per 20 samples per Regional requirements or policy*
- Trip blank (VOCs) – 1 per sample cooler
- Temperature blank – 1 per sample cooler

* Equipment blanks (also referred to as rinsate blanks) should be collected if equipment is field cleaned and reused onsite or if necessary to document that low-level contaminants were not introduced by sampling equipment (see E&E FTP-400 “Equipment Decontamination”).

7. RECORDS

Records generated as a result of this procedure shall be submitted to the designated electronic record system in accordance with E&E A17.1 “Project Records Management”.

8. REFERENCES

- E&E A17.1, Project Records Management
- E&E FTP-400, Equipment Decontamination
- E&E FTP-601, Groundwater Sampling Using a HydroPunch
- E&E FTP-602, Water Level Measurement in Wells
- E&E FTP-625, Sample Chain of Custody
- E&E FTP-650 Labeling, Packaging and Shipping of Environmental Samples
- E&E FTP-651, Hazardous Materials/Dangerous Goods Shipping
- E&E FTP-1215, Field Activity Documentation
- E&E FTP-1225, Field Demobilization Checklist for Investigative Derived Waste
- EHS-46, Management of Waste Generated at Project Sites
- EHS-48, Stop Work Authority

Refer to https://apps.prism.leidos.com/eiapps/qa for the current version of E&E referenced procedures.

Current Environmental Health and Safety (EHS) procedures are maintained at https://prism.leidos.com/command_media/command_media_folders/leidos_ehs_manual pdf.

9. ATTACHMENTS

- Attachment 1. Sampling Checklist (Example)
- Attachment 2. Groundwater Sampling Record (Example)

10. DOCUMENT CHANGE RECORD

- Revision 0, dated 31 Jan 2015, is the original version of this procedure issued under Leidos.

- Revision 1, dated 31 Dec 2020, is a minor revision to the procedure. Revisions included the following:
  - Updated organization name from ESE Operation to E&E Division.
  - Revised signature line titles for clarity/consistency.
  - Changed web addresses to reflect current location.
  - Editorial changes to be consistent with other procedures.
  - Section 1.1 – Updated to reference E&E Division.
  - Section 1.2 – Added statement to implement required regulations/standards.
  - Section 3 – Included stop work authority information.
  - Section 8 – Updated references.

ATTACHMENT 1

SAMPLING CHECKLIST (EXAMPLE)

Well Identification: ______________________________

	Yes	No
Map of Site Included?		
Wells Clearly Identified with Roads?		
Well Construction Diagram Attached?		

Well Construction:

Diameter of Borehole: ______________________________

Diameter of Casing: ______________________________

Casing Material: ______________________________

Screen Material: ______________________________

Screen Length: ______________________________

Total Depth: ______________________________

Approximate Depth to Water: ______________________

Maximum Well Development Pumping Rate: ______________________

Date of Last Well Development: ______________________

Previous Sampling Information:

Was the Well Sampled Previously? ______________________________

If yes, complete the table below:

Table of Previous Sampling Information				
Parameter	**Previously Sampled**	**Number of Times Sampled**	**Maximum Concentration**	**Notes (include previous purge rates)**

ATTACHMENT 2

GROUNDWATER SAMPLING RECORD (EXAMPLE)

GROUNDWATER SAMPLING RECORD

Well ID: ____________ Station ID: ________________ Date: _______________

Facility/Site Name: ____

Well Depth (ft-BTOC[1]): _______________ Water Level (static) (ft): ______________

Casing Material: _______________ Well Diameter: ______________

Volume of Water per Well Volume: __________________________

Sampling Crew: ____

____

Type of Pump: _____________ Tubing Material: ___________ Pump Placement (ft from TOC[2]): _____________

Weather Conditions: ____

Notes: ____

____

WATER QUALITY INDICATOR PARAMETERS

Stabilization Criteria: DO +/- 0.3 mg/l, Turbidity +/- 10%, SEC +/- 3%, ORP +/- 10 mV, pH +/- 0.1 unit

Time	Water Level (ft)	Volume Pumped (L)	Pumping Rate (L/min)	DO[3] (mg/L)	Temp (°C)	SEC[4] (µS/cm)	pH	ORP[5] (mV)	Turbidity (NTU)

[1] BTOC - Below Top of Casing
[2] TOC - Top of Casing
[3] DO - Dissolved Oxygen
[4] SEC - Specific Electrical Conductance
[5] ORP - Oxidation Reduction Potential

Other Parameters Obtained: ______________________________

____

Total Volume Purged Prior to Sample Collection: ______________________

Sampled at: ____________ Sampling Device: ____________

Parameters Collected	**Number of Bottles**	**Bottle Lot Number**

ENERGY & ENVIRONMENTAL DIVISION

STANDARD OPERATING PROCEDURE

Water Level Measurement in Wells

E&E FTP-602, Revision 1

Effective 31 Dec 2020

Approved By: ______________________________

Michael D. Simms, P.E.
E&E Division Manager

Kimberly C. Murphree

____

Kimberly C. Murphree, P.E.
E&E Division Quality Assurance Manager

TABLE OF CONTENTS

1. PURPOSE

This Standard Operating Procedure (SOP) establishes a method used to obtain water level measurements in completed wells or piezometers.

1.1 Scope and Limitations

This procedure applies to the Leidos Energy & Environmental (E&E) Division and provides overall technical guidance for obtaining groundwater head measurements in wells using a conducting probe (electronic water level indicator). The procedure does not include the variety of additional methods applicable to water level measurement.

1.2 Regulations or Standards

Although no regulation(s) or standard(s) are included here, it does not mean that none may exist for the activity defined in this SOP. It is the responsibility of the Project Manager to verify that all that all applicable regulations and standards are implemented as necessary.

1.3 Definitions/Acronyms

Aquifer – A consolidated or unconsolidated geologic unit (material, stratum, or formation) or set of connected units that yields water of suitable quantity to wells or springs in economically usable amounts.

Depth – Distance downward from an upper reference point to a target level.

Elevation – The height of a target level above or below a fixed reference point (commonly mean sea level).

Elevation head – The height of groundwater above or below mean sea level.

Hydraulic head (h) – The elevation of groundwater in a well in reference to a specific datum (commonly mean sea level). Hydraulic head is the sum of the elevation head and the pressure head.

Pressure head – Hydrostatic pressure expressed as the height of a groundwater column in a well above the bottom elevation of the point of measurement.

Sampling and Analysis Plan (SAP) – A plan that documents the procedural and analytical requirements for a project that involves the collection of samples to characterize potential areas of contamination. This may be a stand-alone plan or included as a section in another site- or project-specific plan.

Water table – The surface where groundwater pressure head is equal to the atmospheric pressure (i.e., gauge pressure = 0).

2. QUALIFICATIONS AND RESPONSIBILITIES

2.1 Qualifications

Field staff shall be trained by personnel experienced in the equipment, calibration, data collection, and quality control/assurance protocols for this SOP prior to conducting applicable activities. Training may consist of field application under direct supervision of experienced field personnel and training shall be documented in the field records.

2.2 Responsibilities

Project Manager (PM)

- Communicating client or project specific requirements, general and project-specific test goals and locations to the Field Manager.
- Verifying that personnel performing the activity described herein are trained to this procedure as well as other applicable Federal, State or local requirements, and that the training is documented.
- Verifying equipment decontamination protocols are in place. Communicating protocols to Field Manager as warranted by testing to be conducted.

Field Manager

- Overall management of field activities, Leidos, and subcontractor personnel related to water level measurements.
- Assigning appropriate field staff for training and test completion.
- Training inexperienced field personnel in equipment setup, data collection, data management, and results verification.
- Correctly identifying and verifying wells to be measured.
- Communicating health and safety protocols to field staff.
- Communicating client or project specific requirements, general and project-specific goals and locations to the field staff.
- Identifying and acquiring appropriate equipment and materials to perform work.
- Verifying equipment decontamination protocols are in place and communicated to field staff.

Site Safety and Health Officer

- Monitoring of the well headspace and breathing zone concentrations to determine level of protection needed.
- Providing guidance on health and safety requirements.

Field Staff

- Obtaining available information for locations to be measured.
- Inspecting, handling, and managing field equipment per requirements.
- Verifying equipment is operational and calibrated, and that batteries are charged.
- Correctly locating and verifying wells to be measured.
- Completely documenting activity including problems encountered, timing and sequence of events.

3. HEALTH AND SAFETY

Groundwater level measurement may require lifting weights in the range of 15 pounds. Because measurements are commonly conducted at hazardous waste sites, field personnel should be aware of potential for exposure to harmful constituents in groundwater or the well breathing zone. Proper personal protective equipment shall be worn at all times when performing field work.

Procedures for the safe handling and disposition of investigative derived waste, including wash water and rinse water, are in the EHS-46 "Management of Waste Generated at

Project Sites" procedure. The SAP, and/or the project-specific Waste Management Plan may also include information for proper handling and disposal of these materials. In addition, the checklist in E&E FTP-1225 "Field Demobilization Checklist for Investigative Derived Waste" should be reviewed for applicability.

Implement stop work authority (EHS-48) any time an activity potentially poses an uncontrolled risk to human health or the environment.

Refer to the site- or project-specific Health and Safety Plan for relevant or required health and safety requirements. Questions, comments or concerns should be directed to the Field Manager and/or Site Safety and Health Officer.

4. EQUIPMENT AND SUPPLIES

- Electronic Water-Level Indicator (Conducting Probe)
- Keys to Unlock Wells
- Field Logbooks/Forms (see E&E FTP-1215 "Field Activity Documentation")
- Writing Utensil (indelible blue or black ink, black preferred)
- Appropriate Containers for Waste and Equipment
- Decontamination Equipment (as specified in E&E FTP-400 "Equipment Decontamination")
- Personal Protective Equipment (Refer to the site- or project-specific Health and Safety Plan for relevant requirements.)
- Plastic Sheeting (optional)
- Manufacturer's Calibration and Instrument Manual
- Monitoring Equipment (PID, OVA, and Rad Meters)

5. PROCEDURE

5.1 Overview

The measurement of the groundwater level in a well is commonly conducted in conjunction with ground water investigations to establish the configuration of unconfined or confined groundwater surfaces and to determine ground water hydraulic gradients and flow directions. Groundwater level and well depth measurements are also needed to determine the volume of water or drawdown in the well casing for proper well development and purging. Groundwater level measurements are made relative to a fixed reference point on the well casing. The reference point is usually identified by the well installer using a permanent marker for PVC wells, or by notching the top of casing with a chisel for stainless steel wells. The reference point elevation is surveyed in the NGVD (National Geodetic Vertical Datum) or a local datum. For an isolated group of wells, it is acceptable to use an arbitrary datum common to all wells in that group, if necessary.

The water level in the well should be allowed to equilibrate prior to measurement after removing sealing caps. There are no set guidelines and appropriate equilibration times can range from minutes to hours depending on well recharge, local geology and topography, and project objectives.

Measuring the depth to the ground water in a well is accomplished using an electronic water level Indicator consisting of a spool of dual conductor wire, a probe attached to the end and an indicator. When the probe comes in contact with the water, the circuit is closed and a meter light and/or audible buzzer attached to the spool will signal contact. Penlight or 9-volt batteries are normally used as a power source. Measurements should be made and recorded to the nearest 0.01 foot.

Any deviations from specified requirements will be justified to and authorized by the Project Manager. Deviations from project requirements will be documented to allow re-creation of the modified process.

5.2 Preparation

- Don clean gloves, check the well with organic vapor analyzer (OVA), photon ionization detector (PID), and/or radiation detection meters. Unlock and open the well and note the condition of the well in the field logbook (E&E FTP-1215 "Field Activity Documentation").
- Record sampling station number, date, time, and other pertinent information, as applicable. Information related to weather conditions including precipitation should be recorded in the field logbook. The total depth of the well is measured and recorded, if possible.
- Initial monitoring of the well headspace and breathing zone concentrations using a PID, flame ionization detector (FID), and combustible gas meters will be evaluated by the Site Safety and Health Officer to determine required levels of protection.
- Cascading water will result in spurious readings with some types of sounding devices. Flush mounted wells are particularly vulnerable to cascading water from surface sources (runoff, flooding) and water from these sources should be mitigated as they may affect water quality as well as water level. Cascading water within a well casing is usually an indicator that a well casing is compromised or that a well screen is not fully saturated. If this condition is observed, it should be abated and noted in the logbook.
- Oil layers may cause problems in determining the true water level in a well. Note the existence of oil layers in the field logbook.
- Water level readings should be obtained at the frequency specified in the SAP.
- Groundwater with dilute ionic content may not conduct enough current between the electrodes of the electronic water level indicator to activate the instrument.
- Measuring tapes with a weighted end usually have a limit of about 100 feet. The weight will be stainless steel or an inert material specified by the SAP.
- Sampling tools and equipment are protected from sources of contamination prior to sampling and decontaminated prior to and between sampling as specified in FTP-400, Equipment Decontamination.

5.3 Water Level Measurements

Locate the reference mark at top of the inner well casing. The field notes must clearly describe the reference used. If the reference mark is not present, notify the Field Manager, and then make a reference mark on the highest side of the inner well. Make a scratch on the outside edge of the well casing with a file or suitable instrument, being careful that cuttings do not fall into the well casing.

- To achieve consistent results, an electronic water level indicator with a direct-read, graduated flat tape marked every 0.01 feet is recommended. Depth indication on ungraduated indicator probe cables is commonly provided by numbered metal tags securely crimped to the cable at specific intervals.
- Check battery on decontaminated electronic water level indicator and on alarm.
- Lower an electronic water level indicator probe into the well, making sure that the cord or the probe does not scrape the sides of the well casing.
- Stop lowering the probe when the alarm sounds and/or the red light illuminates.
- Raise the probe until alarm no longer sounds.
- Lower probe again slowly. Stop at the instant the alarm sounds and/or the light illuminates and remains illuminated.
- When using a water level indicator that is not graduated in 0.01 foot increments, at the sound of the indicator tone press the cord against the side of casing where the reference mark is etched.
- Mark cord with thumb where it touches reference mark.
- Measure the distance on the cable (using a field ruler or tape measure) from the held mark to the next or previous marked depth increment on the cable. Add or subtract the measured distance from the cable increment to determine the total depth from reference point to the water level.
- Record measurement to within 0.01 feet as depth to water in field logbook.
- Repeat measurement three times for consistency. Measurements should remain constant.
- Pull electronic water level indicator from well and decontaminate in accordance with E&E FTP-400 “Equipment Decontamination”.
- Close and lock the well cap.

6. QUALITY ASSURANCE / QUALITY CONTROL

Data collected under this SOP is subject to the provisions for data collection and management as documented in the project-specific SAP and Quality Assurance Project Plan. Data recorded manually in field notebooks should be reviewed for consistency on a test by test basis. Field records for testing should be maintained on site and copied for distribution to Project Manager.

7. RECORDS

Records generated as a result of this procedure shall be submitted to the designated electronic record system in accordance with E&E A17.1 “Project Records Management”.

8. REFERENCES

- E&E A17.1, Project Records Management
- E&E FTP-400, Equipment Decontamination
- E&E FTP-1215, Field Activity Documentation
- E&E FTP-1225, Field Demobilization Checklist for Investigative Derived Waste
- EHS-46, Management of Waste Generated at Project Sites
- EHS-48, Stop Work Authority

Refer to https://apps.prism.leidos.com/eiapps/qa for the current version of E&E referenced procedures.

Current Environmental Health and Safety (EHS) procedures are maintained at https://prism.leidos.com/command_media/command_media_folders/leidos_ehs_manual pdf.

9. ATTACHMENTS

Not Applicable.

10. DOCUMENT CHANGE RECORD

- Revision 0, dated 31 Jan 2015, is the original version of this procedure issued under Leidos.
- Revision 1, dated 31 Dec 2020, is a minor revision to the procedure. Revisions included the following:
    - Updated organization name from ESE Operation to E&E Division.
    - Revised signature line titles for clarity/consistency.
    - Changed web addresses to reflect current location.
    - Editorial changes to be consistent with other procedures.
    - Section 1.2 – Added statement to implement required regulations/standards.
    - Section 3 – Included stop work authority information.
    - Section 8 – Updated references.

ENERGY & ENVIRONMENTAL DIVISION

STANDARD OPERATING PROCEDURE

Sample Chain of Custody

E&E FTP-625, Revision 1.1

Effective 31 Dec 2020

Approved By: ____________________________
Michael D. Simms, P.E.
E&E Division Manager

Kimberly C. Murphree
____
Kimberly C. Murphree, P.E.
E&E Division Quality Assurance Manager

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ATTACHMENT(S)

1. PURPOSE

This Standard Operating Procedure (SOP) establishes the processes necessary to maintain and document the chain of custody (COC) for samples from collection through final disposition. Proper custody control and documentation is essential to verify the integrity of the samples and associated data.

1.1 Scope and Limitations

This procedure applies to samples collected and custody transfers executed by the Leidos Energy & Environmental (E&E) Division. The receiving laboratory shall be responsible for tracking custody transfers that happen internally including final disposition.

1.2 Regulations or Standards

Although no regulation(s) or standard(s) are included here, it does not mean that none may exist for the activity defined in this SOP. It is the responsibility of the Project Manager to verify that applicable regulations and standards are implemented as necessary.

1.3 Definitions / Acronyms

Chain-of-Custody (COC) Form – A form used to document sample custody transfers from the time of collection through final disposition. A COC form may be identified by a unique number printed or entered on the form.

Custody Holder – The individual with custody of the sample. Initially this is the sampler.

Custody Seal – A narrow strip of adhesive backed paper used to indicate tampering.

Custody Transfer – The process of passing responsibility, control, and access to a sample from one individual to another.

FM – Field Manager. The Field Manager supervises personnel on a site, ensuring everyone on the team is performing their responsibilities in the field.

Package – Container used to store and ship individual samples. Typically, a cooler will be used when samples must be preserved with ice.

PM – Project/Program Manager. The project manager will be responsible for PM designated activities in this procedure. If a project manager is not defined, then the responsibilities shall be assumed by the program manager.

Sample – A representative portion of a population.

Sample Custody – A sample is considered to be under a specific person's custody if the following conditions are met:

a) The sample is in the person's actual possession, or
b) The sample is in view of the person in possession; or
c) The sample is secured by the person in possession so that tampering can be detected.

Sample Team – Group of samplers working together to collect samples for a defined project.

Sample Team Leader – Team member designated by the PM or FM as the individual with primary responsibility for the integrity of samples collected by the team.

Sampler – The individual that collects the sample. References to sampler in this document may refer to either an individual or a sampling team. If the reference is being interpreted as a team then a sampling team leader must be designated in the field notes. The sampling team leader shall assume designated sampler responsibilities.

Secure Area – A space with restricted access used to protect samples when custody is not maintained by either direct physical possession or line of sight.

QA/QC – Quality Assurance / Quality Control

2. QUALIFICATIONS AND RESPONSIBILITIES

2.1 Qualifications

Staff shall be trained to this procedure prior to conducting field activities and that training shall be documented.

2.2 Responsibilities

Project and/or Program Managers (PMs)

- Verifying that personnel performing the activity described herein are trained to this procedure as well as other applicable Federal, State or local requirements, and that the training is documented.
- Verifying conformance with applicable Sampling and Analysis Plan(s) (SAPs).

Field Manager (FM)

- Overall management of field activities including communicating the importance of sample custody procedures and verifying their implementation.

Sampler

- Initiating the COC record prior to transferring sample custody and properly executing the initial custody transfer.

3. HEALTH AND SAFETY

Implement stop work authority (EHS-48) any time an activity potentially poses an uncontrolled risk to human health or the environment. Proper personal protective equipment shall be worn at all times when performing field work.

Questions, comments or concerns about health and safety requirements should be directed to the Field Manager and/or Site Safety and Health Officer.

4. EQUIPMENT AND SUPPLIES

- Chain of Custody (COC) Form – minimum requirements:
  - Unique field sample ID, traceable to the field notes that clearly identify the physical location of sample origin.
  - Date and time of sample collection.
  - Number and type of sample containers, including preservation.

  - Name of the sampler or sample team leader.
- Custody Seal – minimum requirements:
  - Narrow strip of adhesive backed paper used to indicate if tampering has occurred.
  - Must be signed and dated by the person affixing the seal immediately after it is applied.
- Writing Utensil –handwritten entries shall be made using indelible blue or black ink, with black ink preferred.

5. PROCEDURE

5.1 Overview

A chain of custody form is used to record sample custody transfers. The form must be completed in a manner that accomplishes the following:

- Sample possession must be traceable from the time that samples are collected through analysis and final disposition.
- All sample custody transfers must be recorded on a COC form while Leidos maintains custody.
- All entries must be legible. Zeroes shall be recorded with a slash (/) through them to distinguish from the letter o.
- All handwritten entries shall be made using indelible blue or black ink, black ink preferred.
- Dates and times shall be recorded using the format mm/dd/yy for the date and the military or 24-hour clock format for time entries.
- Erroneous entries may only be marked out using a single line in a manner that does not obliterate the original entry.
- All corrections or additions shall include:
  - the signature or initials of the person making the change,
  - the date of the change, and
  - any information necessary to support and/or explain the need for the change.

The COC record must be initiated and completed by the sampler as soon as practicable following sample collection and before the initial custody transfer. The completed COC must accompany the sample(s) as long as Leidos maintains custody. Each sample must be listed on the COC form with the following minimum information:

- A unique sample ID, traceable to the field logbook (see E&E FTP-1215 “Field Activity Documentation”).
- Date and time of sample collection.
- Number and type of sample containers, including preservation.
- Name of the sampler.

If QC or split samples are provided to another laboratory or entity, a separate COC will be filled out. Neither COC shall contain information revealing that the samples were split in order to maintain the integrity of the QA process.

5.2 Details

Samples may be retained by the sampler, transferred directly to another person, or transferred to another person via a common carrier or courier. Custody seals and secured areas must be used, as appropriate, to maintain custody control.

- Custody Seals
  Custody seals verify the integrity of the custody chain. The presence and condition of custody seals shall be noted on the COC when custody is officially transferred to the receiving party.
  - Custody seals must be affixed in a manner such that tampering will be evident
  - They must be signed and dated by the individual with custody of the samples immediately following application.
  - A minimum of two custody seals must be applied to the package, such as a cooler, on opposing corners.
  - A custody seal should also be used on inner packaging.
- Secure Area
  Packages of samples must be moved to a secure area as soon as practicable when custody is not maintained by either direct physical possession or line of sight. Packages of samples left in secure areas must also be protected from tampering by using custody seals if someone other than the custody holder may access the secure area.

5.2.1 Retain Custody

The custody holder may retain possession of the samples. Custody will be maintained by one of the following methods:

- Keeping the samples in the custody holder’s possession;
- Keeping the samples in the custody holder’s line of sight; or,
- Securing the samples in a manner such that tampering can be detected and storing the packaged samples in a secure area as soon as practicable.
  - Samples must be packaged and preserved appropriately.
  - All samples must be listed on the COC and the original COC must remain with the samples. Required information must be included on the COC before the samples are left in the secure area. However, the “Relinquished by” or equivalent field should not be signed or dated.
  - A minimum of two custody seals must be affixed to the package of samples. Custody seals must be signed and dated, at the time of application, by the custody holder.

5.2.2 Transfer Custody

The signatures of the individuals relinquishing and accepting custody shall be entered on the COC record at the time of the custody transfer along with the date and time the transfer occurs. The number of custody transfers should be minimized.

Note that custody is not formally passed to a courier or common carrier during shipping. The custody transfer is completed at the shipping destination by the individual that breaks the custody seal and signs the COC as the recipient.

- Details of the initial custody transfer shall be recorded in the field logbook.
- The person relinquishing and accepting custody should check that samples listed on COC are present and intact at the time of the transfer and that the COC is complete and accurate.
- All samples must be packaged with adequate preservative and packing materials to safely transport samples.
- Shipping information must be recorded on the COC when a courier or common carrier is used. Shipping paperwork must be retained for project files and tracking information must be recorded in the field notes.
- A copy of the executed COC should be retained for the project records by the sampler.
- The original COC must accompany the samples and generally should be sealed in a watertight, plastic cover in the package with the samples. This practice must be followed when shipping by a courier or common carrier. A convenient method to accomplish this is to place the COC in a re-sealable bag and tape it to the inside of the package.
- Custody seals must be used when shipping samples by a courier or common carrier.
- The condition of custody seals must be noted on the COC prior to accepting custody.
- When shipping multiple packages, samples must be grouped and recorded on COC(s) in a manner that clearly indicates the contents of each individual package.

6. QUALITY ASSURANCE / QUALITY CONTROL

All COCs should be peer reviewed prior to the initial custody transfer whenever practicable. Any peer review conducted shall be recorded in the field logbook and/or noted on the Chain of Custody form.

7. RECORDS

Records generated as a result of this procedure shall be submitted to the designated electronic record system in accordance with E&E A17.1 “Project Records Management”.

8. REFERENCES

- DoD Environmental Field Sampling Handbook, Revision 1, April 2013.
- E&E A17.1, Project Records Management
- EHS-48, Stop Work Authority

Refer to https://apps.prism.leidos.com/eiapps/qa for the current version of E&E referenced procedures and forms.

Current Environmental Health and Safety (EHS) procedures are maintained at https://prism.leidos.com/command_media/command_media_folders/leidos_ehs_manual pdf.

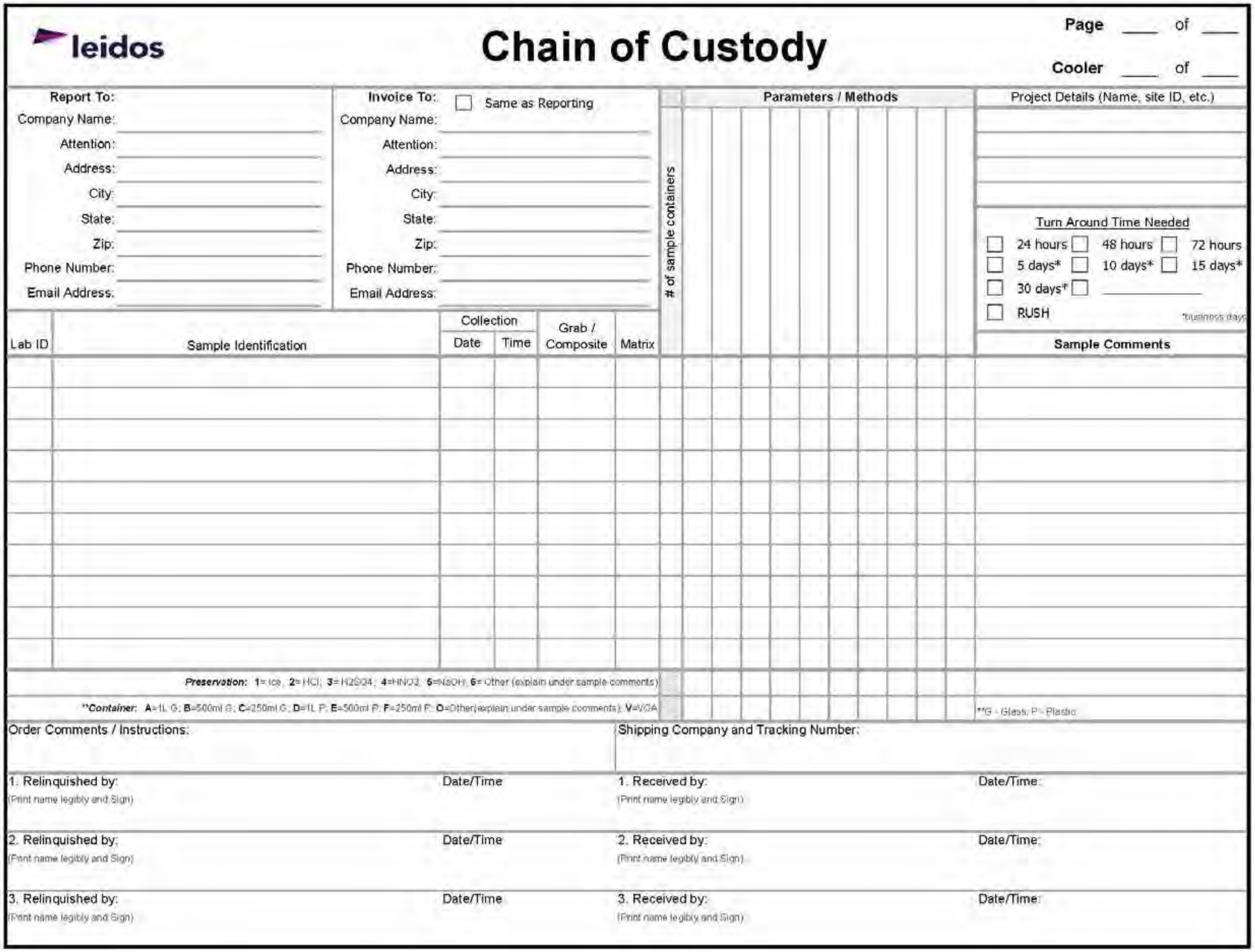
9. ATTACHMENTS

- Attachment 1. Chain of Custody (Example)

10. DOCUMENT CHANGE RECORD

- Revision 0, dated 3 Mar 2014, is the original version of this procedure issued under Leidos.
- Revision 1, dated 4 Feb 2015, is the first revision of this procedure. Minor revisions included the following:
  - Changing the Operation name from Environment and Civil Infrastructure (ECI) to Environmental Science and Engineering (ESE).
  - Revised footer on cover page.
  - Section 1.1 – Updated reference to ESE Operation.
  - Section 8 – Updated references. Added statement regarding where current versions of ESE procedures are located.
  - Section 7 – Revised statement to match information in other ESE procedures.
  - General formatting changes to be consistent with other ESE procedures.
- Revision 1.1, dated 31 Dec 2020, is a minor revision to the procedure. Revisions included the following:
  - Updated organization name from ESE Operation to E&E Division.
  - Revised signature line titles for clarity/consistency.
  - Changed web addresses to reflect current location.
  - Editorial changes to be consistent with other procedures.
  - Section 1.2 - Added statement to implement required regulations/standards.
  - Section 3 – Included stop work authority information.
  - Section 5 – Reformatted using 3rd level headers.
  - Section 8 – Updated references.

ATTACHMENT 1
CHAIN OF CUSTODY (EXAMPLE)



leidos **Chain of Custody**

Page ____ of ____

Cooler ____ of ____

Report To:
Company Name:
Attention:
Address:
City:
State:
Zip:
Phone Number:
Email Address:

Invoice To: ☐ Same as Reporting
Company Name:
Attention:
Address:
City:
State:
Zip:
Phone Number:
Email Address:

Parameters / Methods

Project Details (Name, site ID, etc.)

Turn Around Time Needed
☐ 24 hours ☐ 48 hours ☐ 72 hours
☐ 5 days* ☐ 10 days* ☐ 15 days*
☐ 30 days* ☐ ____________
☐ RUSH *business days

Lab ID	Sample Identification	Collection Date	Collection Time	Grab / Composite	Matrix	# of sample containers	Parameters / Methods	Sample Comments

Preservation: **1**= Ice; **2**= HCl; **3**= H2SO4; **4**=HNO3; **5**=NaOH; **6**= Other (explain under sample comments)

***Container:* **A**=1L G; **B**=500ml G; **C**=250ml G; **D**=1L P; **E**=500ml P; **F**=250ml P; **O**=Other(explain under sample comments); **V**=VOA

**G - Glass; P - Plastic

Order Comments / Instructions:

Shipping Company and Tracking Number:

1. Relinquished by: (Print name legibly and Sign)	Date/Time	1. Received by: (Print name legibly and Sign)	Date/Time:
2. Relinquished by: (Print name legibly and Sign)	Date/Time	2. Received by: (Print name legibly and Sign)	Date/Time:
3. Relinquished by: (Print name legibly and Sign)	Date/Time	3. Received by: (Print name legibly and Sign)	Date/Time:

ENERGY & ENVIRONMENTAL DIVISION

STANDARD OPERATING PROCEDURE

Labeling, Packaging, and Shipping Environmental Samples

E&E FTP-650, Revision 1

Effective 31 Dec 2020

Approved By: ______________________________
Michael D. Simms, P.E.
E&E Division Manager

Kimberly C. Murphree
____
Kimberly C. Murphree, P.E.
E&E Division Quality Assurance Manager

TABLE OF CONTENTS

1. PURPOSE

This Standard Operating Procedure (SOP) establishes the minimum requirements for sample classification, storage, packaging, handling and shipment of samples.

1.1 Scope and Limitations

This SOP only applies to environmental samples obtained by the Leidos Energy & Environmental (E&E) Division personnel and subcontractors. Additional requirements, outside this scope, apply if the material sampled is known or expected to present a hazard. A sample that meets the criteria for one of the nine classes of hazardous materials as defined by the Department of Transportation (DOT, 49 CFR) or is identified as a dangerous good as defined by the International Air Transport Association (IATA, Dangerous Goods Regulations manual) must be packaged and shipped per the applicable requirements. See E&E FTP-651 "Hazardous Materials/Dangerous Goods Shipping" for more information.

The mention of trade names or commercial products in this procedure does not constitute an endorsement or recommendation for its exclusive use.

1.2 Regulations or Standards

The regulation(s) or standard(s) included below may not be a complete list of regulations or standards applicable to the activity described in this SOP. It is the responsibility of the Project Manager to verify that applicable regulations and standards are implemented as necessary.

- Code of Federal Regulations, Title 49, Transportation (The DOT Materials of Trade regulation includes a specific exemption for environmental samples.)
- Dangerous Goods Regulations, International Air Transport Association (IATA), latest revision

1.3 Definitions/Acronyms

<u>49 CFR</u> – Title 49 of the Code of Federal Regulations containing the principle set of rules and regulations issued by the Department of Transportation.

<u>DOT</u> – Department of Transportation

<u>Environmental Sample</u> – A sample of material that is collected from an environmental source.

<u>Hazardous Material</u> – material that falls under one or more of DOT's nine classes of hazardous materials: 1) Explosives, 2) Gases, 3) Flammable Liquid and Combustible Liquid, 4) Flammable Solid, Spontaneously Combustible and Dangerous When Wet 5) Oxidizer and Organic Peroxide, 6) Poison (Toxic) and Poison Inhalation Hazard, 7) Radioactive, 8) Corrosive, 9) Miscellaneous.

<u>IATA</u> – International Air Transport Association

<u>Limited Quantity (Radionuclides)</u> – Limited quantity is defined by 49 CFR as the maximum amount of hazardous material for which there is a specific labeling or packaging

exception. Specifically, it is a quantity of Class 7 (radioactive) material not exceeding the material's package limits specified in 49 CFR 173.425 and conforming with requirements specified in 49 CFR 173.421.

Materials of Trade – Materials of trade are hazardous materials that are carried on motor vehicles for at least one of the following purposes.

- To protect the health and safety of the motor vehicle operator or passengers (e.g., insect repellant, fire extinguishers).
- To support the operation or maintenance of motor vehicles/auxiliary equipment (e.g., engine starting fluid, gasoline, spare battery).
- Materials that must be carried by a private motor carrier to directly support a principal business that is not transportation (e.g., pest control, plumbing, painting).

Sampling and Analysis Plan (SAP) – A plan that documents the procedural and analytical requirements for a project that involves the collection of samples to characterize potential areas of contamination. This may be a stand-alone plan or included as a section in another site- or project-specific plan.

2. QUALIFICATIONS AND RESPONSIBILITIES

2.1 Qualifications

Staff shall be trained to this procedure prior to conducting applicable activities and that training shall be documented.

2.2 Responsibilities

Project and/or Program Managers (PMs)

- Communicating general and project-specific sample identification requirements to the Field Manager.
- Verifying that personnel performing the activity described herein are trained to this procedure as well as other applicable Federal, State or local requirements, and that the training is documented.

Site Safety and Health Officer

- Reviewing appropriate site- or project-specific documents and/or procedures to verify that proper labeling, packaging, and shipping requirements are defined.
- Providing guidance on health and safety requirements.
- Periodically reviewing labeling, packaging and shipping activities to verify compliance with requirements.

Field Manager

- Overall management of field activities related to sample identification and packaging.
- Communicating client or project specific requirements to the field staff.
- Verifying that the field staff has the necessary materials (e.g., sample labels, packing materials, etc.) to perform work.

Field Staff

- Labeling samples accurately.
- Packaging and handling samples properly to prevent breakage and/or cross-contamination.
- Performing assigned tasks in a safe and effective manner according to established operating procedures.
- Attending required training and understanding tasks assigned.
- Using required personal protective equipment.
- Reporting unsafe or questionable conditions to a supervisor.

3. HEALTH AND SAFETY

Implement stop work authority (EHS-48) any time an activity potentially poses an uncontrolled risk to human health or the environment. Proper personal protective equipment shall be worn at all times when performing field work.

Refer to the site- or project-specific Health and Safety Plan for relevant health and safety requirements. Questions, comments or concerns should be directed to the Site Safety and Health Officer and/or and the Field Manager.

4. EQUIPMENT AND SUPPLIES

Equipment and supply requirements for environmental sample labeling, packaging and shipping may vary based on sample matrix and project requirements. The following list includes some of the more common requirements:

- Chain of Custody forms (see E&E FTP-625 “Sample Chain of Custody”)
- Custody seals
- Field logbook/forms (see E&E FTP-1215 “Field Activity Documentation”)
- Packaging Materials (required as-needed):
    - Ice chest/cooler
    - Plastic liners sufficient to provide secondary containment for liquids
    - Ice (dry or wet; if required as a preservative)
    - Material to pad sample containers (e.g., bubble wrap/bags, vermiculite)
    - Re-sealable food bags
    - Wide clear tape (i.e., packing tape)
    - Temperature blank (may be optional depending on project requirements)
- Sample Labels
- Writing Utensil –indelible blue or black ink, black ink preferred.

5. PROCEDURE

5.1 Overview

Classification of samples (e.g., environmental, hazardous, dangerous goods) shall be based on the suspected level of contaminant concentration, which determines subsequent packaging and labeling requirements, shipping procedures and handling of samples.

This procedure specifically covers the requirements for shipping environmental samples. Samples classified as hazardous or dangerous goods shall be shipped only by appropriately trained personnel and by means specified in DOT (49 CFR) or the IATA Dangerous Goods regulations as appropriate. Requirements for shipping hazardous and dangerous goods are specifically not covered in this procedure. If there is uncertainty as to the sample classification, the field staff must consult with the Field Manager, the Site Safety and Health Officer, and the Project Manager prior to shipping samples.

Typical requirements for labeling, packaging and shipping environmental samples are discussed below. If a client or project requires different methods, those methods shall be followed provided they are not less stringent than the requirements stated here.

Deviations from the requirements in this SOP shall be clearly documented in the SAP or other appropriate project-specific document.

5.2 Sample Classification

Samples may be classified as environmental if site conditions are known, and the sample does not meet the criteria for any of the nine hazard classes identified by DOT. If site conditions are not known, it is important to be conservative in the estimate of contaminant concentrations until data exists to support classifying samples as environmental.

Samples taken for the purpose of radiological characterization are considered environmental samples as long as the shipment does not exceed the limited quantity of radionuclides. If the shipment exceeds limited quantity for the radionuclides present, refer to 49 CFR 173 for details regarding shipping requirements.

5.3 Environmental Sample Labeling

Unique sample identification shall be assigned to each sample container. The identification scheme shall be defined in the SAP or other appropriate project-specific document. The identification scheme should be designed such that the site, sample location within the site, sample matrix, and sample type (i.e., environmental, duplicate, split, composite, etc.) can be ascertained from sample identification. Some projects may have specifically defined requirements for sample identification that must be followed.

The sample label, which should be waterproof or affixed so it is protected from damage, shall include the following information, at a minimum:

- Sample identification
- Time of collection (24-hour, four-digit)
- Date of collection (MMDDYY or MM/DD/YY)
- Location of sample
- Identity of the sampler
- Preservation used

Other information that may be appropriate on a label includes company information, company phone number, sample interval, media, analytical method name and number, and field preparation information (e.g., filtered). Information required on labels must be defined in the SAP.

5.4 Sample Storage

Samples shall be stored in a manner consistent with the requirements for sample preservation to maintain the quality of the sample. Samples preserved by cooling shall be stored so that an acceptable range of temperature is maintained for the duration of the holding time. The cooling process must be initiated immediately after sample collection in the field. Shipment to the laboratory should be completed as soon as possible and within holding time limits specified for the particular analyses. If temporary storage is necessary, samples shall remain in an area that has been designated as a sample storage area that must be locked and secured to maintain sample integrity and chain of custody requirements (see E&E FTP-625 “Sample Chain of Custody”). Samples subjected to temporary storage shall be checked periodically to confirm the appropriate holding temperature is being maintained. The holding temperature and periodic temperature measurements shall be recorded in the field logbook or field form (see E&E FTP-1215 “Field Activity Documentation”).

Samples shall not be stored in refrigerators, coolers, or other areas where food or drink may also be stored and vice versa.

5.5 Environmental Sample Packaging

5.5.1 Regulatory Considerations

Current DOT and IATA requirements shall be reviewed by the Field Manager prior to a sampling event to verify that samples are shipped appropriately depending upon matrix and expected type and concentration of contaminants.

5.5.2 Shipping Containers

All sample containers should be placed inside a strong, tight container capable of withstanding a 4-foot drop on solid concrete in the position most likely to cause damage. A metal or plastic cooler (ice chest) with a hard plastic liner withstands this test. Drainage holes present must be taped shut on the inside and outside of the cooler to prevent contents from escaping (e.g., broken containers, water from melted ice, etc.).

The shipping container should be marked “THIS END UP” on all four sides with arrows indicating the proper upward position of the container.

Two plastic liners should be placed inside the shipping container and samples and ice (if required) shall be placed inside these liners.

The chain(s) of custody and other appropriate paperwork shall be sealed in a plastic bag and taped to the inside lid of the shipping container. Custody seals shall also be used, as appropriate, and in accordance with the requirements in E&E FTP-625 “Sample Chain of Custody”.

The shipping container should be taped shut to form a seal around the lid to prevent leakage in the event the cooler is turned over. Strapping tape should also be wrapped around the container in two locations if shipping via commercial carrier.

To prevent cross-contamination, shipping containers must be adequately cleaned between shipments with soap (preferably laboratory grade/specialty soap such as Alconox® or Liquinox® and water, unless stronger cleaner is required.

5.5.3 Ice

Samples requiring cooling are typically packed in loose or bagged wet ice, inside the cooler liner. Other methods of cooling the samples with ice may be used as long as the requirements are clearly defined in the SAP. The amount of ice used will depend on the available space in the cooler and the temperature requirements for the samples.

5.5.4 Glass Sample Bottles

The lid of the glass sample bottle shall be tightened to ensure an adequate seal and to prevent loosening during transit. If appropriate, lids should be sealed with tape or other secure fastening. Glass containers shall be wrapped and cushioned in an inert packing material such as vermiculite, closed-cell foam packing material, or bubble wrap. Samples containers should be placed upright in the shipping container and they should not be stacked.

5.5.5 Plastic Containers

Plastic containers do not require individual cushioning material, but must be packed to prevent movement during transit. Caps should be adequately tightened to prevent loosening. If appropriate, caps should be sealed with tape or other secure fastening. Samples containers should be placed upright in the shipping container and they should not be stacked.

5.6 Shipping Environmental Samples

Environmental samples may be shipped by commercial common carrier, vehicle, or air-cargo service to the laboratory. Commercial carriers should be contacted prior to packaging samples to ascertain specific restrictions, such as weight limits, as well as delivery and pick up schedules and/or receiving hours.

Preserved samples shall be received by the laboratory within the prescribed holding times.

6. QUALITY ASSURANCE / QUALITY CONTROL

Care must be taken at all times to ensure preservation requirements are maintained for samples, if needed, and that analytical hold times are being monitored.

Chain of custody forms should be verified with the contents of a shipping container prior to shipment by the field staff that will close and seal the container.

7. RECORDS

Documentation generated as a result of this procedure is submitted to the designated record system in accordance with E&E A17.1 "Project Records Management."

8. REFERENCES

- E&E A17.1, Project Records Management
- E&E FTP-625, Sample Chain of Custody
- E&E FTP-651, Hazardous Materials/Dangerous Goods Shipping
- E&E FTP-1215, Field Activity Documentation
- EHS-48, Stop Work Authority

Refer to https://apps.prism.leidos.com/eiapps/qa for the current version of E&E referenced procedures.

Current Environmental Health and Safety (EHS) procedures are maintained at https://prism.leidos.com/command_media/command_media_folders/leidos_ehs_manual pdf.

9. ATTACHMENTS

Not Applicable.

10. DOCUMENT CHANGE RECORD

- Revision 0, dated 31 Jan 2015, is the original version of this procedure issued under Leidos.
- Revision 1, dated 31 Dec 2020, is a minor revision to the procedure. Revisions included the following:
  - Updated organization name from ESE Operation to E&E Division.
  - Revised signature line titles for clarity/consistency.
  - Changed web addresses to reflect current location.
  - Editorial changes to be consistent with other procedures.
  - Section 1.1 – Updated to reference E&E Division.
  - Section 3 – Included stop work authority information.
  - Section 8 – Updated references.

ENERGY & ENVIRONMENTAL DIVISION

STANDARD OPERATING PROCEDURE

Analytical Method Selection for Environmental Samples

E&E FTP-655, Revision 1

Effective 31 Dec 2020

Approved By:

Michael D. Simms, P.E.
E&E Division Manager

Kimberly C. Murphree

Kimberly C. Murphree, P.E.
E&E Division Quality Assurance Manager

TABLE OF CONTENTS

1. PURPOSE

This Standard Operating Procedure (SOP) establishes guidance on the selection of appropriate methodology for the chemical analysis of environmental samples and presents the various factors that should be considered during this selection.

1.1 Scope and Limitations

This SOP applies to the Leidos Energy & Environmental (E&E) Division. The requirements in this SOP may be superseded in the event a client requires different methodologies or analytical protocols. Client-specific requirements must be documented clearly in the Sampling and Analysis Plan (SAP) or other project-specific document.

1.2 Regulations or Standards

Although no regulation(s) or standard(s) are included here, it does not mean that none may exist for the activity defined in this SOP. It is the responsibility of the Project Manager to verify that applicable regulations and standards are implemented as necessary.

1.3 Definitions/Acronyms

Data Quality Objectives (DQO) – Qualitative and quantitative statements derived from the DQO process that clarify study technical and quality objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

Quality Assurance Project Plan (QAPP) – a document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved.

Sampling and Analysis Plan (SAP) – A plan that documents the procedural and analytical requirements for a project that involves the collection of samples to characterize potential areas of contamination. This may be a stand-alone plan or included as a section in another site- or project-specific plan.

2. QUALIFICATIONS AND RESPONSIBILITIES

2.1 Qualifications

Staff shall be trained to this procedure prior to conducting applicable activities and that training shall be documented.

2.2 Responsibilities

Project and/or Program Managers (PMs)

- Communicating general and project-specific sample analysis requirements to the Field Manager.

Field Manager

- Overall management of field activities related to sample collection for the appropriate chemical analysis.
- Communicate client- or project-specific requirements to the field staff.

Project Chemist

- Communicate with the selected analytical laboratories and serve as the principle point-of-contact between the analytical laboratory and the Project Manager.
- Reviews methods selected for appropriateness in meeting the established data quality objectives.
- Work with the Field Manager and the analytical laboratory to coordinate the collection of samples with the appropriate sample bottles and preservatives to meet the analytical method requirements.

3. HEALTH AND SAFETY

Not Applicable.

4. EQUIPMENT AND SUPPLIES

Not Applicable.

5. PROCEDURE

5.1 Overview

For most of the analytical parameters associated with the chemical analysis of environmental samples, there is generally more than one analytical method. This SOP presents various factors to be considered in method selection if project requirements do not specifically dictate methods to be used.

To select the most appropriate method for analysis, the following factors will be considered:

- physical state of sample;
- anticipated concentration of analytes;
- required detection limit;
- data quality objectives (DQOs);
- regulatory requirements;
- set up and equipment available at the analytical facility; and
- cost of analysis.

Selecting the appropriate method involves assessing the characteristics of each sample, the intended use of the data obtained from the analysis, and the limitations imposed by the analytical facility.

Analytical levels of support are selected based upon DQOs. The analytical levels may be defined as follows, or as otherwise specified in the project-specific documents:

- Level I – Field screening using portable instruments. Results are often not compound specific and not quantitative.
- Level II – Field analysis using more sophisticated portable analytical instruments. In some cases, the instruments may be set up in a mobile laboratory on site. There is a wide range in the quality of data that can be generated. It depends on the use

of suitable calibration standards, reference materials, sample preparation equipment, and the training of the operator.

- Level III – Analyses performed in an analytical laboratory, primarily utilizing standard EPA-approved procedures. This level provides qualitative and quantitative analytical data but does not usually include the extent of validation and documentation required for Level IV.
- Level IV – Analyses are performed in an analytical laboratory following Contract Laboratory Program (CLP), Department of Defense (DoD) Quality Systems Manual (QSM), or other stringent protocols designed to meet the intent of the project, program, or contract. This level is characterized by rigorous QA/QC protocols and documentation and provides qualitative and quantitative analytical data.
- Level V – Analysis by nonstandard methods in an analytical laboratory. Method development or modification may be required for specific constituents or detection limits.

5.2 Analytical Methods

The analytical methods to be applied to the samples are selected during the development of the SAP or QAPP or may be determined by regulatory or client requirements.

Due to unexpected sample characteristics that become evident only when the sampling or analysis task is actually performed, an alternative analytical method may be required; however, a tentative analytical method selection is necessary for cost estimating purpose. This enables the laboratory to prepare for the analysis (e.g., ordering reagents, scheduling analyses, etc.) and to prepare the proper sample containers.

5.3 Assessing the Sample

The physical state of the sample has an impact on the methods to be selected. Possible phase characteristics include aqueous, oil or organic liquid, sludge or sediment, solid, groundwater, or multiphasic. For multiphase samples, more than one method may be required.

5.4 Analyte Concentration

The expected level of contamination impacts the analytical method selection.

- Estimate the expected concentration of the analytes of interest for each sample. This estimate is based upon knowledge of the area being sampled, previous data obtained for that area, and field screening results available.
- Also, consider anticipated components of the sample that may interfere with the analysis of the sample and, therefore, require the use of a special analytical method.

5.5 Detection Limit

When communicating with the lab, define the terms and requirements (method detection limit, limit of detection, reporting limit, practical quantitation limit, etc.)

- Determine the required analytical detection limit for the parameter of interest. This determination is based upon the intended use of the data, as well as the program under which the samples are analyzed.
- The required detection limit may be determined by the applicable regulatory level or the concentration at which a specific action will be taken.
- A method that achieves the lowest detection limit possible is considered for composite samples.
- Samples that require dilution due to high concentrations of compounds of interest or sample matrix interferences will increase the level of detection.

5.6 Data Quality Objectives (DQOs)

During the preparation of project plans DQOs are established based upon the intended use of the data, developed during project planning, and documented in the QAPP. The required data quality level impacts the analytical methods that may be used. For example, if the purpose of the analysis is to qualitatively determine the presence or absence of a compound or group of compounds, a simple screening method may be applied. If however, a particular compound needs to be quantified with a high degree of precision and accuracy, a more rigorous method must be selected.

5.7 Regulatory Requirements

Samples collected must be analyzed in accordance with applicable federal, state or agency-specific regulatory requirements. Such requirements may dictate the detection limits to be achieved or, more specifically, the analytical methods to be used.

5.8 Analytical Facility

The selection of the laboratory, and analytical methods, may be impacted by the certification or accreditation required. The Project Chemist must verify the certification or accreditation of the laboratory for the parameters of interest.

Laboratory personnel will advise on limitations and method preferences of the analytical facility. It should be noted that most laboratories have restrictions on the limit of radioactivity that they may receive. Guidance will be sought from the receiving laboratory prior to sampling and transporting samples.

5.9 Cost

If a choice still remains, after all other factors have been considered, select the most cost-effective method. All method selections must meet the objectives of the SAP.

6. QUALITY ASSURANCE / QUALITY CONTROL

Analytical chemistry methodologies have prescribed quality assurance/quality control requirements in the written methods.

7. RECORDS

Records generated as a result of this procedure shall be submitted to the designated electronic record system in accordance with E&E A17.1 “Project Records Management”.

8. REFERENCES

- E&E A17.1, Project Records Management

Refer to https://apps.prism.leidos.com/eiapps/qa for the current version of E&E referenced procedures.

9. ATTACHMENTS

Not Applicable.

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  - Editorial changes to be consistent with other procedures.
  - Section 1.2 – Added statement to implement required regulations/standards.
  - Section 8 – Updated references.

ENERGY & ENVIRONMENTAL DIVISION

STANDARD OPERATING PROCEDURE

Field Measurement Procedures

E&E FTP-750, Revision 1

Effective 31 Dec 2020

Approved By: ______________________________

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1. PURPOSE

This Standard Operating Procedure (SOP) establishes the general methodology to obtain the following field measurements: organic vapor, combustible gas, mercury vapor, pH, temperature, salinity, conductivity, turbidity, dissolved oxygen, oxidation-reduction potential and radiation.

1.1 Scope and Limitations

This procedure describes the use of various equipment types to obtain measurements in the field by Leidos Energy & Environmental (E&E) Division personnel and subcontractors. The information herein is meant to serve as a guide to instrument operations. It does not indicate that the information contained herein is the generally preferred method, the only method, or the only instrument type that may be used. Specific calibration, operation and maintenance requirements are defined by the manufacturer's operating instructions.

1.2 Regulations or Standards

Although no regulation(s) or standard(s) are included here, it does not mean that none may exist for the activity defined in this SOP. It is the responsibility of the Project Manager to verify that applicable regulations and standards are implemented as necessary.

1.3 Definitions/Acronyms

DO – Dissolved oxygen

ME – Membrane electrodes

ORP – Oxidation-reduction potential

Sampling and Analysis Plan (SAP) – A plan that documents the procedural and analytical requirements for a project that involves the collection of samples to characterize potential areas of contamination. This may be a stand-alone plan or included as a section in another site- or project-specific plan.

2. QUALIFICATIONS AND RESPONSIBILITIES

2.1 Qualifications

Staff shall be trained to this procedure prior to conducting field measurement activities with the instruments discussed herein and that training shall be documented.

2.2 Responsibilities

Project and/or Program Managers

- Verifying appropriate equipment is selected for the work required.
- Verifying that personnel performing the activity described herein are trained to this procedure as well as other applicable Federal, State or local requirements, and that the training is documented.

Field Manager

- Verifying compliance with the Sampling and Analysis Plan (SAP).
- Verifying that personnel perform their assigned duties in accordance with this procedure, as applicable.

- Overall management of field activities.

Site Safety and Health Officer

- Providing guidance and answering questions about health and safety requirements.

Field Staff

- Operating equipment in accordance with this procedure and/or appropriate manufacturer instructions.

3. HEALTH AND SAFETY

Health and safety requirements can vary with regard to using any piece of equipment. Operating instructions should be reviewed before operating equipment. Implement stop work authority (EHS-48) any time an activity potentially poses an uncontrolled risk to human health or the environment. Proper personal protective equipment shall be worn at all times when performing field work.

Refer to the site- or project-specific Health and Safety Plan for relevant health and safety requirements before performing work. Health and safety questions, comments or concerns should be directed to the Site Safety and Health Officer and/or the Field Manager.

4. EQUIPMENT AND SUPPLIES

Equipment and supplies vary depending upon the analytical analysis and the type of field instrument used. Refer to the manufacturer's instructions for specific details regarding the equipment and supplies necessary to properly calibrate, operate, use and maintain the equipment.

The following describes some of the instrumentation that is commonly used in the collection of data discussed in this procedure; it is not meant to be a comprehensive or all-inclusive list of field instruments. The SAP or another project-specific document will provide the specific equipment list needed for the execution of the field measurements.

- Organic vapor detectors are used for volatile organic compound (VOC) detection, hydrocarbon detection, soil contamination measurement, to detect organic vapors in depressions or confined spaces, to screen drums or other containers for the presence of trapped vapors, and to assess an area for elevated levels of volatile organics. Instrumentation suitable for these determinations includes photoionization detector (PID), flame ionization detector (FID), and colorimetric gas detection tubes. Examples include Photovac FID Organic Vapor Analyzers (OVAs), RAE Systems detectors, and Draegar tubes.
- Combustible gas sensors are designed to measure combustible gas or vapor content in air and may be used by hazardous materials teams or for confined space entry. These devices range from simple Oxygen/Lower Explosive Limit (LEL) combustible gas monitors (which measure explosive limits) to multi-gas monitors (which measure compounds that are potentially toxic at levels below the sensitivity

of the LEL sensors) for toxic environments. An example would be a MultiRAE Gas Detector.

- Mercury vapor analyzers are portable devices that detect mercury vapor concentrations at a single point in time. They utilize various detection techniques including gold film sensors, ultraviolet absorption, or atomic fluorescence.
- Water quality parameters including pH, oxidation-reduction potential (ORP), temperature, dissolved oxygen (DO), conductivity, turbidity, and salinity are determined via single or multiple parameter field devices with one or more sensors. These sensors may include a temperature sensor (resistance temperature detector), a glass electrode sensor that uses a potentiometric method to measure pH and ORP, multi-electrode conductivity sensors, a polarographic sensor or an optical sensor for DO, and an electronic nephelometer for turbidity. Common devices include multi-parameter YSI meter or In-Situ TROLL probes.
- Radiation survey equipment may include ionization chambers, proportional counters, Geiger-Mueller (GM) counters, and scintillation detectors.

Other types of equipment and supplies may be required during field activities utilizing the equipment discussed in this procedure. Typical items include sample containers, calibration solutions, decontamination supplies, waste containers, personal protective equipment, field logbooks and field forms. The SAP or other project-specific document will define the specific equipment and supplies required.

5. PROCEDURE

5.1 Overview

Any deviations from the guidance contained herein, SAP-specified protocols or manufacturer instructions for equipment use must be authorized by the Project Manager and/or the relevant Program Manager and documented on the appropriate field change form. Justification for the deviation must be clearly defined.

The manufacturer’s operating instructions for each instrument in use must be present on site for reference.

The procedure E&E A12.1 “Control of Measuring and Test Equipment” will be followed for identification, storage and calibration of instruments used, as applicable.

Each section below will serve as a guide to the operation for the instrument discussed in that section.

5.2 Field Measurements

The following steps are typical for any field instrument:

- Choose an instrument that is consistent with the investigation requirements. Refer to the Health and Safety Plan or the SAP for detection requirements that must be met, as well as for details regarding sampling intervals or locations.
- Inspect the instrumentation for damage. If damaged, replace or repair before use.

- Verify the calibration date is current and perform routine calibration checks per the manufacturer's instructions. Adjust calibration if required. If the calibration date of the instrument has passed, do not use the instrument.
- Document routine calibration activities (field logbook entry or separate calibration log). Information to be recorded includes:
    - Name of the person performing the routine calibration.
    - Name and number (serial number or other identifying number) of the instrument.
    - Concentration of calibration gas or solution.
    - Calibration standard information (vendor and lot number (if applicable).
    - Date and time of the calibration.
    - Instrument reading when exposed to calibration gas (if applicable).
    - Amount of adjustment (if any).
    - Post-adjustment instrument reading (if applicable).
- Operate the instrument per the manufacturer's instructions and perform the required measurements.
- Record measurements in field logbooks or field forms in accordance with E&E FTP-1215 "Project Records Management". Information to be recorded for field measurements includes:
    - Name of the person operating the instrument.
    - Name and number (serial number or other identifying number) of the instrument used, reading(s).
    - Date, time, and location of the measurement (e.g., headspace of sample A, 5 inches from top of auger at soil boring 4, breathing zone of driller, etc.).
    - Measurement details/readings obtained. The minimum units for measurements shall be defined in the SAP or other appropriate project-specific document.
    - If applicable, information recorded must be sufficient to demonstrate to a third party that worker exposures were less than the exposure limits or when overexposures were detected and corrected.
- Decontamination of instruments may be required. Decontamination requirements shall be in accordance with E&E FTP-400 "Equipment Decontamination" and specifically defined in the SAP or other appropriate project-specific document.
- Record equipment problems encountered or environmental factors that may influence false readings and notify the Field Manager.

Specific field instruments are discussed below. The typical steps identified above are applicable to all of these instruments. Deviations or additions to the typical steps are highlighted.

5.2.1 Organic Vapor Detectors

The requirements listed in paragraph 5.2 are applicable to organic vapor detectors with the following addition:

- If extremely high concentrations are encountered while using an organic vapor detector, verify that the instrument is still operating properly before continuing to use the instrument.

5.2.2 Combustible Gas Detectors

Combustible gas detectors will not indicate the combustible gas content in an inert gas background, furnace stack, or in other atmospheres with less than 16% oxygen. Combustible gas detectors should not be used where the oxygen concentration exceeds that of fresh air (i.e., oxygen enriched atmosphere) because the extra oxygen makes any combustible mix easier to ignite and, thus, more dangerous.

The requirements listed in paragraph 5.2 are applicable to combustible gas detectors with no changes.

5.2.3 Mercury Vapor Analyzer

The requirements listed in paragraph 5.2 are applicable to mercury vapor analyzers with no changes.

5.2.4 Water Quality Parameters

Parameters associated with water quality parameters (e.g., pH, temperature, salinity, conductivity, ORP, and turbidity) may be measured with one instrument that is capable of measuring multiple parameters or separate instruments if necessary. The requirements listed in paragraph 5.2 apply whether one instrument is used or separate instruments are used.

5.2.5 Dissolved Oxygen (DO) Meter

The use of the membrane electrodes (ME) probe method for field measurement of dissolved oxygen in a variety of ground, surface, and saline waters, as well as in domestic and industrial wastes may be as a single probe or as a combination water quality meter (section 5.2.4).

The most common ME instruments for determination of DO in water are dependent upon the rate of diffusion of molecular oxygen across a membrane and upon electrochemical reactions. Under steady-state conditions, the current or potential can be correlated with DO concentration. Interfacial dynamics at the ME-sample interface are a factor in probe response and a significant degree of interfacial turbulence is necessary. For precision performance, turbulence must be constant.

Dissolved inorganic salts are a factor in the performance of DO probes. Reactive gases that pass through the ME probes may cause interference. Hydrogen sulfide will also interfere with ME probes under certain conditions.

ME probes are temperature sensitive. A temperature compensation factor is normally provided by the manufacturer.

The requirements listed in paragraph 5.2 are applicable to DO meters with the following additions:

- Calibration adjustments may be required if the sample temperature is significantly greater (greater than 10%) than the calibration temperature. Calibration may also be required if the DO readings show a distinct change in DO levels.
- Inspect the membrane before each use for air bubbles, oily film, and/or holes. If the membrane is defective, it must be replaced and a new membrane prepared (soaked in distilled water before calibration).
- When taking measurements, verify the ME stirring apparatus is working (if using a submersible stirrer). If an operator is stirring the ME probe manually, the probe must be stirred as directed by the manufacturer.
- Always keep the probe in water when not in use to prevent the membrane from dying out.

5.2.6 Radiation Survey Equipment

This section is limited to ionization chambers, proportional counters, Geiger-Mueller (GM) counters, and scintillation detectors. The information provided below should be considered supplementary to the instrument’s instruction manual.

Radiation survey instruments shall be portable, rugged, sensitive, simple in design and operation, reliable, and intrinsically safe for use in explosive atmospheres.

An ionization chamber consists of a gas-filled envelope (usually air at atmospheric pressure) with two electrodes at different electrical potential. Ionizing radiation entering the chamber produces ions that migrate toward the electrode because of the applied potential, producing a current. The current requires amplification to a measureable level before it can be recorded on a meter. These are high-range instruments (low sensitivity) and are used extensively for measuring high intensity beta, gamma, or x-radiation. If no audio indication is possible with the instrument, the operator must be constantly aware of the meter to determine radiation intensity. Ionization chambers do not record individual radiation particles but integrate all signals produced as an electric current to drive the meter. They should be calibrated to the type and intensity of radiation to be measured.

The proportional counter has a probe with an extremely thin window that allows alpha particles to enter, and so is used extensively for this type of radiation detection by adjusting instrument parameters to discriminate against beta and gamma radiation. The meter is read in counts per minute and usually has several sensitivity scales. It should be noted that because of the nature of alpha particles, it is important to hold the probe as close as possible to (though not in contact with) the surface being monitored. The window of the proportional counter is delicate in construction, requiring care when being used as a field instrument.

GM counters operate principally in the same manner as ionization chambers except that secondary electrons are formed allowing greater sensitivity. They are very sensitive and are commonly used to detect low-level gamma and/or beta radiation. Meters are read in counts per minute or milliroentgens/hour. The gas amplification process inherent to this type of detector allows a single beta particle or gamma photon to be detected. It should be noted that these devices are sensitive instruments and care should be taken not to exceed their maximum capacity to prevent damage to the GM tube.

Scintillation detectors depend upon light produced when ionizing radiation interacts with a media (solid crystal used in survey instruments). They are extremely sensitive instruments used to detect alpha, beta, or gamma radiation simply by choosing the correct crystal. Alpha particles are detected with a silver activated zinc sulfide screen, beta radiation with an anthracene crystal (covered with a thin metal foil to screen alpha particles), and gamma or x-rays with a sodium iodide crystal. The instrument can be calibrated in the same manner as for ion chambers and GM counters. The operator should keep in mind that in older models the detector might be damaged if directly exposed to light without first disconnecting the voltage.

The requirements listed in paragraph 5.2 are applicable to radiation survey instruments with the following addition:

- The selection of the appropriate instrument is based on the suspected contaminant radionuclide, the type of radiation emitted, and the efficiency of the instrument to detect radiation.

6. QUALITY ASSURANCE / QUALITY CONTROL

Measurements are useful only when they are made at the correct time and location, have sufficient accuracy and precision, and are repeatable and reproducible. If these conditions are met and the measurements are obtained and recorded appropriately, the data can be confidently used in various decision-making situations. Good quality and defendable measurements can only be achieved if properly calibrated instruments are used and the instruments themselves are used in the appropriate manner. Calibration requirements must be specified in the SAP or other appropriate project-specific document. E&E Division employees shall not operate any instrument that is not calibrated or is past its calibration date, nor shall any instrument be used if the employee is not trained on proper use of the instrument.

7. RECORDS

Records generated as a result of this procedure shall be submitted to the designated electronic record system in accordance with E&E A17.1 “Project Records Management”.

8. REFERENCES

- E&E A12.1, Control of Measuring and Test Equipment
- E&E A17.1, Project Records Management
- E&E FTP-400, Equipment Decontamination
- E&E FTP-1215, Field Activity Documentation
- EHS-48, Stop Work Authority

Refer to https://apps.prism.leidos.com/eiapps/qa for the current version of E&E referenced procedures.

Current Environmental Health and Safety (EHS) procedures are maintained at https://prism.leidos.com/command_media/command_media_folders/leidos_ehs_manual pdf.

9. ATTACHMENTS

Not Applicable.

10. DOCUMENT CHANGE RECORD

- Revision 0, dated 31 Jan 2015, is the original version of this procedure issued under Leidos.
- Revision 1, dated 31 Dec 2020, is a minor revision to the procedure. Revisions included the following:
  - Updated organization name from ESE Operation to E&E Division.
  - Revised signature line titles for clarity/consistency.
  - Changed web addresses to reflect current location.
  - Editorial changes to be consistent with other procedures.
  - Section 1.1 – Updated to reference E&E Division.
  - Section 1.2 – Added statement to implement required regulations/standards.
  - Section 3 – Included stop work authority information
  - Section 8 – Updated references.

ENERGY & ENVIRONMENTAL DIVISION

STANDARD OPERATING PROCEDURE

Field Activity Documentation

E&E FTP-1215, Revision 2

Effective 31 Dec 2020

Approved By:

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ATTACHMENT(S)

1. PURPOSE

This Standard Operating Procedure (SOP) establishes the minimum requirements for recording field activities in logbooks and field forms along with the initiation, tracking and disposition of those records.

1.1 Scope and Limitations

Documentation is required under this SOP for field activities, as defined in Section 1.3 below, performed or directed by the Leidos Energy & Environmental (E&E) Division. Work plans, Sampling and Analysis Plans, Health and Safety Plans, Quality Assurance Plans, or other client specifications may include additional requirements for documenting field activities that must also be followed. Requirements shall be at least as stringent as those herein, unless approval is obtained from the Division QA Manager for alternate requirements.

1.2 Regulations or Standards

Although no regulation(s) or standard(s) are included here, it does not mean that none may exist for the activity defined in this SOP. It is the responsibility of the Project Manager to verify that applicable regulations and standards are implemented as necessary.

1.3 Definitions / Acronyms

Electronic Record Archival System – System used to electronically archive field activity records.

Field Activities – Work performed by the E&E Division or its subcontractors outside of a standard office, warehouse, or laboratory environment. Examples include environmental sampling, installation and/or operation of systems or equipment on site, remediation or construction activities, or other work that poses physical hazards or regulatory risks.

Field Forms – A project-specific collection of forms. Field forms are not required to be bound; however, they must be maintained securely to prevent loss. Field forms serve a similar purpose to a field logbook in that field data is captured in real time, in a specific format, and relevant to the objectives of the investigation or site activity.

Field Project Planning and Readiness Review (FPPRR) database – A database (https://apps.prism.leidos.com/eiapps/fieldpprr) designed to compile and track information necessary to successfully plan and execute a field activity. The completed database record forms the basis for the Readiness Review and provides evidence for determining field project readiness.

Force Majeure – An extraordinary event or circumstance beyond the control of the responsible person, such as war, strike, riot, crime, flood, tornado, earthquake, or volcano, which prevents fulfillment of an obligation. Force Majeure is not intended to excuse negligence or other malfeasance, as where non-performance is caused by the usual and natural consequences of external forces (e.g., predicted rain stops an event).

FTP – Field Technical Procedure

Logbook – A bound book with sturdy cover used to create a permanent, real-time record of activities, conditions, significant events, observations, measurements, field equipment calibration data, and other similar information occurring or related to field activities. Pages shall be sequentially numbered prior to use. Logbooks shall provide adequate detail in order to recreate the field event if necessary.

Logbook Tracking/Management System – System used to track the possession and location of logbooks.

Physical Storage Location – Designated location, defined as an official storage location for logbooks when not in use. Locations can range from a centralized location in a given office to a decentralized location such as a file cabinet in a Project Manager's office.

2. QUALIFICATIONS AND RESPONSIBILITIES

2.1 Qualifications

Staff shall be trained to this procedure prior to conducting field activities and that training shall be documented.

2.2 Responsibilities

Project and/or Program Managers (PMs)

- Communicating general and project specific field activity documentation requirements to the field staff.
- Ensuring that the field documentation meets the project technical needs, including the eventual importation of field data to contract-, project- or program-specific databases.
- Verifying that personnel performing the activity described herein are trained to this procedure as well as other applicable Federal, State or local requirements, and that the training is documented.
- Assigning responsibility for scanning and archiving field activity records in the timeframe required.
- Communicating requirements for record archival.
- Providing a process for QC review of field activity records within a reasonable period following the field activity consistent with Section 6 of this procedure.

Field Manager

- Implementing and overseeing use of this procedure during a field activity, including the use of a logbook tracking/management system.
- Support and verify that the field staff has the necessary logbooks and field forms for the field activity.
- Reinforcing general and project specific requirements for field activity documentation.
- Verify that field activity records are reviewed as required and maintained in an electronic system.

Field Staff

- Checking out required logbooks for the field activity from the designated logbook tracking/management system.
- Accurately and completely documenting field activities.
- Uploading copies of field notes to the designated electronic record archival system.

- Maintaining physical control of logbooks and/or field forms while under their care.
- Checking logbooks back into the designated logbook tracking/management system following a field activity.
- Returning the logbook and field forms to the designated physical storage location following a field activity.
- Performing assigned tasks in a safe and effective manner according to established operating procedures.
- Using required personal protective equipment.
- Reporting unsafe or questionable conditions to a supervisor.

QC Reviewer

- Conducting a thorough review of the logbook and field form records for the field activity in accordance with the requirements in Attachment 1.
- Documenting the review by initialing or signing each page reviewed along with the date reviewed.
- Communicating issues noted during the review to the appropriate person for resolution.
- Reviewing necessary corrections identified during the QC review.

3. HEALTH AND SAFETY

Implement stop work authority (EHS-48) any time an activity potentially poses an uncontrolled risk to human health or the environment.

4. EQUIPMENT AND SUPPLIES

- *Logbooks* – minimum requirements:
  - Bound with sturdy cover.
  - Sequentially numbered pages. The pages must be numbered prior to use so that page removal will be apparent.
  - Waterproof or Rite in the Rain type paper is preferred.
- *Field Forms* – as applicable.
- *Writing utensil* – handwritten entries shall be made using indelible blue or black ink, with black ink preferred. Avoid felt tip pens and *do not use pencil*.
- *Electronic media* – electronic options may be utilized in lieu of hardcopy logbooks. However, their use must be evaluated and approved during the Readiness Review (see E&E A2.2 "Field Project Planning and Readiness Review") prior to implementation.

5. PROCEDURE

5.1 Overview

A logbook(s) will be initiated, checked out of the designated logbook tracking/management system and used to record a field activity as it occurs. Each logbook shall be project-specific, and if possible site-specific. Records (logbooks and field forms) shall be uploaded to the designated electronic record archival system as soon as practicable following each day's activities. Records shall undergo a QC review as described in Section 6.

5.2 Details

5.2.1 Logbook Initiation

The type of logbook(s) needed to record a field activity will be determined during project planning. The logbook(s) shall be obtained, recorded in the designated logbook tracking/management system and initiated with the following information.

- Outside front cover
  - Unique logbook number.
  - Optional, but highly recommended – client name, project name, site location, project number.
- Inside cover and/or first page(s)
  - Ownership information - Company name, office address, office phone number.
  - Printed name, signature and initials of each individual making an entry in the logbook.
  - Date initiated.
  - Optional/Recommended – Table of Contents

5.2.2 Field Forms

Field forms should be designed/designated during the project planning phase and approved for use by the PM. The field logbook shall include a daily inventory of forms used. Field forms must include the following information, at a minimum:

- Title
- Site/Project information
- Date
- Page numbers in the form of “Page x of y”, or similar, on each page
- Associated logbook number

5.2.3 Logbook and Field Form Entries

The logbook and associated field forms constitute the compiled and chronological written record of the field activities conducted. These records shall be detailed enough so that another similarly qualified person unfamiliar with the site could recreate the field activities as they occurred. Entries must be factual, detailed, objective, and unbiased. Entries must be legible and entered using indelible blue or black ink, with black ink preferred.

Keep in mind that logbooks and field forms are work products that belong to the client; therefore, only entries that are appropriate to share with the client or third parties should be included. A listing of applicable logbook entries is included as Attachment 1 to this procedure.

- The following items should NOT be included in logbook or field form entries.
  - Unsubstantiated opinions (best professional judgment may be necessary in some cases).
  - Editorializing.
  - Language that is derogatory or that would not be acceptable in front of the client or in a public forum.
  - Events not relevant to the field activity.

  - Speculation or unfounded assumptions without basis.

- The following words should be avoided unless absolutely necessary and appropriate.
  - Approve
  - Inspection*
  - Supervision*
  - Definitive words such as – final, any, all, none, full, every, will, or shall.
  - Words of promise such as – guarantee, warrant, certify, ensure, or insure.

*Inspect and supervise are potentially dangerous words. Court decisions have interpreted these words to mean superintend, oversee, control, manage, direct, restrict, regulate, govern, administer, and/or conduct.

5.2.4 Logbook and Field Form Disposition

Logbooks and field forms shall be returned to the originating office (unless otherwise specified by the PM or Field Manager) and checked back in to the designated logbook tracking/management system as soon as practicable following completion of the field activity. Copies of logbooks and associated field forms shall be uploaded to the designated electronic record archival system.

6. QUALITY ASSURANCE / QUALITY CONTROL

Logbooks and field forms are both subject to subpoena and are admissible as evidence in legal proceedings. As such, they may be subjected to cross-examination. Consequently, the integrity and completeness of field activity records are critical.

- All records (logbooks and field forms) must undergo a QC review and be uploaded to the designated electronic record archival system within 14 calendar days of the record creation unless an alternate schedule is approved in the FPPRR database for the field activity (see E&E A2.2 “Field Project Planning and Readiness Review”). The QC review will evaluate the accuracy, completeness, legibility, consistency, and clarity of the records.

- The QC Reviewer shall indicate acceptance of the logbook and field form entries by adding their initials or signature at the bottom of each page along with the date reviewed.

- If errors, omissions, or uncertainties are found, the QC Reviewer will resolve them with the person responsible for making the original entries prior to signing or initialing the logbook/field form(s). The QC Reviewer will verify that the appropriate corrections are made. If the original person making the entries is not available, then the issue will be resolved with the Field Manager or Project Manager.

  - All corrections or additions shall include the signature or initials of the person making the change along with the date of the change, and information necessary to support or explain the need for the correction.

  - Erroneous entries may only be marked out using a single line in a manner that does not obliterate the original entry.

7. RECORDS

Records generated as a result of this procedure shall be submitted to the designated electronic record system in accordance with E&E A17.1 “Project Records Management”.

8. REFERENCES

- DoD Environmental Field Sampling Handbook, Revision 1, April 2013.
- E&E A2.2, Field Project Planning and Readiness Review
- E&E A17.1, Project Records Management
- E&E FTP-1220, Documenting and Controlling Changes to Approved Work Plans
- EHS-48, Stop Work Authority

Refer to https://apps.prism.leidos.com/eiapps/qa/ for the current version of E&E referenced procedures.

Current Environmental Health and Safety (EHS) procedures are maintained at https://prism.leidos.com/command_media/command_media_folders/leidos_ehs_manual pdf.

9. ATTACHMENTS

- Attachment 1. Applicable Logbook Entries

10. DOCUMENT CHANGE RECORD

- Revision 0, dated March 3, 2014, is the original version of this procedure issued under Leidos.
- Revision 1, dated 4 Feb 2015, is the first revision of this procedure. Minor revisions included the following:
    - Changing the Operation name from Environment and Civil Infrastructure (ECI) to Environmental Science and Engineering (ESE).
    - Revised footer on cover page.
    - Section 1.3 – Removed acronyms HS and QA/QC from the list.
    - Section 8 – Updated references. Added statement regarding where current versions of procedures are located.
    - Section 7 – Revised statement to match information in other procedures.
    - General formatting changes to be consistent with other procedures.
- Revision 2, dated 31 Dec 2020, is a major revision to the procedure. Revisions included the following:
    - Updated organization name from ESE Operation to E&E Division.
    - Revised signature line titles for clarity/consistency.
    - Changed web addresses to reflect current location.
    - Editorial changes to be consistent with other procedures.
    - Section 1.2 – Added statement to implement required regulations/standards.
    - Section 5 – Reformatted using 3rd level headers.
    - Section 8 – Updated references.
    - Clarifying information added to Attachment 1.

ATTACHMENT 1

APPLICABLE LOGBOOK ENTRIES

- All entries shall be made using indelible blue or black ink, with black ink preferred. *Do not use pencil.*
- All entries must be legible. Zeroes shall be recorded with a slash (/) through them to distinguish from the letter o.
- Each day of the field activity should start on a new page.
- Entries should be made in chronological order and introduced with a notation of the time.
- Each page used must be signed or initialed and dated by the person making the entry.
- Unused portions of logbook pages and completed logbooks will be indicated by drawing a single line across the unused area. This line will be noted with the signature or initials of the person making the entry and the date of the entry.
- All dates must include the year, month and day.
- All times must be recorded in 24-hour format (e.g., 1500 rather than 3:00 p.m.)
- Corrections shall be made by drawing a single line through the incorrect information in a manner that does not obliterate the original entry. The correction shall include the initials or signature of the person making the correction, the date of the correction, and information necessary to support or explain the need for the correction.
- Additions to original entries must include the initials or signature of the person making the addition, the date of the addition, and information necessary to support or explain the need for the addition.
- The following shall be recorded as applicable:
  - Date and time of arrival at the field site.
  - Time required for equipment set up and time sampling started.
  - Purpose of the site visit/field work.
  - Notation of governing documents (e.g. work plan, sampling and analysis plan, etc.)
  - Weather conditions, updated throughout the day as appropriate.
  - Names and affiliations of anyone present during the field activities (e.g., Jane Doe (Leidos), John Smith (XYZ Contractor)).
  - Site sketch or map and description with a north arrow and rough scale. It is permissible to use a site map (reduced if necessary) and permanently affix it in the field logbook. The sketch or map shall identify surrounding permanent features (i.e., streets, rivers, buildings, parks, businesses, etc.) in order to provide a clear understanding of general location.
  - Problems, delays or unusual circumstances including equipment issues along with resolutions.

- Deviation(s) from the Sampling and Analysis Plan or other site-specific document governing the field activity, including the name(s) of personnel that authorized the deviation(s). See E&E FTP-1220 "Documenting and Controlling Changes to Approved Work Plans" for information regarding other required documentation.
- Level of PPE being used.
- Field testing equipment - model and serial number or other unique identifier.
- Calibration standards – lot number and expiration date.
- Calibration and maintenance information for each piece of field testing equipment or a reference to the logbook(s) where this information is recorded.
- Field measurements including the time of the measurement and units.
- Sample collection methods and observations.
- Relevant conversations with others present (e.g. discussion with a client representative or landowner, member of public). Include names and affiliation when possible.
- Log of photographs including approval to take photographs along with the time, date, and description of each photograph.
- Samples
    - Location identification. This may include measurements and a description from permanent features to the sample point and/or coordinates. It is important to thoroughly describe sample source locations so that they can be accurately located for future sampling events.
    - Date and time of sample collection.
    - Sample information – matrix, grab, composite, etc.
    - Field sample preparation information such as filtering. In the case of filtering, describe how the sample was filtered, including the type (manufacturer, lot number, pore size, filter description) of filter used.
    - Type and number of sample containers filled and preservatives used. If sample containers are not pre-preserved, then the addition of chemical preservatives must be described.
    - Custody procedures, chain of custody numbers.
    - Packing and shipping procedures, including use of custody seals.
    - Courier or Common Carrier contact information and tracking number.
    - Laboratory contact information.
- Equipment decontamination procedures.
- Disposition of excess materials.
- All personnel site departures during the day and the final departure time at the conclusion of the day's activities.

Leidos Proprietary

ENERGY & ENVIRONMENTAL DIVISION

STANDARD OPERATING PROCEDURE

Documenting and Controlling Field Changes to Approved Work Plans

E&E FTP-1220, Revision 1

Effective 31 Dec 2020

Approved By:

Michael D. Simms, P.E.
E&E Division Manager

Kimberly C. Murphree

Kimberly C. Murphree, P.E.
E&E Division Quality Assurance Manager

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ATTACHMENTS

1. PURPOSE

This Standard Operating Procedure (SOP) establishes the method for documenting and controlling field changes to approved project plans.

1.1 Scope and Limitations

This procedure applies to Leidos Energy & Environmental (E&E) Division personnel and subcontractors involved in field efforts governed by an approved project plan. This procedure should be used and referenced within the project plan when no other process (e.g., client directed) for the documentation of field changes exists.

1.2 Regulations or Standards

Although no regulation(s) or standard(s) are included here, it does not mean that none may exist for the activity defined in this SOP. It is the responsibility of the Project Manager to verify that applicable regulations and standards are implemented as necessary.

1.3 Definitions / Acronyms

Field Change – For the purposes of this procedure, a field change is a planned deviation from a procedure or requirement established in an approved project plan. Examples of typical field changes include the following:

- A change in the number of samples to be collected.
- A change in sample depth, location, or interval.
- A change in method of sample collection.
- A clarification to conflicting or confusing work plan or procedural requirements.
- The discovery of unanticipated hazards or changes in site hazards, hazard monitoring, or hazard controls.

Field Change Request (FCR) – A form used to request and document signature approval of a field change.

Field Change Control Log – A log used to track the status of requested field changes.

Field Logbook – A bound book with sturdy cover used to create a permanent, real-time record of activities, conditions, significant events, observations, measurements, and other similar information occurring or related to field activities. Pages shall be sequentially numbered prior to use.

2. QUALIFICATIONS AND RESPONSIBILITIES

2.1 Qualifications

Staff shall be trained to this procedure prior to performing applicable activities and that training shall be documented.

2.2 Responsibilities

Project Manager/Program Manager (PM)

- Verifying that personnel are trained to this procedure and understand the process to initiate an FCR.
- Initiating FCRs.

- Coordinating with the Contract Manager to verify changes are not out of scope.
- Coordinating with the Contract Manager to obtain agreement from the client for the field change.
- Notifying the Field Manager of approved FCRs.
- Verifying that a copy of the approved FCR and associated documentation are maintained as a project record and providing a copy to the Contract Manager.

Site Safety and Health Officer

- Reviewing and approving or rejecting, as appropriate, FCRs that affect the Health and Safety Plan, or which may affect the health and safety of an employee or subcontractor.

Contract Manager

- Assisting the PM to obtain agreement from the client regarding field changes.
- Assisting the PM to verify that requested changes are not out of scope.

Field Manager

- Identifying items that may require a field change and notifying the PM.
- Providing appropriate information to the PM for FCR initiation.
- Completing and maintaining the Field Change Control Log. (Note: This responsibility may be designated by the PM to someone other than the Field Manager.)
- Maintaining updated copies of FCRs with the Field Change Control Log. (Note: This responsibility may be designated by the PM to someone other than the Field Manager.)
- Notifying affected field personnel of approved FCRs.

Field Staff

- Identifying items that may require an FCR and notifying the Field Manager.
- Correctly implementing the change after the FCR is approved.

3. HEALTH AND SAFETY

FCRs that affect the Health and Safety Plan, or the health and safety of any Leidos employee or subcontractor, must be reviewed and approved by the Site Safety and Health Officer before changes are implemented.

Implement stop work authority (EHS-48) any time an activity potentially poses an uncontrolled risk to human health or the environment. Questions regarding health and safety shall be addressed to the Site Safety and Health Officer and/or the Field Manager.

4. EQUIPMENT AND SUPPLIES

Not Applicable.

5. PROCEDURE

5.1 Overview

Signature approval (preferred) or other formal documentation of client approval of an FCR must be obtained before the FCR is implemented.

5.2 Completion of the FCR Form

An example of a FCR form is included in Attachment 1. It is recommended that the attached form be used for FCRs; however, it is not required. The following information is required on a FCR, regardless of the format used:

- FCR Number – number assigned to the change request. Numbers should identify the project and be sequential.
- Date Initiated – date the change was first requested.
- Project – name of the affected project.
- Contract Number – contract number under which the project operates.
- Requestor Identification – the name of the person requesting the change, organization, phone number and title. Requestor also signs the form.
- Baseline Identification – Identify which baseline(s) is/are affected (i.e., cost, scope, milestone, method).
- Affected Document – exact title, revision number, section number, etc., of the affected project plan or procedure.
- Description of Change – provide sufficient detail and information for the reviewer to determine exactly how the affected project plan or procedure will be changed.
- Justification – include reasons for the change request (e.g., reduction in cost, minimization of health and safety risks, etc.).
- Impact of Not Implementing the Request – provide information regarding the impact if the change is not approved.
- Participants Affected by Implementing Request – identify participants affected (e.g., field personnel, data users, subcontractors, etc.).
- Cost Estimate – include an estimate of cost effect if request is implemented.
- Signature of Estimator – person providing the cost estimate signs and dates the form and provides their phone number.
- Previous FCR Affected – Indicated whether a previous FCR is affected by the current FCR. If yes, provide the previous FCR number.
- Approval Signatures – The client PM, client QA Manager (if applicable), and the Leidos Site Safety and Health Officer (if applicable) shall sign and date the form if approved. Note that while signature approval is preferred, approval may be documented without signatures on the form as long as another formal method of documenting approval is obtained. Documentation used to indicate approval must be maintained with the FCR form.

5.3 FCR Processing

The following steps shall be followed to initiate and obtain approval for a FCR:

- The PM, or designee, completes the FCR form.
- The Field Manager, or designee, initiates an entry in the Field Change Control Log (example included in Attachment 2) by entering the FCR number, the date initiated, the status, the plan(s) or procedure(s) affected, and the name of the person making the request.
- A copy of the unapproved FCR is maintained with the Field Change Control Log.
- The PM discusses the requested change with appropriate members of the project team (e.g., quality assurance, contracts, health and safety, field staff, etc.) as appropriate. The PM may revise the FCR, if necessary, based on these discussions.
- If the FCR includes a change in the project Health and Safety Plan or has a potential effect on the field team (including subcontractors) the Site Safety and Health Officer must approve the FCR.
- The PM or Contract Manager notifies the client of the scope, justification, and impact of the request. The FCR form is sent to the client for approval.
- When the client approves the FCR and the form is signed (or other documentation is obtained to indicate client approval), the PM provides the approved FCR and associated documentation to the Field Manager (or designee). The PM, or designee, shall submit a copy of the completed FCR to the designated electronic record system in accordance with E&E A17.1 “Project Records Management”.
- The Field Manager, or designee, replaces the unapproved FCR originally maintained with the Field Change Control Log with the approved copy. The status and date of FCR approval is noted on the Field Change Control Log to indicate the field change is complete.
- At the first opportunity, the Field Manager or PM notifies affected personnel of the field change. This notification is documented in the field logbook (see E&E FTP-1215 “Field Activity Documentation” for field logbook requirements). If the FCR affects health and/or safety, the Site Safety and Health Officer includes notification of the changes in one or more site safety briefings.
- If the client does not approve the FCR, the Field Change Control Log will be updated to indicate the rejection of the FCR. Information provided by the client on why the FCR was rejected should be recorded.

6. QUALITY ASSURANCE / QUALITY CONTROL

Any deviation from the requirements of an approved project plan without an approved FCR, or prior to approval of an FCR, constitutes a nonconformance and shall be documented on a Nonconformance and Corrective Action Report (NCR). See E&E A16.1, “Nonconformance and Corrective Action” for details regarding initiating NCRs.

7. RECORDS

Records generated as a result of this procedure shall be submitted to the designated electronic record system in accordance with E&E A17.1 “Project Records Management”.

8. REFERENCES

- ESE A16.1, Nonconformance and Corrective Action
- ESE A17.1, Project Records Management
- ESE FTP-1215, Field Activity Documentation
- EHS-48, Stop Work Authority

Refer to https://apps.prism.leidos.com/eiapps/qa for the current version of E&E referenced procedures.

Current Environmental Health and Safety (EHS) procedures are maintained at https://prism.leidos.com/command_media/command_media_folders/leidos_ehs_manual pdf.

9. ATTACHMENTS

- Attachment 1. Field Change Request Form (Example)
- Attachment 2. Field Change Control Log (Example)

10. DOCUMENT CHANGE RECORD

- Revision 0, dated 31 Jan 2015, is the original version of this procedure issued under Leidos.
- Revision 1, dated 31 Dec 2020, is a minor revision to the procedure. Revisions included the following:
  - Updated organization name from ESE Operation to E&E Division.
  - Revised signature line titles for clarity/consistency.
  - Changed web addresses to reflect current location.
  - Editorial changes to be consistent with other procedures.
  - Section 1.2 – Added statement to implement required regulations/standards.
  - Section 3 – Included stop work authority information.
  - Section 8 – Updated references.

ATTACHMENT 1

FIELD CHANGE REQUEST FORM (EXAMPLE)

FIELD CHANGE REQUEST (FCR)			
FCR Number:		Date Initiated:	
Project:			
Contract Number (CRN):			
Requestor Name:		Organization:	
Phone Number:		Title/Project Role:	
Requestor Signature:			
Baselines Affected:	☐Cost ☐Scope ☐Milestone ☐Method of Accomplishment		
Document(s) Affected (full title, revision no., page, section):			
Description of Change:			
Justification:			
Impact of Not Implementing the Request:			
Participants Affected by Implementing the Request:			
Cost Estimate ($):			
Estimator Name:		Phone Number:	
Estimator Signature:			
Previous FCR Affected:	☐ Yes ☐ No	If yes, FCR number:	

APPROVAL SIGNATURES			
Client Project Manager:		Date:	
Client QA Manager (if applicable):		Date:	
Leidos Site Safety & Health Officer (if H&S related):		Date:	

ATTACHMENT 2

FIELD CHANGE CONTROL LOG (EXAMPLE)

Program:			
Project Name:		**Contract Number (CRN):**	
Project Manager Name:			

FCR Number	Date Initiated	Status[1]	Document Affected[2]	Requestor	Date FCR Approved

[1] Open, Canceled, Rejected, Approved, or other appropriate designation for status

[2] Include full title and revision number along with chapter, section, and/or page number information as appropriate.

ENERGY & ENVIRONMENTAL DIVISION

STANDARD OPERATING PROCEDURE

Field Demobilization Checklist for Investigative Derived Waste

E&E FTP-1225, Revision 1

Effective 31 Dec 2020

Approved By: ______________________________

Michael D. Simms, P.E.
E&E Division Manager

Kimberly C. Murphree
____
Kimberly C. Murphree, P.E.
E&E Division Quality Assurance Manager

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ATTACHMENT(S)

1. PURPOSE

This Standard Operating Procedure (SOP) establishes the specific responsibilities and requirements for the use of the Field Demobilization Checklist for Investigative Derived Waste (IDW). This form shall be utilized when ending a field effort either as a final or temporary demobilization. This checklist will support requirements in the EHS-46 "Management of Waste Generated at Project Sites" procedure.

1.1 Scope and Limitations

This procedure applies to IDW generated during Leidos Energy & Environmental (E&E) Division field projects. Work plans, Sampling and Analysis Plans (SAPs), Quality Assurance Project Plans (QAPPs), Waste Management Plans (WMPs), or other client specifications may identify and include specific regulations or standards for documenting field demobilization activities that must also be followed. If information in this SOP conflicts with applicable federal, state, local and/or contractual/facility requirements, those requirements shall take precedence.

1.2 Regulations or Standards

Although no regulation(s) or standard(s) are included here, it does not mean that none may exist for the activity defined in this SOP. It is the responsibility of the Project Manager to verify that applicable regulations and standards are implemented as necessary.

1.3 Definitions / Acronyms

Demobilization – The activities associated with ending a field activity permanently or, in some cases, temporarily due to completion of a phase of an ongoing activity.

Investigative Derived Waste (IDW) – IDW is waste that is generated in an environmental investigation at a site that is potentially or actually contaminated with hazardous substances or petroleum products. In general, IDW covered by this procedure includes, but is not limited to, the following:

- Solid Wastes: Soil cuttings from borings and monitoring well installation; soils from sampling; sludge; and/or sediment from sampling.
- Liquid Wastes: Purge water from monitoring well development and groundwater sample collection; drilling fluids; solutions used to decontaminate personal protective equipment (PPE) or investigation related equipment; and/or calibration solutions.
- Disposable Equipment: Contaminated disposable PPE or investigation related equipment.

Personal Protective Equipment (PPE) – Specialized clothing or equipment worn by employees to minimize exposure to health and safety hazards.

Waste Management Plan (WMP) – Plan that addresses the collection and disposal of waste generated during field activities. Waste Management Plans should be reviewed by an authorized approver before waste is collected.

2. QUALIFICATIONS AND RESPONSIBILITIES

2.1 Qualifications

Staff shall be trained to this procedure prior to conducting field activities and that training shall be documented.

2.2 Responsibilities

Program Manager

- Verifying the Project Manager is aware of the requirements of this procedure and performs said requirements appropriately.
- Providing adequate resources to implement the WMP.

Project Manager (PM)

- Developing and implementing a site-specific plan for managing IDW that conforms to the requirements in EHS-46 "Management of Waste Generated at Project Sites".
- Reviewing and archiving the Field Demobilization Checklist.
- Verifying the retention of relevant memoranda and supporting data concerning waste management.
- Verifying that personnel performing the activity described herein are trained to this procedure as well as other applicable Federal, State or local requirements, and that the training is documented.

Site Safety and Health Officer

- Providing guidance on safe work practices when handling IDW.
- Reviewing the WMP, as appropriate.

Field Manager

- Managing wastes generated by Leidos during a field project. This includes verifying that:
  - Requirements concerning containerization, labeling, storage, and storage time limits as specified in the waste management plan are met, and
  - Subcontractors manage waste in compliance with the waste management plan.
- Completing the Field Demobilization Checklist for IDW.
- Submitting completed Field Demobilization Checklists to the Project Manager.

3. HEALTH AND SAFETY

Implement stop work authority (EHS-48) any time an activity potentially poses an uncontrolled risk to human health or the environment. Proper personal protective equipment shall be worn at all times when performing field work.

Refer to the site or project specific HSP for relevant health and safety requirements. Questions regarding health and safety components of IDW shall be addressed to the Site Safety and Health Officer and/or the Field Manager.

4. EQUIPMENT AND SUPPLIES

Various types of equipment may be required to properly manage project waste. The WMP or other appropriate project-specific plan should be referenced for specific details on required equipment and supplies.

5. PROCEDURE

5.1 Overview

The Project Manager and Field Manager will determine if mobilization will cover one continuous effort or be divided into distinct cycles. For projects consisting of one continuous effort, then the Field Demobilization Checklist for Investigative Derived Waste (Attachment 1) will be completed at the end of the cycle. If the project will require more than one cycle, then a Field Demobilization Checklist for Investigative Derived Waste will be completed at the end of each cycle. Completed checklists will be placed in the project files in accordance with E&E A17.1 “Project Records Management”.

The Field Demobilization Checklist for Investigative Derived Waste provided in Attachment 1 is an example and may be amended for specific project requirements, if necessary, as long as the information captured on an amended checklist is at least as detailed as the checklist in this SOP.

5.2 Completion of Demobilization Checklists

The Field Manager completes the Field Demobilization Checklist for Investigative Derived Waste at the end of a field cycle.

- All line items must be completed on the checklist.
- Items checked N/A (not applicable) must have a brief justification in the comments column of the checklist.
- The Field Manager must verify that items are answered appropriately for field demobilization. Inconsistencies must be corrected prior to leaving the site.
  - Changes to the checklist must be initialed by the person making the change. A date must be included along with an explanation to justify the change.

5.3 Disposition of Demobilization Checklists

Completed checklists shall be submitted by the Field Manager to the PM for review, approval, and retention. The PM must approve the checklist before demobilization is complete.

6. QUALITY ASSURANCE / QUALITY CONTROL

The Project Manager shall review Field Demobilization Checklist(s) for Investigative Derived Waste. The Project Manager shall indicate acceptance and approval by adding their signature and printing their name at the end of each checklist along with the date reviewed.

If errors, omissions, or uncertainties are identified during the review, the PM shall take immediate action to resolve the issues.

7. RECORDS

Records generated as a result of this procedure shall be submitted to the designated electronic record system in accordance with E&E 17.1 “Project Records Management”.

8. REFERENCES

- E&E A17.1, Project Records Management
- EHS-46, Management of Waste Generated at Project Sites
- EHS-48, Stop Work Authority

Refer to https://apps.prism.leidos.com/eiapps/qa for the current version of E&E referenced procedures.

Current Environmental Health and Safety (EHS) procedures are maintained at https://prism.leidos.com/command_media/command_media_folders/leidos_ehs_manual pdf.

9. ATTACHMENTS

- Attachment 1. Field Demobilization Checklist (Example)

10. DOCUMENT CHANGE RECORD

- Revision 0, dated 31 Jan 2015, is the original version of this procedure issued under Leidos.
- Revision 1, dated 31 Dec 2020, is a minor revision to the procedure. Revisions included the following:
  - Updated organization name from ESE Operation to E&E Division.
  - Revised signature line titles for clarity/consistency.
  - Changed web addresses to reflect current location.
  - Editorial changes to be consistent with other procedures.
  - Section 1.2 - Added statement to implement required regulations/standards.
  - Section 3 – Included stop work authority information.
  - Section 8 – Updated references.

ATTACHMENT 1

FIELD DEMOBILIZATION CHECKLIST FOR INVESTIGATIVE DERIVED WASTE (EXAMPLE)

Project Title:	
CRN*:	**Project No:**
Person Completing Checklist (printed name):	**Person Completing Checklist (Signature):**
Date Checklist Completed:	

*Contract Record Number

SECTION A

Action	Yes	No	N/A	Date Completed	Initials	Comments
1. Are there wastes known to be RCRA hazardous waste or contain TSCA-regulated substances? **Note:** *If no, skip to Section B. If yes, continue with Section A.*						
2. Have known regulated wastes been transferred to the client (with transfer documented) or properly disposed offsite? **Note:** *Regulated waste must be transferred to the client's custody within three days of collection.*						
3. If known project-generated regulated wastes have not been transferred to the client (with transfer documented) or properly disposed offsite, have steps been taken to disposition the waste? (Describe the steps in the Comments section)						

SECTION B

Action	Yes	No	N/A	Date Completed	Initials	Comments
4. Does waste remain on site? **Note:** *If no, skip to Section C. If yes, continue with Section B.*						
5. Does Leidos have an on-going responsibility for storage, management or maintenance of waste remaining on site?						
6. Have remaining wastes been characterized, or samples taken to provide characterization information?						

SECTION B (cont.)

Action	Yes	No	N/A	Date Completed	Initials	Comments
7. Have actions required to remove the wastes for disposition been determined?						
8. Has a Leidos point of contact for the waste been established?						
9. If a waste hauling subcontractor is required, have they been notified that wastes are ready for disposal?						
10. Are waste containers remaining on site properly labeled (e.g., container number, date of generation, site name, source, client name, description of waste, approximate volume of waste, and physical state)?						
11. If a waste storage area is required, does it have security and postings appropriate to the type(s) of waste (e.g., warning signs, emergency points of contact, spill procedures)?						
12. If required, has photographic documentation of the waste containers been made, or a diagram of the waste storage area been prepared?						
13. Are liquid wastes containerized in secondary containment and protected from the elements (e.g., freezing)?						
14. Do containers of liquid to be left outdoors have sufficient headspace to prevent bulging? **Note:** *General rule of thumb for waste water is the headspace should be approximately 10% of the container volume.*						
15. Has secondary containment been provided for liquid wastes remaining on site pending disposition? If no, state why such containment was not required.						
16. If secondary containment is required for liquid waste remaining on site, have arrangements been made to exclude or remove precipitation from the containment receptacle?						

SECTION B (cont.)

Action	Yes	No	N/A	Date Completed	Initials	Comments
17. If waste is to remain on site and Leidos has a responsibility for storage and maintenance, have arrangements been made for routine inspections? Has the volume and type of waste been recorded in the field logbook?						

SECTION C

Action	Yes	No	N/A	Date Completed	Initials	Comments
18. Has IDW and/or other project-generated waste been transferred to the control of the client?						
19. Has IDW or other project-generated waste been transported offsite for disposal, and disposal documented?						

SECTION D

Action	Yes	No	N/A	Date Completed	Initials	Comments
20. Have residual chemicals (e.g., calibration gas, alcohol, acids) been dispositioned to preclude or minimize returning those items to Leidos facilities?						
21. Have pre-preserved sample containers been returned to the laboratory? Were the containers returned appropriately (proper shipping, labeling, packaging requirements)?						
22. Have samples (e.g., environmental or geotechnical) been accounted for and a process put in place to assure they are not returned to Leidos property?						

Project Manager Approval

Printed Name:	**Date:**
Signature:	

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A.2 – Ohio EPA and USEPA Standard Operating Procedures

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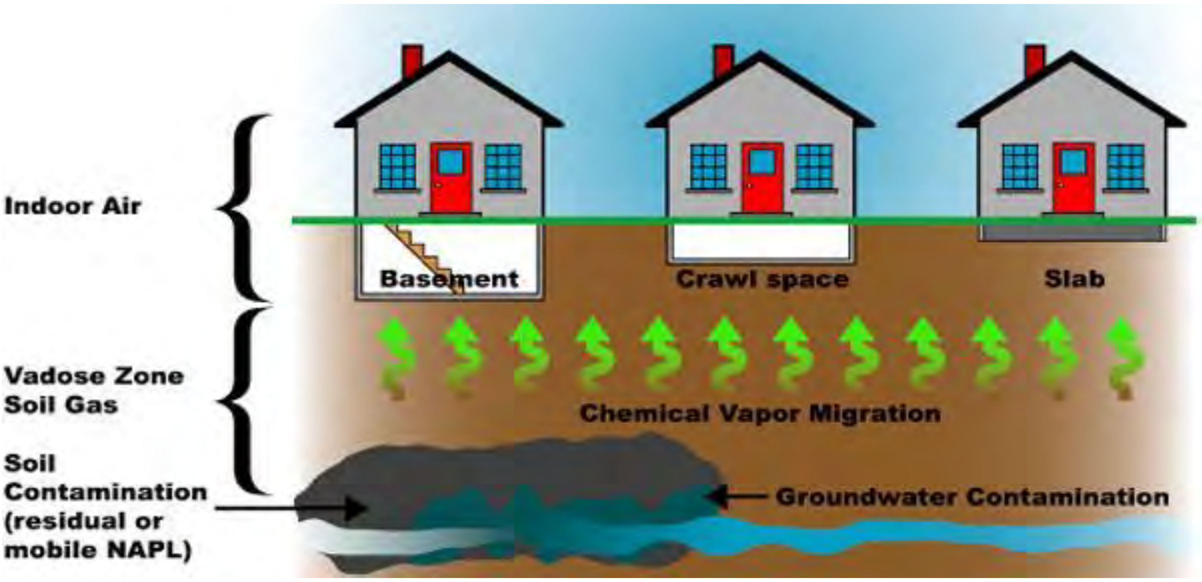
Ohio Environmental
Protection Agency

SAMPLE COLLECTION AND EVALUATION OF VAPOR INTRUSION TO INDOOR AIR

FOR REMEDIAL RESPONSE, RESOURCE CONSERVATION AND RECOVERY ACT AND VOLUNTARY ACTION PROGRAMS



Division of Environmental Response and Revitalization
March 2020

Acknowledgements

This updated guidance was developed by a workgroup of Ohio Environmental Protection Agency (EPA) staff.

Workgroup members included:

Michael Allen
Gavin Armstrong
Sarah Beal
Chris Bulinski
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Corin Fogle
Erik Hagen
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Chuck Mellon
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Vanessa Steigerwald-Dick
Brian Tucker
Katie Weyrauch

The following guidance document represents an update to the May 2010 Ohio EPA document of the same title and supersedes any and all previous vapor intrusion guidance documents presented by the agency. This update reflects the Ohio EPA Division of Environmental Response and Revitalization's (DERR) latest understanding of appropriate policies regarding vapor intrusion. The document was developed using established guidance from the United States (U.S.) Environmental Protection Agency (EPA), the Interstate Technology Resource Council (ITRC), American Society of Testing and Materials (ASTM), and other states, modified for the purposes of complying with remedial response, resource conservation and recovery act and voluntary actions in Ohio. Special thanks to the California Environmental Protection Agency, Department of Toxic Substances Control, for permission to use the Interim Final Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air, December 2004, as a template. In some instances, exact phrasing from California's guidance was used.

Disclaimer

This guidance was developed solely for sites under the oversight of Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), the Resource Conservation and Recovery Act program (RCRA), and the Voluntary Action Program (VAP), carried out under the supervision of Ohio EPA DERR. In this document sites managed under CERCLA and RCRA will be characterized as remedial programs

(RP). Use of this guidance for other Ohio EPA programs or other state agency programs may not be appropriate.

The guidance serves as an instructional tool for the investigation and evaluation of vapor intrusion at sites in Ohio. It is not meant to be a regulatory document and any statements provided herein are not legally binding.

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LIST OF ACRONYMS

AC	Alternating Current
ADS	Active Depressurization System
AF	Attenuation Factor
APU	Air Purifying Unit
AST	Aboveground Storage Tank
ASTM	American Society of Testing and Materials
BGS	Below Ground Surface
BTEX	Benzene Toluene Ethylbenzene Xylene
BUSTR	Bureau of Underground Storage Tank Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COCs	Chemicals of Concern
CP	Certified Professional
CPRG	Closure Plan Review Guidance
CSM	Conceptual Site Model
CVAFS	Cold Vapor Atomic Fluorescence Spectrometry

CV/AA	Cold Vapor/Atomic Absorption
DERR	Division of Environmental Response and Revitalization
DNAPL	Dense Non-Aqueous Phase Liquid
DQOs	Data Quality Objectives
EC	Environmental Covenant
ECD	Electron Capture Detector
ELCR	Excess Lifetime Cancer Risk
EPA	Environmental Protection Agency
FFS	Federal Facilities Section
FID	Flame Ionization Detector
FSOP	Field Standard Operating Procedure
GC/MS	Gas Chromatograph/Mass Spectrometer
HASP	Health and Safety Plan
HEPA	High-Efficiency Particulate Air
HQ	Hazard Quotient
HRV	Heat Recovery Ventilation
HVAC	Heating, Ventilation and Air Conditioning
IDLH	Immediately Dangerous to Life and Health
IRIS	Integrated Risk Information System
ITRC	Interstate Technology Resource Council
J&E Model	Johnson and Ettinger Vapor Intrusion Model
LDPE	Low Density Polyethylene
LEL	Lower Explosive Limit
LNAPL	Light Non-Aqueous Phase Liquid
LPM	Liters Per Minute
MIP	Male Iron Pipe
NAPL	Non-Aqueous Phase Liquid
NCP	National Contingency Plan

NJDEP	New Jersey Department of Environmental Protection
O&M	Operation and Maintenance
OAC	Ohio Administrative Code
OD	Outer Diameter
ODH	Ohio Department of Health
Ohio EPA	Ohio Environmental Protection Agency
ORC	Ohio Revised Code
OSHA	Occupational Safety and Health Administration
OSI	Office of Special Investigation
OSWER	Office of Solid Waste and Emergency Response (U.S. EPA)
PCBs	Polychlorinated Biphenyls
PCE	Tetrachloroethylene
PDS	Passive Depressurization System
PEL	Permissible Exposure Limit
PHC	Petroleum Hydrocarbons
PID	Photoionization Detector
PPB	Parts per Billion
PPBV	Parts per Billion Volume
PPM	Parts per Million
PPMV	Parts per Million Volume
PTFE	Polytetrafluoroethylene
PVI	Petroleum Vapor Intrusion
QA	Quality Assurance
QC	Quality Control
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
RP	DERR Remedial Programs (CERCLA and RCRA)

RSL	Regional Screening Level
SARA	Superfund Amendments and Reauthorization Act
SCIA	Source Control Interim Action
SIFU	Site Investigation Field Unit (Ohio EPA)
SIM	Selected Ion Monitoring
SOP	Standard Operating Procedure
SSWP	Site-Specific Work Plan
STEL	Short-Term Exposure Limits
SVE	Soil Vapor Extraction
TCD	Thermal Conductivity Detector
TCE	Trichloroethylene
TPH	Total Petroleum Hydrocarbons
TSCA	Toxic Substances Control Act
UPUS	Unrestricted Potable Use Standards
U.S. EPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VAP	Voluntary Action Program
VI	Vapor Intrusion
VISL	Vapor Intrusion Screening Level (U.S. EPA)
VOA	Volatile Organic Analysis
VOCs	Volatile Organic Compounds

EXECUTIVE SUMMARY

The intrusion of volatile chemicals from the subsurface into buildings is one of many exposure pathways that must be considered when assessing risk to human health from contamination. The Ohio EPA Division of Environmental Response and Revitalization (DERR) recommends a stepwise approach and sampling methodologies for evaluating vapor intrusion, as described in this document.

Ohio EPA DERR currently administers four environmental media clean-up programs: the Voluntary Action Program (VAP), the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) program, the Federal Facilities Section (FFS) and the Resource Conservation and Recovery Act (RCRA) program. In this document sites managed under CERCLA, FFS and RCRA will be characterized as Remedial Programs (RP).

The VAP is semi-privatized and operates under Ohio Revised Code (ORC) 3746 and Ohio Administrative Code (OAC) 3745. Site assessments and clean-ups in the VAP are conducted by Certified Professionals certified by the program. Site clean-ups under the RP are directed by Ohio EPA staff, and follow the requirements of CERCLA as modified by the Superfund Amendments and Reauthorization Act, and the National Contingency Plan. Corrective Actions and Unit Closures are directed by Ohio EPA staff and follow the requirements of RCRA and subsequent amendments. There are differences between the programs and their methods of assessment, decision points and remedy selection. However, this guidance applies to all Ohio EPA DERR clean-up programs unless explicitly noted.

Stepwise Approach

If volatile chemicals are present in the subsurface at a site, then the vapor intrusion pathway should be evaluated along with other complete or anticipated exposure pathways identified through the site assessment. Due to the complexity of vapor intrusion, many professional disciplines may be needed to evaluate and mitigate the exposure.

Ohio EPA recommends evaluating multiple lines of evidence in a systematic, stepwise approach depicted in Figure 1 (the flowchart) for the evaluation of the vapor intrusion pathway. It is not necessary to investigate a site for potential vapor intrusion risk in the order presented in this guidance. For sites where the environmental release history is unknown, the stepwise approach should be most useful and effective. However, many sites in Ohio EPA DERR programs have been assessed in some manner prior to investigating potential vapor intrusion issues. Therefore, entering the flowchart (Figure 1) at various steps may be appropriate.

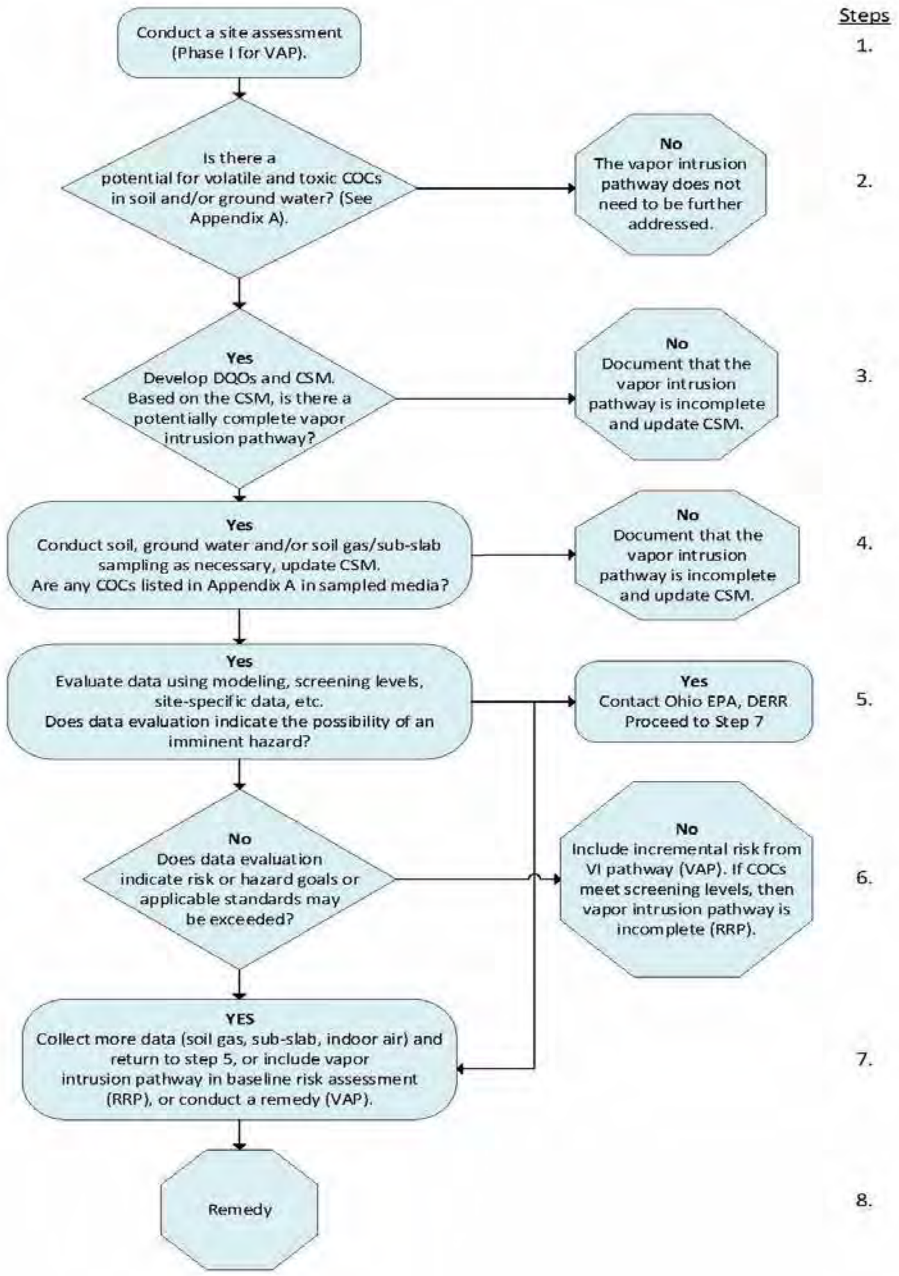

Figure 1. Stepwise Approach for Evaluating the Vapor Intrusion Pathway

Step 1 Conduct the site assessment.

The site assessment is paramount to determining whether the potential for the vapor intrusion pathway exists at a site. A site assessment involves examining current and former activities such as, the types of chemicals used, stored and managed at the site, as well as the administrative history to determine whether releases occurred or if there was potential for releases of hazardous substances or petroleum to environmental media (*i.e.*, soil, ground water, soil gas, sub-slab vapor or indoor air). A site walkover/inspection is also necessary.

Step 2 Determine if there is the potential for any volatile and toxic chemicals in soil or ground water.

Chemicals in the subsurface must be both sufficiently volatile and toxic to present a vapor intrusion risk. If there is no reason to believe that a release of a volatile chemical may have affected the site, then the information supporting this decision should be documented and the vapor intrusion pathway does not need further evaluation.

Step 3 Determine if there is a potentially complete vapor intrusion pathway.

If there was a release, or a release of any sufficiently volatile and toxic chemicals was possible, then develop an investigative workplan that includes a Conceptual Site Model (CSM) for evaluating the vapor intrusion pathway. The potential for a complete vapor intrusion pathway depends on factors such as current or future land use, distance between contamination and existing or proposed buildings, preferential pathways, and whether contaminant plumes are at steady state. The CSM is not static, but continually refined and revised based on data and other information collected at the site.

Step 4 Sample environmental media.

After the vapor intrusion pathway is determined to be potentially complete, sample environmental media (*i.e.*, soil, ground water, soil gas, sub-slab vapor or indoor air) and determine if concentrations indicate a vapor source is present and/or if vapors have infiltrated a building. Data from only one environmental medium is generally not sufficient to fully assess the vapor intrusion exposure pathway. A multiple lines of evidence approach is preferred to evaluate pathway completeness from all environmental media, to assess the complete and potentially complete vapor intrusion exposure pathway to human receptors, and to reduce uncertainties.

Step 5 Evaluate data and determine if data evaluation indicates the possibility of an imminent hazard.

A number of tools can be used at this stage to determine if the vapor intrusion pathway poses a potential unacceptable risk for building occupants. Compare ground water, soil gas, and/or sub-slab vapor concentrations to vapor intrusion screening levels (VISLs) that correspond to a non-cancer hazard of 1 and an excess lifetime cancer risk (ELCR) of 1E-5. Update the CSM depending on the outcome of data evaluation. If data indicate the possibility of an imminent hazard, which is any condition which poses an immediate risk of harm to public health, safety, or the environment, Ohio EPA should be contacted as soon as possible and the volunteer should be prepared to move to Steps 7 and/or 8, as appropriate, in a timely manner.

Step 6 Evaluate the potential risk and hazard from the vapor intrusion pathway.

For RP sites, if data evaluation indicates that concentrations are below screening values, those chemicals of concern (COCs) are eliminated from further vapor intrusion assessment. For VAP properties, if the concentrations are below screening values the vapor intrusion pathway may not be complete for that COC, however the data and screening values must be used to calculate incremental site-wide risk.

Step 7 If data evaluation indicates risk or hazard goals are or may be exceeded, then additional data may be collected, or a remedy may be implemented (see Step 8).

If data evaluation indicates a potential for unacceptable human health risk, then additional data collection may be necessary to conduct a risk assessment, evaluate lines of evidence, and/or determine what, if any, remedy is needed. Further investigation may include the following:

- Collecting data to define physical and chemical parameters for site-specific soil using recommended test methods.
- Collecting soil gas samples to define the vapor plume at sites where buildings do not exist.
- Collecting sub-slab vapor samples or crawl space samples at an existing building.
- Collecting indoor air samples in conjunction with sub-slab vapor or soil gas samples.
- Additional evaluation of the environmental data may be needed to derive an exposure point concentration for use in a property-specific risk assessment.

Step 8 Remediation, Mitigating Indoor Air Exposure and/or Conducting Long-Term Monitoring.

If data evaluation indicates the potential for unacceptable human health risk, there are several remedies that may be considered to mitigate vapor intrusion to indoor air. For VAP sites, the volunteer selects the remedy. For RP sites, the remedy is selected following procedures outlined in CERCLA as amended by SARA and the NCP and may be defined by site-specific orders.

Potential remedies may include:

- Removing vapor-forming chemical contamination through site remediation.
- Installing passive or active vent systems (existing buildings).

- Installing passive and/or active vent systems/membrane systems (future buildings).
- Designing ventilation systems to mitigate indoor air concentrations (HVAC).
- Using institutional controls to restrict structures or land use on contaminated property.
- Implementing and monitoring of appropriate engineered remedies to prevent or mitigate exposure through vapor intrusion. Monitoring of engineered controls must continue until risk-based clean-up levels as measured in environmental media have been met.

For any remedy chosen for a site, long-term monitoring of soil gas and/or indoor air may be necessary under an Operations and Maintenance (O&M) plan. The frequency of the monitoring will depend upon site-specific conditions and the degree of vapor-forming chemical contamination.

1.0 INTRODUCTION

Volatile chemicals in soil or ground water can migrate through the subsurface, enter buildings, and potentially cause an unacceptable chemical exposure for building occupants. If volatile chemicals are present at a site, Ohio EPA DERR requires that potential risk from vapor intrusion be included in the CSM and the potentially complete pathway investigated. This guidance provides a framework for site characterization and investigation of the vapor intrusion pathway.

Evaluation of the vapor intrusion to indoor air pathway may involve sampling environmental media to evaluate and characterize subsurface chemical releases, using screening models to predict indoor air concentrations, and usually includes conducting indoor air sampling. This guidance outlines the technical aspects of evaluating the vapor intrusion pathway and provides recommendations for elements that should be included in a site investigation. This guidance is not intended to provide detailed information on conducting a baseline or property specific risk assessment.

Due to the complexity of vapor intrusion, many professionals of varying disciplines may be needed to evaluate and mitigate exposure, such as geologists, risk assessors, engineers, HVAC specialists, Certified Industrial Hygienists, and risk communication specialists. Accordingly, an appropriate project team should be gathered when evaluating vapor intrusion issues. Ohio EPA DERR anticipates that this guidance will be used by regulators, responsible parties, environmental consultants, community groups, and property developers.

Vapor intrusion is a developing field and it is anticipated that some of the procedures and practices within this guidance will change as understanding of vapor intrusion progresses. Ohio EPA DERR will update this document as needed to accommodate refinements and advances in the field of vapor intrusion.

2.0 SCOPE

This guidance provides options of technically defensible and consistent approaches for evaluating the vapor intrusion to indoor air pathway, but it is not comprehensive, nor does it impose any requirements or obligations on the regulated community. Other technically equivalent sampling and engineering procedures exist and those investigating vapor intrusion may use other technically sound approaches. Furthermore, this guidance does not alleviate a volunteer or potentially responsible party from any obligations that U.S. EPA may require.

This guidance document provides procedures to evaluate the vapor intrusion to indoor air pathway only. All other media characterization and evaluation of complete exposure pathways at a site must be done in accordance with the rules or procedures of the appropriate Ohio EPA DERR programs. This guidance is meant to provide information to fully characterize the potential risk from vapor intrusion at DERR sites.

This guidance assists in addressing, but is not limited to, the following questions:

- What sites are candidates for potential risk from vapor intrusion to indoor air?
- What site-specific data are needed to conduct a vapor intrusion evaluation?
- What methods are recommended for sampling subsurface media and indoor air?
- Should indoor air sampling be conducted?
- What are the data requirements for an evaluation of the vapor intrusion pathway?
- What measures are available to mitigate indoor air exposures?

3.0 VAPOR INTRUSION EVALUATION

The following text describes the stepwise approach for evaluating vapor intrusion found in Figure 1 (the flowchart). The stepwise approach in this guidance document is meant to be flexible and may be tailored to site-specific circumstances. Pathway evaluation may begin at any step in the flowchart provided that the data collection and the CSM clearly justify entry into that step. However, most vapor intrusion pathway evaluation decisions and determinations regarding the need for remedial activities and long-term mitigation are not made using indoor air sampling results alone because a vapor intrusion exposure pathway is assumed to be complete unless demonstrated otherwise. For this reason, it is preferred to also have data collected from soil, ground water, soil gas, and/or sub-slab vapor when making decisions and drawing conclusions about a potential vapor intrusion pathway from indoor air sampling results.

3.1 Initial Vapor Intrusion Assessment

The steps outlined in the flowchart apply at sites whether or not buildings are currently present and/or occupied. Current buildings and future building scenarios, as appropriate, will determine sampling strategy and data evaluation. While the assessment process is presented in a stepwise fashion, the vapor intrusion pathway is generally evaluated in an iterative manner and steps may be repeated.

Flowchart Step 1 and Step 2: Conduct the site assessment and determine if there is a potentially complete vapor intrusion pathway

A comprehensive evaluation of the current and historical operations at a site should be conducted to identify potential or known releases of volatile chemicals to subsurface environmental media. A complete compilation of site information is essential for identifying all potential vapor intrusion exposure pathways. For VAP properties, a complete Phase I property assessment must be conducted in accordance with the Ohio Administrative Code (OAC) 3745-300-06. RP sites may use ASTM E1527-13 (or most recent version) Standard Practice for Environmental Site Assessments: Site assessment Environmental Site Assessment Process (ASTM, 2013), DERR’s Closure Plan Review Guidance (CPRG) (Ohio EPA, 2017) or other relevant CERCLA and RCRA guidance.

For simplicity, this guidance will not repeat the requirements necessary to conduct a site assessment. However, using the site assessment information when developing a CSM is a necessary component of this guidance. See the discussion in Step 4 for more details on CSM components for evaluating the vapor intrusion pathway.

U.S. EPA's June 2015 *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (VI Guidance) (U.S. EPA, 2015b) states that the chemicals in the subsurface must be both sufficiently volatile and toxic to present a vapor intrusion risk. A chemical is considered "volatile" if its:

- Vapor pressure is greater than 1 millimeter of mercury (mmHg); or
- Henry's law constant is greater than 10^{-5} atmosphere-meter cubed per mole (atm m^3 mol^{-1}).

In addition to being sufficiently volatile, a chemical must be potentially toxic to present a vapor intrusion risk. A volatile chemical may be considered toxic in regard to vapor intrusion if:

- The vapor concentration of the pure component exceeds the target indoor air concentration, when the subsurface vapor source is in soil; or
- The saturated vapor concentration exceeds the target indoor air risk level, when the subsurface vapor source is in ground water.

In addition to researching a chemical's physical-chemical properties, the most recent version of the U.S. EPA Vapor Intrusion Screening Level (VISL) calculator can be used as a tool to help determine if a chemical meets the criteria of sufficiently volatile and toxic and should be included in a vapor intrusion investigation. Chemicals that are sufficiently volatile and toxic in regard to vapor intrusion are referred to in this guidance document as vapor-forming chemicals. For additional information on identifying vapor-forming chemicals, please refer to Chapter 3 of U.S. EPA's June 2015 OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air (U.S. EPA, 2015b).

If any chemicals that meet these criteria were potentially released, then the site should be evaluated for vapor intrusion. This includes evaluating the history of adjacent properties for potential releases of vapor-forming chemicals that may have affected the subject site. If there is no reason to believe that a release of a vapor-forming chemical may have affected the site, then the information supporting this decision should be documented and the vapor intrusion pathway does not need further evaluation.

Please note, polychlorinated biphenyls (PCBs) and PCB mixtures (*i.e.*, Aroclors) are considered sufficiently volatile and toxic in the U.S. EPA VISL calculator. However, only lighter PCB mixtures and degradants would be expected to volatilize at a site. In most cases, PCBs do not need to be evaluated in a vapor intrusion (VI) assessment; please contact Ohio EPA if the site assessment identifies PCBs for vapor intrusion on a site.

Based on the site assessment decide if further investigation and understanding of the vapor intrusion pathway is warranted. The potential for a complete vapor intrusion pathway depends on factors such as current or future land use, distance between contamination and existing or proposed buildings, preferential pathways, and whether contaminant plumes are at steady state. A potentially complete or complete vapor intrusion pathway exists if there is: 1) a potential or confirmed source of a sufficiently volatile and toxic chemical or chemicals; 2) a current or future mechanism to transport the chemical; and, 3) a current or future human receptor. Please note, future buildings are to be reasonably anticipated. If a determination is made that there is no complete or potentially complete vapor intrusion pathway, this determination must be documented. If the three factors listed above are present at a site, an investigative workplan that includes a CSM for evaluating the vapor intrusion pathway should be developed. The CSM is not static, but continually refined and revised based on data collected at the site.

Flowchart Step 3: Develop a conceptual site model and data quality objectives

3.2 Conceptual Site Model

Site investigations should include the development and refinement of a CSM. The purpose of a CSM is to provide a conceptual understanding of the potential for exposure to hazardous contaminants based on knowledge of the sources of contamination present, release mechanisms to the environment, transport mechanisms, exposure pathways, and potential receptors. The CSM should include a diagrammatic or schematic representation that relates the source of contamination to human and ecological receptors and identifies all potential sources of contamination, the potentially contaminated media, and exposure pathways. The CSM should evolve as site-specific conditions are better understood and additional data becomes available, thus the CSM should not be static. The CSM organizes and communicates information about the site characteristics and is not only a necessary component of any vapor intrusion site investigation, but an essential decision-making and communication tool for all interested parties.

For vapor intrusion sites the CSM is integral to the development of a sampling plan. The CSM will focus on the potential receptors and pathways and is updated as additional data and information is obtained. Ohio EPA recommends that the following items be included in a CSM for the vapor intrusion pathway. However, in the early stages of investigation, not all components listed may be available.

- Primary Sources of Contamination. Provide a list of all volatile chemicals for each potential source. For each potential contaminant source, describe the release and provide a list of volatile chemicals released into the environment.

- Secondary Sources of Contamination. Include all the environmental media potentially contaminated by the primary sources, such as surface soil, subsurface soil, and ground water. Contaminated building materials, such as concrete foundations, can be a source area for a potential release to an environmental medium and should be considered.

- Contaminant Transport Mechanisms. For each potentially contaminated environmental medium, describe the transport mechanism to indoor air, (usually advection and diffusion through the vadose zone), and describe the characteristics of the subsurface.

- Exposure Routes. Describe current buildings, potential future building scenarios, as appropriate, and areas where vapors may accumulate, including smaller enclosed areas in larger buildings. Discuss any preferential contaminant migration pathways associated with the buildings, such as foundation cracks, voids, utility ports, pipes, elevator shafts, sumps, and drain holes.

- Potential Receptors. List all the current and potential future receptors, as appropriate, that could potentially be exposed to contaminated indoor air from the vapor intrusion pathway.

A preferential contaminant migration pathway is a pathway of less resistance than typical pathways available for transport through environmental media, taken by chemicals of concern (COC) while undergoing diffusion or advection. These pathways, which can be natural or anthropogenic, are a result of disturbance in natural soil layers, (such as installation of underground utilities or fractures in bedrock), are more porous and transmissive, and enable more rapid COC transport. Early in the development of a CSM and sampling plan, preferential pathways need to be considered, located and potentially sampled for. For example, it has been observed that utility lines are able to influence the flow of shallow ground water contaminated with vapor-forming chemicals, and either block the flow of such ground water, or conversely, facilitate flow of soil gas and contaminated ground water through the porous bedding material or the pipes themselves. Sewer lines in particular, due to their construction, have been known to convey vapor-forming chemicals for long distances from a source. Older sewer lines may be composed of clay, cast iron or Orangeburg pipe, which may have cracks and voids at joints depending upon their age. Infrastructure present in older cities and towns may be cracked or detached at joints due to settling. Utility lines are surrounded by bedding material which is typically more porous than the surrounding native soils. The presence of any preferential pathway necessitates an examination of whether vapor-forming chemicals can be transmitted beyond the assumed 100-foot buffer zone. A study by McHugh, et. al. (2017) showed that concentrations of vapor-forming chemicals were higher in the basement than the sub-slab vapor concentrations. Therefore, if a sewer line is within the zone of influence (less than 100 feet) from a source of vapor-forming chemicals, or there is reason to suspect that a ground water plume contaminated with vapor-forming chemicals above U.S. EPA VISLs is interacting with the sewer line, then sampling the line and bedding material should be planned and included in the sub-surface investigation and field sampling plan.

To document current site conditions, the CSM should be supported with maps, subsurface cross-sections, site diagrams, and any other site-specific details which may be pertinent, such as building characteristics. The narrative should clearly describe known site conditions and state what assumptions were made to generate the CSM. The narrative should include a description of ambient sources and the presence of nearby potential sources of volatile organic compounds (VOCs) and other volatile chemicals, such as neighboring dry-cleaning operations. Additional information on the development of a CSM can be found in guidance published by various entities, including the U.S. EPA Risk Assessment Guidance for Superfund (U.S. EPA, 1989), Standard Guide for Developing Conceptual Site Models for Contaminated Sites ASTM E1689 – 95 (ASTM, 2014), Ohio EPA DERR Conceptual Site Models Guidance Document (Ohio EPA, 2015), and U.S. EPA Guidance on Systematic Planning Using the Data Quality Objectives Process (U.S. EPA, 2006).

The site evaluation may lead to the conclusion that the vapor intrusion pathway is incomplete. The following are examples of instances where the vapor intrusion pathway may be considered incomplete:

- No buildings are present at the site and there is a prohibition on building structures at the site in the future;
- Absence of sufficiently volatile and toxic chemicals;
- The distance between contamination and existing or proposed buildings is greater than 100 feet leading to low probability of vapor intrusion, as confirmed with soil gas data;
- Lack of preferential pathways; or
- Contamination plumes (*e.g.*, ground water, soil gas or sub-slab vapors) are confirmed to be at steady-state and contaminant concentrations are and will remain below screening levels.

A checklist of information to assist in the development of a CSM for vapor intrusion and for planning a soil gas sampling strategy for a site can be found in Appendix A**.**

3.3 Data Quality Objective Process and Developing a Sample Plan

The scope and objectives of environmental media sampling should be established before the vapor intrusion investigation is conducted by working through the Data Quality Objective (DQO) process. For voluntary actions, the DQO process is part of the Phase II Property Assessment (see OAC 3745-300-07(C)). For RP sites, the CERCLA RI/FS guidance, RCRA Corrective Action Guidance, Closure Plan Review Guidance and general U.S. EPA Quality Management documents should be followed when designing a sampling plan and developing DQOs. The DQOs are qualitative and quantitative statements that:

- Clarify the study objective.
- Identify the chemicals of concern (COCs).
- Define if the sample will provide qualitative or quantitative information.
- Define the type, quantity, and quality of each piece of data collected in the study.
- Determine required analytical detection limits.

- Define how each sample will be used to assess whether vapors are intruding into buildings.
- Determine the most appropriate locations, sampling method, and sampling duration for data collection.
- Specify the amount of acceptable uncertainty in the sampling results.
- Specify how the data will be used to test the exposure hypothesis.

Additional information on the DQO process can be found in U.S. EPA. *Guidance on Systematic Planning Using the Data Quality Objectives Process* (February 2006) at https://www.epa.gov/quality and Ohio EPA, Data Quality Objectives Process Summary, DERR-00-DI-32, Internal Guidance Document, January 2002 at https://www.epa.ohio.gov/portals/30/rules/Data%20Quality%20Objectives%20Process%20Summary.pdf.

The type of environmental media sampled and sampling strategy for the evaluation of the vapor intrusion pathway is dependent on release history, prior site investigations, the CSM, and whether the site is being evaluated under the VAP or RP programs.

For RP sites, the sampling strategy is directed by the RI/FS, RFI/CMS or unit closure site characterization process. For VAP sites, the Phase I will direct the sampling with the results presented in the Phase II. For RP sites, the sampling strategy should be sufficient to characterize the complete nature and extent of contamination. For VAP sites the sampling strategy may be tailored to the remedy selection. During site characterization, the sampling and analysis plan that was developed during the project planning is implemented and field data are collected and analyzed to determine if a complete vapor intrusion pathway exists and to what extent the site poses a threat to human health and the environment. This is an iterative process and the resulting data and information will be used for selecting a remedy for the site.

The U.S. EPA *OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (June 2015) recommends collecting multiple rounds of sampling at multiple locations to evaluate spatial and temporal variations of the concentrations of COCs in environmental media. Spatial and temporal variability factors to consider include depth to ground water, heterogeneity in subsurface materials, weather conditions, building operations, building construction and age, interior compartmentalization, preferential contaminant migration pathways (such as foundation cracks, sumps and utilities), and whether the site is developed or undeveloped.

In most cases, soil gas data is part of the multiple lines of evidence approach to determine whether the vapor intrusion pathway is potentially complete from contaminated soil or ground water. For existing buildings, sub-slab vapor concentrations best reveal the potential for vapor intrusion directly into the building. The flow chart in Figure 1 does not require that environmental media be sampled in a linear fashion (*i.e.*, soil and ground water, then soil gas, then sub-slab vapor, and finally indoor air). However, where receptors are potentially being exposed, the preference is to determine impacts from soil gas, soil, and ground water first to determine if a potential for vapor intrusion exists. A more detailed discussion of the relative importance and iterative sampling of different media is provided in Sections 4.3, 4.5, and 6.4. If soil gas, soil and/or ground water data indicate a potential risk to building occupants, then sub-slab vapor and indoor air data should be collected and used in the risk evaluations. Special considerations are advisable when evaluating residential properties and/or imminent hazard situations and are discussed in Appendix B and Section 11.0, respectively.

Ambient air and sub-slab vapor should be collected when sampling indoor air to aid in data interpretation and determining if vapor intrusion is occurring. Although measuring indoor air concentration is a direct measurement at the exposure point, many factors can influence indoor air results, including materials used or stored indoors, disturbance of sampling equipment during testing, and the possibility of ventilating the building during the sample event (*i.e.*, opening doors/windows). Additionally, indoor air values can be influenced by concentrations of volatile chemicals in ambient outdoor air that are unrelated to releases in soil or ground water.

For all vapor-forming chemical releases, if the data collected during the site investigation indicates existing or future buildings at a site or near the site are greater than 100 feet laterally from the known extent of subsurface contamination above screening levels and there are no preferential pathways (*e.g.*, sewer lines) that can be a direct conduit from a vapor source to a building, then vapor intrusion is not likely under the current site conditions, and no further consideration of the exposure pathway should be needed until such time site conditions change in a way that warrant a vapor intrusion investigation (*e.g.*, a building is built directly above the source area). For relatively small releases compromised of only petroleum hydrocarbon (PHC), such as underground storage tank (UST) sites, a lateral separation distance of 30 feet and a vertical separation distance of 15 feet (above LNAPL) or 6 feet (above dissolved sources) can be applied instead of the default 100 feet. Sites with a potential for larger petroleum releases, such as bulk plants, refineries, petrochemical plants, or pipelines, or sites where lead scavengers were used or stored should use the 100 feet lateral separation distance recommended for non-PHC VOCs. See Sections 9.2 and 9.3 for additional information regarding PHC lateral and vertical separation distances.

Evaluations of building distance from contamination should only be conducted if the movement of subsurface contamination has reached steady-state conditions (*i.e.*, when the maximum migration potential of the subsurface plumes has been reached). For ground water, the migration potential can be evaluated with data from routine sampling of ground water monitoring wells. If COCs in ground water indicate stable or decreasing contaminant trends, the maximum contaminant migration for ground water has probably occurred. For soil gas, a similar evaluation can be conducted if routine sampling data is available from permanent or temporary sampling points. If sufficient time has passed since the chemical release to allow for diffusional movement to the building in question, then steady-state conditions have probably occurred. If soil gas or ground water contaminant plumes are increasing, 100 feet is not an appropriate distance for potential pathway elimination.

When evaluating the distances between subsurface contaminant plumes and buildings, it is important to consider whether preferential pathways exist which could allow vapors to migrate beyond the lateral separation distance. These preferential pathways could be either natural or anthropogenic. Examples of preferential pathways include fractures, macropores, gravel base for utility conduits, and subsurface drains, etc.

Flowchart Step 4: Sample environmental media

4.0 SOIL GAS AND SUB-SLAB VAPOR SAMPLING PROCEDURES

The following section provides basic guidelines for conducting soil gas and sub-slab vapor sampling for assessing the vapor intrusion pathway. Soil gas sampling refers to samples collected outside of a building footprint and sub-slab vapor sampling refers to samples collected from directly underneath an existing building. Appendix C contains Ohio EPA DERR's standard operating procedures for installing soil gas probes, sub-slab vapor probes and direct push techniques for collection of soil gas.

Soil gas and sub-slab vapor sampling can be used for a number of purposes including initial site characterization, delineation of impacts from ground water plumes, identification of source areas and potential receptors, remediation and post-remediation monitoring, and for developing and refining a CSM.

4.1 Soil Gas and Sub-Slab Vapor Sample Collection and Analysis

Depending on the scope of the study and the DQOs, samples may be collected using devices such as gas-tight syringes, Tedlar® bags, passive sorbent samplers or Summa canisters. Gas tight syringes are appropriate only when an on-site field laboratory is used, and samples are analyzed immediately following sample collection. Field screening and use of a mobile lab are acceptable in order to refine DQOs by conducting on-site, real time field analysis. Alternative soil gas and sub-slab vapor sampling options can be proposed to Ohio EPA for considerations.

Prior to collecting the sample for analysis, Ohio EPA DERR recommends purging three tubing volumes or conducting a purge test until parameters (*e.g.*, oxygen, carbon monoxide, or VOCs) stabilize in order to determine the optimal purge volume for the location. The purge volume should be consistent for all samples collected from the study area. An approximate 10-minute delay should occur between purging and sampling. When purging or collecting samples using a vacuum pump or an evacuated canister, the vacuum applied to the probe should not exceed ten inches of mercury or 100 inches water and the flow rate generally should not exceed 200 milliliters per minute. This should limit the potential for ambient air being drawn into the sample from the ground surface and it should limit desorbing of vapors from contaminated soils.

To maintain sample integrity:

- The recommended maximum holding times for samples should not be exceeded. The laboratory should be contacted for holding times and to ensure the sampler uses the best collection method.
- If stored samples are to be subjected to changes in ambient pressure (such as shipping by air), canisters are recommended (ITRC, 2007).
- Samples should not be chilled during storage unless specified by the method.
- Tedlar® bag samples should be kept out of direct sunlight.
- All sampling records should be completed and maintained (*e.g.,* chain of custody, sample data forms).

The appropriate sample method is dependent on the DQOs developed for the project. The contract laboratory can provide information on appropriate sample volume for analysis. Samples should be analyzed for the appropriate COCs, including breakdown products. Syringe samples and Tedlar® bags generally are only acceptable for qualitative and possibly semi-quantitative analyses. Quantitative analysis by TO-15/8260 or TO-17 should be used for human health risk assessments. The analytical method used should be able to identify and quantify the target analytes and be capable of meeting program specific requirements. Sample results submitted to Ohio EPA DERR should be reported in units of ppbv and/or $\mu g/m^3$. Lower explosive limit (LEL) percentages should be used for explosive gas determinations. Soil gas and sub-slab vapor sampling field data should be recorded on either the Soil Gas Probe Field Data Report Form (Appendix D) or the Indoor Air/Sub-Slab Vapor Sampling Form (Appendix E) or equivalent forms, as applicable, and submitted with the results.

Utility and sewer lines should be located prior to conducting sampling for safety and to aid in locating samples. Contact a local municipal utility authority to obtain accurate layout of utilities and sewer lines in immediate vicinity of the site before a subsurface investigation. In Ohio, it is 8-1-1, the Ohio Utilities Protection Service, which coordinates with local utility contacts. The utilities and sewer lines should be depicted on the cross section of the CSM, and a determination should be made if there is a potential for utility or sewer lines to interact with shallow ground water. Utility lines within 100-feet of a known vapor-forming chemical release should be screened via a Photoionization detector (PID) or equivalent field screening instrument.

A utility line preferential pathway investigation should take into consideration the type, depth, diameter and construction specifications of all lines and bedding material, utilizing historical resources. Screen sewer gas and determine depth of lines through manhole apertures if possible, using a PID. Sampling in sewer lines and the bedding around utilities requires caution and expertise given the risks involved if utilities are pierced or damaged. The following resources discuss techniques which can be utilized to sample for soil gas in and around utilities:

- Indiana Department of Environmental Management (IDEM): Investigation of Manmade of Preferential Pathways, Office of Land Quality, August 2015: https://www.in.gov/idem/cleanups/files/remediation_tech_guidance_investigation_mpp.pdf

- Massachusetts Department of Environmental Protection (MassDEP) Vapor Intrusion Guidance, Site Investigation, Mitigation and Closure, October 2016: https://www.mass.gov/files/documents/2016/10/nu/vapor-intrusion-guidance-10-14-2016.pdf

4.2 Analytical Detection Limits

Analytical detection or reporting limits for soil gas samples should be sufficiently low to adequately evaluate the vapor intrusion pathway per the project's DQOs. For VAP sites, an estimate of the applicable standard, adjusted for the presence of multiple chemicals, provides the basis for the minimum detection limits. For screening at Ohio EPA DERR RP sites, the minimum detection limit is determined by the appropriate screening value. More information on the analytical methods and reporting limits can be found in Appendix F.

4.3 Soil Gas Sampling

In many cases, soil gas sampling is essential in evaluating the vapor intrusion pathway. There are a variety of techniques for obtaining these samples, from placing probes using boring devices to measuring soil gas using passive-type samplers. Whatever technique is chosen, the soil lithography and stratigraphy should be determined using on-site data from previous investigations, data from nearby sites, or based on information from county soil surveys to aid in characterizing the source and transport mechanisms. Other pertinent information that should be considered when planning a soil gas investigation include depth to ground water and the presence of perched impermeable zones. This information should be used to determine appropriate sampling depths. Ohio EPA generally expects that initial soil gas samples should be taken above the capillary fringe to determine if a contamination source is of sufficient concentration to warrant additional soil gas sampling or to conduct sub-slab vapor sampling. It may be necessary to install probes at multiple depths to evaluate the vertical distribution of contaminants in soil gas. For vertical delineation, soil gas samples could be collected at various depths (*e.g.*, 5 feet, 10 feet, and 20 feet below ground surface (bgs)) to demonstrate attenuation and the likelihood that the vapor intrusion pathway is complete. Ohio EPA DERR recommends that vadose zone monitoring points for sample collection be installed to evaluate the temporal variations in soil gas concentrations. Soil gas sampling should be postponed at least 24-hours after a major rain event (one-half inch or more) and the sampling area must be free of ponded water.

Soil gas sample locations should be biased toward the source, if known, or toward highest expected concentrations. If a property is developed, sub-slab vapor sampling rather than soil gas sampling is preferred to evaluate the potential vapor intrusion pathway to the building. If sub-slab vapor sampling is not practical, then soil gas samples should be collected as close to the building as possible. However, keep in mind that soil gas samples may exhibit a high degree of spatial and temporal variability (U.S. EPA, 2015b). According to U.S. EPA (2015b), "…soil gas concentrations measured exterior to a building may not be representative of sub-slab concentrations measured directly beneath the building foundation sub-slab. The bias introduced by these factors may be high or low depending on climatic and building conditions and the extent to which the samples accurately represent the spatial and temporal variability of concentrations under the building.” If soil gas samples are being collected in lieu of sub-slab samples, then bias should be given to preferential pathways, such as utilities and fill materials located at the site to account for this potential variability. It is important to note that situations may exist where vertical fractures may provide preferential pathways, in such instances sub-slab vapor sampling may be necessary to adequately evaluate the indoor air pathway.

Ohio EPA DERR recommends that a minimum of two rounds of soil gas data be collected to evaluate the vapor intrusion pathway. However, early or interim response actions may be required following one round of sampling. The two rounds will begin to estimate temporal and seasonal variations at the site and other site-specific factors which may influence vapor migration. Since two rounds constitute a limited database, the maximum concentration detected should be used to evaluate potential risk. Based on these results, additional samples may be required depending on the source strength, plume movement and how soil gas concentrations compare to screening levels. If soil gas samples exceed screening values and buildings are within 100 feet of the sample location for non-petroleum vapor-forming chemicals and within 30 feet of PHC vapor-forming chemicals, then sub-slab vapor samples and/or indoor air samples should be collected to further evaluate the vapor intrusion risk pathway. For further information on evaluating petroleum releases and their inclusion zones see Section 9.0.

For undeveloped sites with vapor-forming chemical contamination, soil gas samples should be collected to evaluate the potential for vapor intrusion should the property be developed in the future. The number and depth of soil gas samples should be sufficient to evaluate concentrations in soil gas and attenuation of soil gas as it migrates to the surface. Reassessment of the vapor intrusion pathway may be warranted once structures are built on the site to evaluate the site-specific situation.

Generally, soil gas samples should not be collected at depths shallower than five feet bgs due to the potential for atmospheric interference. Ambient air may infiltrate the soil column and could result in dilution of the soil gas sample near the surface. For sites where the depth to ground water or the soil source is less than five feet, but sub-slab sampling beneath an enclosed structure is not an option, an attempt should be made to collect soil gas samples from beneath existing impermeable surfaces such as outdoor patios, parking lots, or roads. When shallow (< 5 feet bgs) soil gas sampling is performed, leak testing is a critical element of the sampling to verify the integrity of the vapor probe seal and the quality of the data (Section 4.7). If an impermeable surface is not present beneath a structure or in outdoor areas, then it may be more appropriate to rely on other lines of evidence such as passive soil gas sampling, ground water sampling, crawl space or indoor air sampling to evaluate the vapor intrusion pathway.

4.4 Soil Gas Probes

Soil gas sampling probes are either temporary or permanent. Temporary soil gas probes are only sampled once, and all equipment is removed upon sample completion. Permanent soil gas probes are sampled over time to evaluate seasonal, temporal or other variations in concentrations. When possible, permanent soil gas probes should be installed when collecting soil gas samples for risk assessments. Figure 2 shows several types of soil gas probes (NJDEP, 2005). Whether installing a temporary or permanent soil gas probe, it is necessary to prevent ambient air from diluting the soil gas sample. A leak test should be performed to verify the integrity of the vapor probe seal. For further information on leak testing refer to Section 4.7.

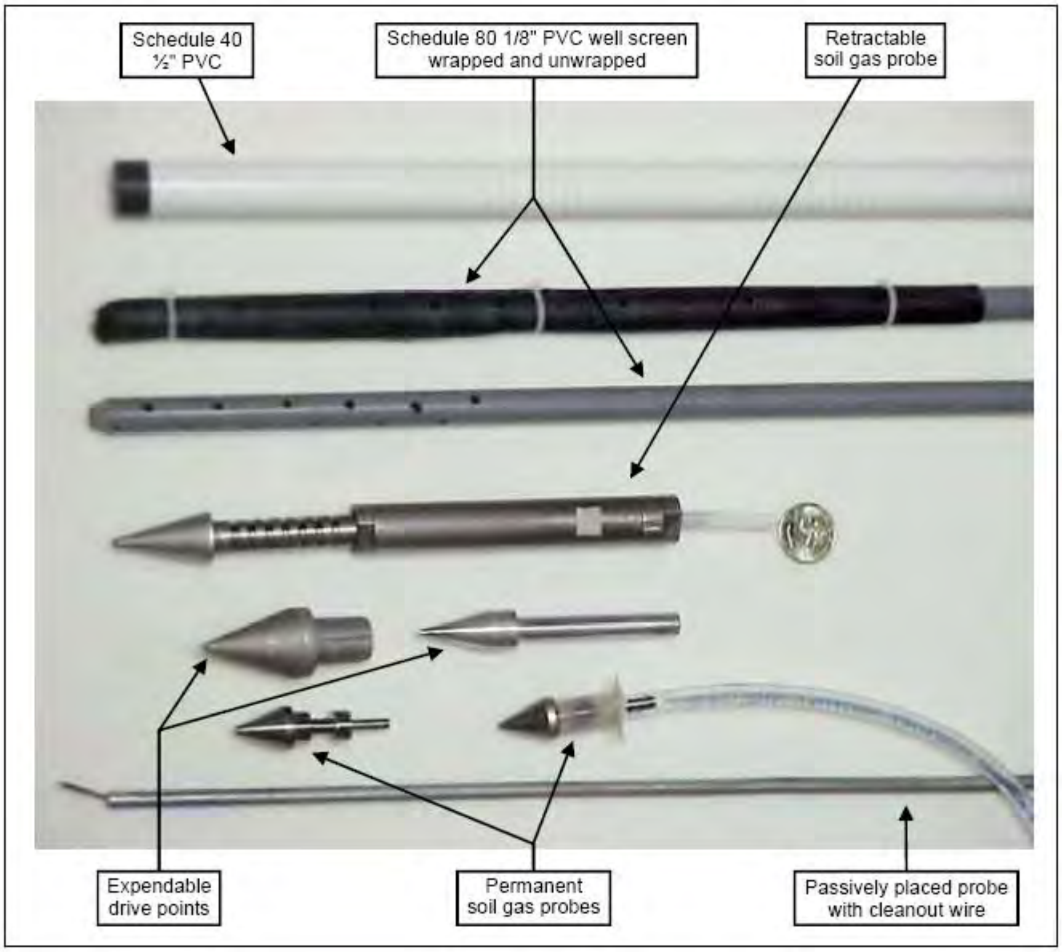

Figure 2. Examples of Soil Gas Sampling Probes (NJDEP, 2005)

Temporary vapor probes can be installed by a variety of methods. The most common methods are direct push and manual slide hammer. These methods allow sample tubing to be placed at the desired depth for sampling then removed once a sample is collected. Temporary vapor probes use a retractable or removable drive tip. Typically, ¼” nylon, Teflon or polyethylene tubing is used to collect subsurface vapors for sampling in temporary applications.

Figure 3 is a schematic of a permanent soil gas probe. Samples from permanent soil gas probes should be collected over an appropriate seasonal or temporal time frame in order to adequately evaluate the risk from the contaminants detected. Permanent soil gas probes typically consist of a screen or sample port installed at the tip or near the bottom of the tubing. Stainless steel, Teflon or nylon tubing are preferred in permanent applications. Tubing selections should be based upon duration of sampling, type of COCs, and how long the sampling point needs to remain in place (see Appendix G for comparison of sample tubing type to vapor absorption). Common installation methods include direct push equipment (*e.g.*, Geoprobe®), hollow stem auger and manual slide hammer (see Appendix C for the standard operating procedure for advancing soil gas probes). The soil gas probe is installed to a specific depth in a bore hole created with a slide hammer, direct-push system or a hollow stem auger. Sand is placed in the annulus around the sampling port screen and the remainder of the bore hole is sealed with hydrated bentonite. The tubing is usually labeled and capped at the surface. The bore hole is completed with a protective cover at the surface.

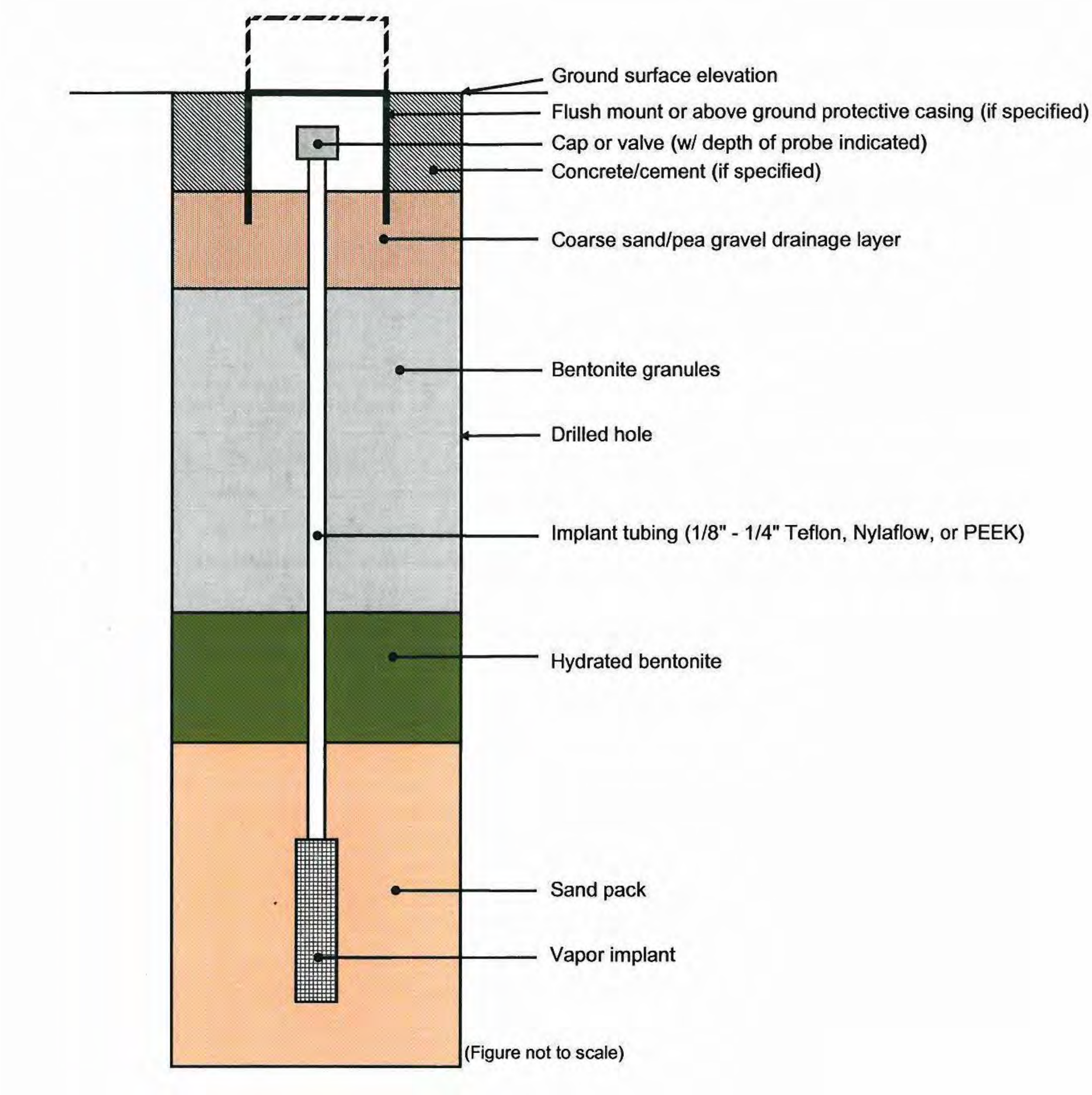

Figure 3. Permanent Soil Gas Probe Schematic

4.5 Sub-Slab Vapor Sampling and Data

Sub-slab vapor data, which is collected from under the foundation floor and is within the advective envelope of building-driven depressurization, indicate whether contaminants have accumulated directly under the building. Analytical detection limits should be low enough to effectively evaluate the indoor air risk posed by the vapor intrusion pathway. See Section 12.0 for more information on evaluating the indoor air risk from vapor intrusion by calculating risk levels.

When there is an indication of a potentially complete exposure pathway, proceeding directly to sub-slab vapor sampling may shorten the investigation. However, if the purpose of an investigation is to directly link a known or suspected source to vapor intrusion, then sub-slab vapor sampling is only one step in the process. In this situation, it is important to also consider collecting soil, ground water, soil gas, sub-slab vapor, utility or sewer line, and indoor air samples, as applicable, in order to link the source to the exposure point (*i.e.*, the indoor air). When collecting sub-slab vapor samples, Ohio EPA DERR recommends the event be paired with indoor air samples and an ambient air sample in order to compare the chemicals detected in these samples to aid in vapor intrusion assessment data interpretation and conclusions.

If COCs are detected in sub-slab vapor samples above screening levels, then installation of permanent sampling ports may be necessary to determine the temporal variability of the data. However, the collection of sub-slab vapor samples can be inconvenient to building occupants since it requires the removal of floor coverings and drilling through the foundation slab, thus clear communication with inhabitants and property owners about the sampling process is needed.

When sub-slab vapor sampling is conducted, an appropriate number of samples should be taken to characterize the sub-slab area. The number, type (time-integrated or grab samples), and locations of the sub-slab samples should be determined based on information collected during the building survey, an understanding of the building foundation(s), the COCs (*e.g.*, PHC versus chlorinated), the results from nearby soil gas, ground water, and/or soil sampling, and the site-specific DQOs. At residential properties, at least two sub-slab vapor samples should be taken with one sample taken in the center of the building's foundation. For foundations greater than 5,000 square feet, at a minimum sub-slab vapor samples should be collected approximately every 2,000 to 5,000 square feet from biased locations, such as locations directly over source areas, maximum ground water concentration areas or near preferential pathways, and one of the sample locations should be located near the center of the building foundation. If indoor air sampling is not performed concurrently, but is subsequently needed, the indoor air samples should be analyzed only for the chemicals detected in the sub-slab vapor (see Section 5.0). By selecting for the chemicals detected in the sub-slab samples, the chance of inadvertent inclusion of indoor sources of chemicals can be decreased or eliminated. However, analyzing indoor air samples for the method's full analyte list can be necessary when the full nature and extent of contamination has not yet been determined.

During sub-slab sampling care should be taken to not damage the integrity of the slab or underground utilities. Sub-slab utilities or tension cables need to be located prior to selecting sampling locations. Blueprints can assist in locating these features. A private utility locating service should be contracted to determine the presence of sub-slab utilities or tension cables if there is no information available from other sources. Since penetrating the slab creates a preferential pathway, proper sealing of the sampling port is essential to avoid leaks. Sub-slab sampling should be avoided in areas where ground water might intersect the slab. Figure 4 is a schematic of a sub-slab vapor probe made with Swagelok® parts. Another alternative is the Cox-Colvin vapor pin®.

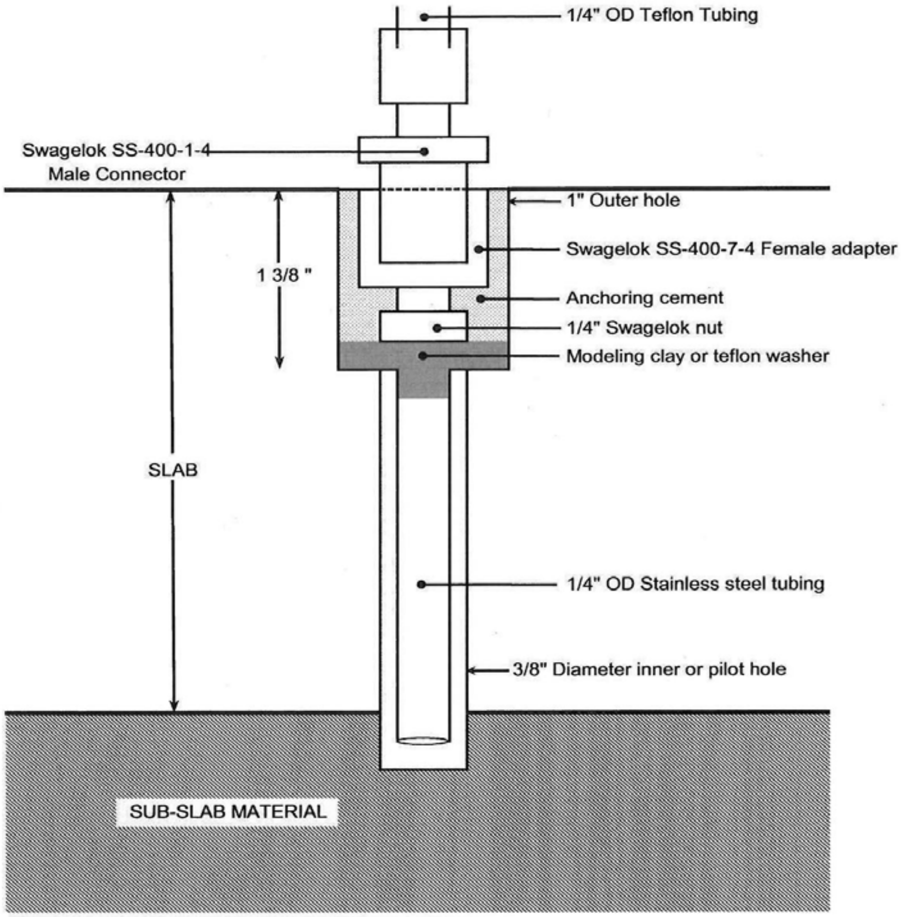

Figure 4. Example of a Sub-Slab Vapor Probe

Multiple sampling rounds may be needed to adequately account for temporal variability due to the "substantial spatial variability in sub-slab vapor concentrations" (U.S. EPA, 2015b). Generally, if both indoor air and sub-slab vapor samples are collected during the most desirable sampling conditions to evaluate reasonable maximum exposure and both are non-detect or below screening values, then one round of sampling may be sufficient. If, however, COCs are detected in both sub-slab vapor and indoor air, or if indoor air is non-detect, but COCs are elevated in sub-slab vapor, soil gas or other media, then multiple rounds of sampling (or preemptive mitigation) are typically required. The number of additional rounds depends on the chemical concentrations and other site-specific circumstances. For example, long-term quarterly, semi-annual, or annual sampling may be necessary in situations where vapor concentrations are variable, or to verify remedy effectiveness.

4.6 Sampling Basements with Dirt Floors and Crawl Spaces

If a basement or crawl space has a dirt floor, any sampling conducted should be with an evacuated air canister in the same manner as for sampling indoor air.

4.7 Leak Testing

Atmospheric air drawn into a soil gas or sub-slab vapor sample can result in dilution of the sample. Negatively biased samples, resulting from the inclusion of atmospheric air during soil gas or sub-slab vapor sampling, will be unusable to demonstrate that a vapor intrusion pathway is incomplete. To ensure that valid soil gas and sub-slab vapor samples are collected, leak tests on the probes should be conducted to demonstrate that dilution is not a concern. It is often desirable to conduct leak testing with utilization of tracer gases or a water dam. The water dam can consist of a secondary, larger hole surrounding the smaller hole that the vapor sampling point is installed through (such as the hole used for flush mount Vapor Pin® installation) or can be a ring temporarily sealed to the floor with VOC-free putty. The water dam is filled with water after connecting the tubing to the Summa canister. Changes in water level or appearance of bubbles during sampling are indicative of possible leaks.

Soil gas probes should be installed greater than five feet bgs and should be tested for integrity with a particular emphasis on the sampling train (*i.e.*, the tubing or the connectors). This testing is usually performed with compounds not found at the site that enshroud the sampling train. Atmospheric oxygen and CO_2 may also be considered for leak tests. As a general rule, shallow soil gas samples (*i.e.*, less than 5 feet bgs), are discouraged. However, if shallow soil gas sampling is the only option at a site, then leak testing should be utilized, and sampling must be discussed with Ohio EPA DERR personnel prior to collection of these samples. Temporary soil gas probes should be abandoned immediately after the investigation is concluded. Sub-slab vapor sample collection can also be affected by leaks from surface air and a sub-set of these samples should also have leak tests performed. In addition to tracer gas leak tests, a mechanical leakage test of the sampling train should be considered, such as Shut-in Test as proposed by McAlary et. al. (2009). This test involves pulling a vacuum on the tubing and valves used to construct the sampling train. Typically, a vacuum of 100 inches of water is applied to the "closed-off" sampling train and potential leaks are verified with an in-line vacuum gauge.

Depending on the contaminants of concern a number of different compounds can be used as a tracer, as shown in Table 1. Sulfur hexafluoride (SF_6), perfluorhydrocarbons and helium are commonly used as tracers because they are readily available, have low toxicity, and can be monitored with portable measurement devices. Isopropanol can also be used as a tracer but requires laboratory analysis for the tracer. In all cases the same tracer should be used for all sampling probes at any given site. The leak test should be conducted using a tracer that is not expected to be present in the soil gas or sub-slab vapor being tested. When choosing a liquid tracer, check with the laboratory to determine the reporting limit for the proposed tracer. Ideally, the reporting limit for the tracer should be similar to the constituents present in the soil gas or sub-slab vapor.

Infiltration of atmospheric air during sampling may also be indirectly evaluated through the measurement of oxygen and carbon dioxide concentration differences due to the presence or absence of petroleum hydrocarbon degradation. For example, if oxygen concentrations at a probe installed within a petroleum hydrocarbon source area are at atmospheric levels, the soil gas data should not be considered reliable and the probe seal should be modified and the probe re-sampled, because oxygen levels would be expected to have been depleted in the biological degradation process. Care should be exercised using this logic when investigating sub-slab vapor as the absence or presence of a robust microbial community may be questionable. The Soil Gas Probe Field Data Report Form in Appendix D is useful for recording data when conducting soil gas evaluations. Table 1 lists advantages and disadvantages of common tracer compounds.

Table 1. Common Tracers Advantages and Disadvantages

Tracer	Advantages	Disadvantages
Helium	Can check for leaks on site with handheld detector. Can quantify amount of leakage accurately. Does not interfere in TO-15 analysis.	Party-grade helium may have low VOC contamination. If used, send a QC sample to lab for analysis. Process is more cumbersome than some others. Cannot be analyzed by TO-15 Can be difficult to apply to sampling train connections.
Liquid Tracers	Easy to use in identifying leaks. Can be detected by VOC analytical methods. Easier to apply to sampling train connections.	Concentration introduced to assess leak is estimated. Large leak may lead to VOC analysis interferences. No simple field screening method. May leave residual contamination on sampling train. Qualitative.
Sulfur Hexafluoride	Can check for leaks with on-site instrument with very low detection limits.	Very expensive. Field instrument subject to interference with chlorinated solvents. Cannot be analyzed by TO-15. A greenhouse gas.
Ambient Air Oxygen	Cost effective, easy. Check for leaks with on-site multi-gas meter.	Cannot be used in an environment where oxygen is expected to be present at ambient levels. Qualitative.

If elevated levels of the tracer (greater than 10% in the shroud) are observed in a sample, the soil gas data should be evaluated for the significance of bias on the results. If the evaluation provides evidence that the results cannot be considered reliable, then re-testing should be attempted after determining the cause for the atmospheric or tracer break through. Portable, tracer gas-specific field monitoring devices with detection limits in the low part per million (ppm) range are available to screen samples for tracer leak testing.

4.8 Passive Soil Gas (Exterior or Sub-Slab) Sampling

Most methods for soil gas sampling involve the measurement of volatile constituents in soil gas after drawing soil gas into evacuated canisters, such as Summa canisters, with analysis by U.S. EPA method TO-15. Summa canister use is limited by flow regulators with sampling durations ranging from immediate grab up to 72-hour samples. Scientists and engineers concerned about impact of temporal variability on the representativeness of soil gas concentrations may consider longer sampling durations using passive soil gas sampling techniques. Passive sampling uses adsorbent materials which are placed in the subsurface and left for a period of time (up to weeks). The sampling devices are then retrieved and analyzed. Passive soil gas samples therefore may provide longer-term time-weighted average concentrations.

Passive samplers generally consist of a container with an opening to allow gas to permeate and be sorbed onto a sorbent. The opening is configured to allow vapors into the device with a steady uptake rate. The sorbent is selected for the chemicals of concern. The average concentration over the sampling period can be determined using the following equation.

$$\mathrm{C} = \mathrm{M}/(\mathrm{UR} \times \mathrm{t})$$

Where:
C = Concentration
M = Mass of sorbed chemical (µg)
UR = Uptake Rate (mL/min)
t = time (min)

Conversion of these parameters into familiar units of $\mu g/m^3$ is usually performed by the laboratory. The analysis of the sorbent material can determine the mass (M) of the chemical adsorbed with high accuracy. The duration of sample acquisition (t) is also known, but the uptake rate (UR) can depend on a variety of factors. These factors include the geometry of the sampling device, the physical-chemical characteristics of the chemicals of concern (diffusion coefficient); the humidity of the soil atmosphere and the permittivity of the chemical through the soil.

Many of these factors for the uptake rate are not known without study, therefore Ohio EPA DERR considers passive soil sampling to be qualitative. Studies (McAlary et al., 2014a) suggest that quantitative passive soil gas sampling analysis is possible, but consultants should consult with Ohio EPA before site work begins to demonstrate the acceptability of passive soil gas sampling for quantitative purposes.

Passive soil gas sampling methods can be a useful tool for:

- Collecting soil gas from low-permeability and high moisture settings where conventional active soil gas sampling may be problematic;
- Detecting compounds present at very low concentrations;
- Assessing preferential vapor migration pathways such as utility corridors and foundation cracks to determine if these pathways are acting as significant VOC migration pathways into a structure; and
- Providing chemical vapor concentrations if the sampling method meets the project DQOs.

For additional information on passive sampling techniques, see:

- ITRC guidance, Vapor Intrusion Pathway: A Practical Guideline. January 2007, Appendix D, page D-16.
- NAVFAC Memorandum (July 2015), Navy Facilities Engineering Command: Passive Sampling for Vapor Intrusion Assessment. TM-NAVFAC EXWC-EV-1503. 14 pages.
- McAlary, T.A., H. Groenevelt, S. Seethapathy, P. Sacco, D. Crump, M. Tuday, B. Schumacher, H. Hayes, P. Johnson, and T. Górecki. 2014b. Quantitative passive soil vapor sampling for VOCs—Part 2: laboratory experiments. *Environ. Sci.: Processes Impacts* 16(3): 491–500.

5.0 INDOOR AIR SAMPLING

Indoor air sampling should be conducted when soil, ground water, soil gas, or sub-slab vapor data indicate the potential for unacceptable risk due to vapor intrusion, or an imminent hazard is suspected. Indoor air sampling in lieu of other media sampling may be necessary under circumstances where soil gas or sub-slab vapor sampling is not viable, such as: contaminated soil or ground water in close proximity to the foundation, during or after mitigation, or where preferential pathways may exist that would limit the usefulness of data from other environmental media. As previously noted, indoor air sampling in conjunction with sampling other media is recommended to prevent the potential for concentrations of chemicals from indoor sources (not related to vapor intrusion) inadvertently being included in the vapor intrusion risk evaluation.

Several steps should be considered when conducting indoor air sampling as part of a vapor intrusion assessment:

- Define the study goals and DQOs;
- Identify the vapor-forming chemicals, including parent and breakdown products;
- Inspect building interiors and product inventory;
- Select the number and location of indoor sample locations;
- Select the number and location of ambient air sample locations;
- Select the duration of samples based on DQOs and risk assessment or risk management needs;
- Select appropriate sampling methods with acceptable detection limit(s); and,
- Establish QA/QC requirements.

When assessing large plumes that have the potential to affect a significant number of structures, Ohio EPA DERR recommends a tiered approach to indoor air sampling. Highest priority for sampling should be given to structures at the greatest risk for indoor air contamination through an evaluation of nearby ground water concentrations, soil gas concentrations, sub-slab vapor concentrations, structural characteristics and sensitivity of receptors. Conduct sampling at the primary structures, *i.e.*, at the greatest risk of indoor air contamination, first. Conduct sampling at secondary structures if COC concentrations in or below primary structures are at unacceptable levels. This systematic “step-out process” should be implemented sequentially until a perimeter of structures with concentrations at acceptable levels is defined.

5.1 Site Inspection, Product Inventory and Field Screening

Prior to indoor air sampling, a site inspection and inventory of products containing volatile chemicals should be conducted in the building (see Appendix E). Activities that could influence indoor air concentration levels should be suspended a minimum of 24-48 hours prior to and during sampling. Activities that should be suspended include, but are not limited to, smoking, use of sprays and/or solvents, mowing, painting, and asphalting. Containers containing products that could confound indoor air vapor intrusion assessment results should be removed from the building if possible.

Field screening instruments used to assist with identifying indoor air sample locations should be capable of detecting vapors in the $\mu g/m^3$ range. However, field screening results are considered qualitative and often are not capable of measuring levels over time or at low enough concentrations to inform risk management decisions. Therefore, quantitatively collected indoor air samples are still needed to evaluate receptor exposure and quantify potential human health risks.

5.2 Indoor Air Sample Collection and Analysis

Ohio EPA DERR recommends that indoor air samples be paired with sub-slab vapor samples and an ambient air sample in order to compare the chemicals detected in these three distinct zones when interpreting data and making conclusions about the vapor intrusion pathway. When conducting paired indoor air and sub-slab vapor sampling, it is recommended that the samples be collected a minimum of 2 hours after the installation of sub-slab vapor ports to allow for equilibration of both the indoor air and sub-slab vapor sampling spaces (U.S. EPA, 2015b).

When collecting indoor air samples, it is preferable to collect samples under conditions that will result in the highest potential concentrations (see Table 2). Indoor air samples should not be collected when doors and windows are open frequently or for long periods of time. Special consideration should be given to areas where sewer lines may provide a preferential pathway, and it is often beneficial to sample in bathrooms, laundries, and mud rooms where dry traps or leaking plumbing are present and may be acting as a preferential pathway. Sampling in the lowest level of a residence or commercial/industrial building is often needed to evaluate the most likely highest concentrations in indoor air. If vapor-forming chemicals are detected in the lowest levels above applicable standards, then additional sampling may be needed from the next higher level of the building to further assess vapor intrusion exposures.

While sampling under the more conservative conditions specified in Table 2 is recommended, Ohio EPA DERR acknowledges that it may be difficult to time sampling to when these conditions are present. The sampling team must decide when to sample based on site-specific circumstances and each individual project's DQOs.

Table 2. Comparison of Indoor Air and Sub-Slab Vapor Sampling Conditions to Bias Sampling to the Highest Potential Concentrations*

Parameter	More Conservative	Less Conservative
Temperature	Indoors 10°F greater than outdoors	Indoor temperature less than outdoor
Wind	Steady greater than 5 mph	Calm
Soil	Dry	Saturated with rain (1/2" of rain or more within 24 hours)
Doors/Windows	Closed	Open
Mechanical Heating System	Operating	Off

*Modified from Mass DEP Vapor Intrusion Guidance Document (2016)

Sampling duration should represent the exposure scenario(s) under consideration. Typical exposure scenarios include residential and commercial categories. A twenty-four (24) hour sampling duration is used to represent exposure for a residential setting and an eight (8) hour sample duration for a commercial or industrial setting. A 24-hour sample in a commercial or industrial setting is also acceptable.

The number and location of indoor air samples is site-specific and dependent upon the site conceptual model. Indoor air samples should, at a minimum, be collected from the lowest level of the structure where vapors are expected to enter such as basements or crawl spaces, and in areas where preferential pathways, including foundation penetrations and cracks, have been identified. In some circumstances, it may be beneficial to collect samples in first or second floor spaces, or necessary when a building is built slab on grade. However, subsequent risk management decisions based on these samples are site-specific and should be made in consultation with Ohio EPA DERR. Multiple indoor air sample locations are typically necessary in the following instances: when there is significant or unknown spatial variability in subsurface contamination, large buildings (>1,500 square feet), small rooms such as offices and break rooms present within larger buildings, buildings with additions, and areas subject to different HVAC systems. In larger buildings, samples should both be biased toward known or suspected subsurface contamination as well as collected from occupied areas of the building.

Multiple rounds of sampling may need to be collected to adequately account for temporal and seasonal variability. Generally, if both indoor air and sub-slab vapor samples are collected during more conservative sampling conditions (see Table 2) and both are non-detect or below screening values, one round of sampling may be sufficient. If, however, COCs are detected in both sub-slab vapor and indoor air, or if indoor air is non-detect but COCs are elevated in sub-slab vapor or subsurface media, then multiple rounds of sampling, or preemptive mitigation, are typically required. The number of additional rounds of sampling depends on the chemical concentrations and other site-specific circumstances. For example, long-term quarterly, semi-annual, or annual sampling may be necessary in situations where vapor concentrations are variable, or to verify remedy effectiveness.

For details on collecting indoor air, see Figure 5 and the appendices.

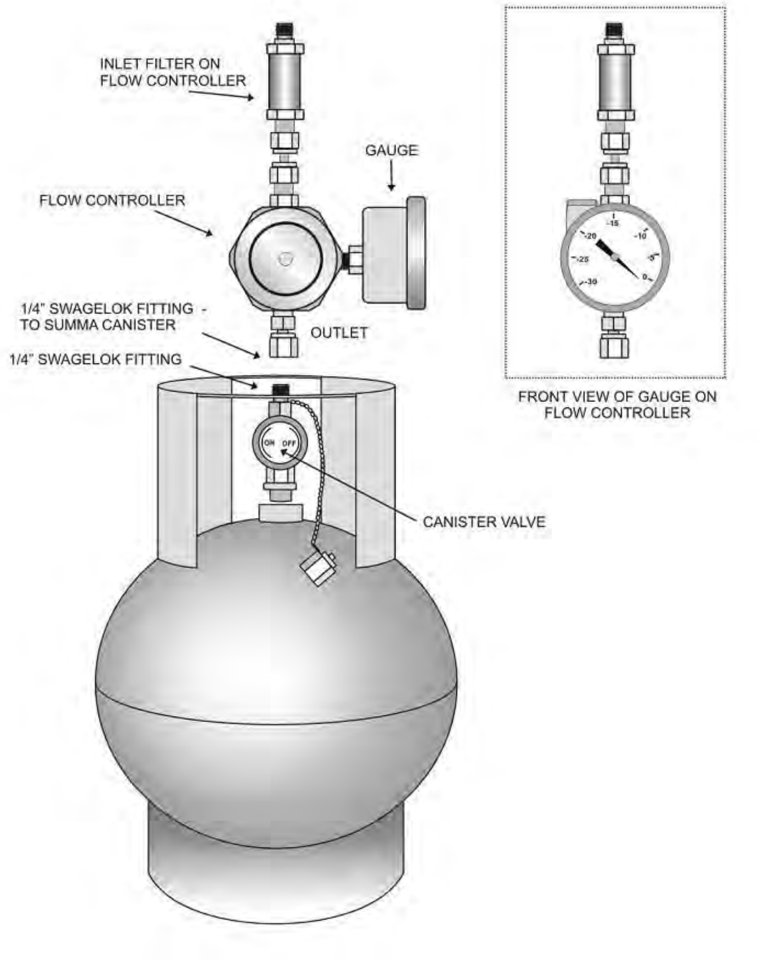

Figure 5. Schematic of a Summa Canister (*Eurofins Lancaster Laboratories Environmental, LLC 109)*

Indoor air samples are typically collected in Summa canisters. When requesting Summa canisters from a lab, it is recommended that you request canisters that are dedicated to indoor air sampling and are certified clean to appropriate levels for indoor air screening. The canisters from a lab can either be certified clean by "batch" certification or "individual" certification. Project DQOs as well as a discussion with the lab should help identify the need for "batch" or "individual" certification of the sample canisters. The analytical method chosen for the indoor air sample analysis must be able to identify and quantify the target volatile chemicals and be capable of detection below acceptable indoor air risk evaluation levels. Ohio EPA DERR recommends that laboratory analysis for VOCs be done using gas chromatography/mass spectrometry (GC/MS) and where appropriate, using the high-resolution selected ion monitoring (SIM) mode for low level detection.

Analyzing indoor air samples for the method’s full analyte list is often necessary when the full nature and extent of contamination has not yet been determined, such as when indoor air samples are collected prior to or in lieu of sampling other media. However, if contaminant concentrations in ground water, soil, sub-slab vapor and/or soil gas have been sufficiently characterized, the analyte list may be limited to only those COCs known or suspected to be present and the degradation products of the primary VOC contaminants. By selecting for the chemicals detected in the release, the chance of inadvertent inclusion of indoor sources of chemicals can be decreased or eliminated.

6.0 GROUND WATER MONITORING AND EVALUATION

Vapor-forming chemical contamination in ground water can be a source of vapors that may impact an overlying structure. Ideally, soil gas or sub-slab vapor sampling should be conducted in addition to ground water sampling when a source of vapor-forming chemicals is present in or on the ground water. However, ground water data alone can sometimes be used to evaluate the potential for vapor intrusion from ground water contamination. Proper ground water monitoring well placement and construction, including screen placement, screen lengths, and sampling protocols, are important for gathering appropriate ground water data to evaluate the presence and concentrations of vapor-forming chemicals to assess vapor intrusion potential and the need for additional media samples. For technical guidance on installing and sampling ground water monitoring wells, please see the Ohio EPA Division of Drinking and Ground Waters Technical Guidance Manual in addition to the modifications for the VI assessment discussed below.

6.1 Well Placement

Sufficient sampling is needed to determine ground water contamination levels, contamination location, plume movement, and to assess and evaluate the potential vapor intrusion from ground water contamination. For the purposes of investigating vapor intrusion, wells should be placed in each area of anticipated maximum concentrations, or the core of the plume(s). Monitoring wells must also be properly located proximal to areas of known indoor air receptors to assess the potential impacts to those receptors. A conceptual site model and DQOs can help evaluate spatial and temporal variability in ground water concentrations and identify potential well locations.

6.2 Screen Placement

Ground water samples obtained from the uppermost portion of the aquifer are recommended to characterize representative vapor source concentrations for vapor intrusion assessments. Ground water samples from wells screened across the water table interface are preferred. Ohio EPA recommends that samples representing a flow-weighted average be collected as close as possible to the top of the water table using sampling methods designed to minimize loss of volatiles because VOCs volatilize from the top of the water table. Thus, monitoring wells used to make vapor intrusion evaluations should not have screens submerged below the top of the water table.

6.3 Screen Lengths

Monitoring wells with long well screens, regardless of screen placement, should not be used for VI evaluations. When sampling long well screens, clean water entering the well screen at depth may dilute the contaminated ground water near the top of the screen, biasing the sampling results and the associated risk determination. Therefore, short screen lengths are preferred for monitoring wells that will be used to make vapor intrusion evaluations. Ideally, the saturated thickness at a well screen should always be less than 10 feet.

A flow-weighted averaging of ground water concentrations happens when mixing of water from different stratigraphic units occurs while purging a well using low-flow methods, such as low-flow purge and sample. Areas of higher conductivity provide a proportionally higher volume of water than lower conductivity regions across the screened interval.

6.4 Ground Water Sampling

Ohio EPA recommends low-flow ground water sampling with bladder pumps or submersible pumps. These pumps minimize the loss of VOCs during sample collection and handling. Some submersible pumps can cause cavitation of the ground water and release of volatiles, so care should be taken in selection and operation of the pumps. For well-characterized sites where the contaminants are known, the appropriate diffusion bags may be used to sample ground water following the procedures in Interstate Technology and Regulatory Council (2004) guidance document *Technical and Regulatory Guidance for Using Polyethylene Diffusion Bag Samplers to Monitor Volatile Organic Compounds in Groundwater*. However, if levels of VOCs in ground water collected using diffusion bags are found to be near screening levels, samples may need to be verified using bladder or submersible pump sampling techniques.

This may require multiple sampling events conducted quarterly over several years to represent seasonal variations. The stability of the VOC plume must be demonstrated so that the risk to receptors would not be expected to increase due to contaminant migration or degradation to more toxic constituents, such as the degradation of tetrachloroethylene (PCE) and trichloroethylene (TCE) to vinyl chloride. Plume stability and migration may be affected by factors as simple as a change in the surface drainage and recharge patterns. Understanding these changes is important when characterizing the vapor intrusion potential of a ground water source.

6.5 Soil Gas Confirmation of Ground Water Concentration

Ground water chemical concentrations can be compared to VISLs to evaluate the potential of VI and the need for further sampling (see Section 8.3). Ohio EPA recommends applying the appropriate VISLs for any building with receptors within 100 feet of the plume boundary for non-PHC vapor-forming chemicals and 30 feet for PHC vapor-forming chemicals.

If ground water concentrations are less than VISL and a determination is made that additional sources in soil or preferential pathways are not present the investigation may be discontinued. If there is uncertainty as to whether a complete vapor intrusion pathway exists, soil gas, sub-slab vapor and/or indoor air data may be needed in addition to ground water data to determine vapor concentrations in vadose zone soils. Indoor air samples may be needed to establish whether the vapor intrusion exposure pathway from environmental media to indoor receptors is complete.

When collecting soil gas samples to measure concentrations of vapor-forming chemicals emanating from ground water, Ohio EPA recommends that seasonal ground water table elevation fluctuations be considered. Ground water elevation fluctuation can impact measured vapor concentrations in the vadose zone. Multiple sampling events may be needed to adequately address seasonal variations in concentrations from sources in ground water.

6.6 Other Factors

If the vapor-forming chemicals are present as Light Non-Aqueous Phase Liquid (LNAPL), then ground water sampling may underestimate soil gas concentrations in the vadose zone and a soil gas survey should be conducted. For further information on evaluating petroleum releases see Section 9.0.

7.0 BULK SOIL

Soil data are used to define the type, location and extent of soil contamination when investigating the potential for vapor intrusion. If a release of a vapor-forming chemical has been confirmed, a lack of detections in soil should not be interpreted to indicate the absence of a subsurface vapor source and soil data alone is not recommended to evaluate vapor intrusion risk or pathway completeness. Rather, a well-developed conceptual site model along with multiple lines of evidence should be used when evaluating the potential for vapor intrusion at a site. The uncertainty associated with soil partitioning equations and the potential for VOC contaminant loss during sample collection and analysis (Hewitt, 1994; Hewitt, 1999; Liikala et al., 1996; Vitale et al., 1999) makes using soil data alone unreliable for drawing risk assessment conclusions about a suspected or confirmed release at a site. Therefore, Ohio EPA DERR recommends soil vapor sampling when a suspected or known soil source of vapor-forming chemicals has a potential for vapor intrusion. VOC loss during sampling can be minimized using SW-846 Method 5035A (U.S. EPA, 2002). U.S. EPA SW-846 Method 5035A (2002) provides the minimum requirements and standards to prevent loss of VOCs during sample collection and handling. Specific soil collection requirements for SW-846 Method 5035A include chemical preservation in the field, using multi-functional sampling devices, or using empty, tared and labeled Volatile Organic Analysis (VOA) vials with Polytetrafluoroethylene (PTFE)-lined septum caps. Refer to the method for specific instructions.

Flowchart Step 5: Evaluate data and determine if data evaluation indicates the possibility of an imminent hazard

8.0 DATA EVALUATION AND ANALYSIS

For each site, multiple lines of evidence are used to assess the vapor intrusion pathway. Most of the lines of evidence will be based on empirical data from environmental media including soil, ground water, soil gas, sub-slab vapor and/or indoor air. Evaluating data from several environmental media, averaging among different collection times, and differing environmental conditions, poses a unique set of considerations when evaluating data for vapor intrusion. Generally, the multiple lines of evidence approach starts with evaluating soil and/or ground water data from the environmental release for the presence of volatile chemicals to assess the vapor intrusion pathway. If sufficiently volatile and toxic chemicals are detected in soil and/or ground water, additional sampling is usually warranted to further assess the vapor intrusion pathway.

Analytical methods, quantitation limits, qualified and coded data, and blanks should all be evaluated prior to relying on the data for decision making. Data are evaluated for several reasons which should be described in DQOs for the site. Generally, data are evaluated to determine the most logical and efficient next step in the investigation or remedial process. Initial comparisons to the appropriate risk-based screening levels or applicable standards may be appropriate and provide evidence for reacting to an imminent hazard or implementing early or interim response measures. For more information on comparisons to risk-based screening levels and appropriate responses to imminent hazards see Section 11.0 and flowchart Step 5.

8.1 Vapor Intrusion Screening Levels

U.S. EPA VISLs (https://www.epa.gov/vaporintrusion/vapor-intrusion-screening-levels-visls) are media-specific, risk-based screening level concentrations for ground water, sub-slab vapor and soil gas, and indoor air. VISLs are applied to identify site areas, building locations, exposure points, and/or concentrations of COCs that are either unlikely to present a human health concern and can be eliminated from further assessment or where further evaluation of the VI pathway is needed. Established DQOs should be met, and exposure assumptions should be consistent with the appropriate exposure scenario (*i.e.*, residential or commercial/industrial land use).

For Ohio EPA DERR RP sites, when considering concentrations measured in sub-slab vapor, soil gas, or ground water, the VISLs should be applied corresponding to an excess lifetime cancer risk (ELCR) of 1E-5 (*i.e.*, one increased cancer risk in 100,000 people) and a noncancer hazard quotient (HQ) of 1. Ohio EPA considers the generic application of the attenuation factor (AF) within the VISL calculation as an appropriate extension of safety to provide for applying these ELCR and HQ values. If the measured concentrations in the sampled media are less than the appropriate exposure scenario VISLs set at an ELCR of 1E-5 and a HQ of 1, Ohio EPA DERR considers the pathway to be ‘incomplete’ and additional investigation or risk estimation of this pathway is not warranted.

For Ohio EPA DERR VAP sites the VISLs should be applied corresponding to an ELCR of 1E-5 and a HQ of 1. If the measured concentrations in the sampled media are less than the appropriate VISLs set at an ELCR of 1E-5 and a HQ of 1 for the appropriate exposure scenario then additional investigation of this pathway is not warranted. However, the estimation of risk generated from the analysis of the media or indoor air must be included within the sitewide risk characterization in accordance with VAP rules OAC 3745-300-08 and OAC 3745-300-09. A sitewide risk characterization must meet the Ohio EPA cumulative risk goals of an ELCR of 1E-5 and a HQ of 1. In summary, the removal of detected COCs from the risk assessment using a risk-based approach is not permitted in the VAP, and the detected COCs must be multiple chemically adjusted and included in the summation of risk and hazards across the complete exposure pathways.

Ohio EPA considers concentrations in indoor air to be the exposure point concentration from which risk and hazard levels can be estimated and applicable standards can be demonstrated. When VISLs or U.S. EPA Regional Screening Levels (RSLs) are being used for risk and hazard assessment, care should be taken to use the appropriate land use scenario and an ECLR of 1E-5 and a HQ equal to 1. In some cases, it may be appropriate to evaluate multiple chemicals within indoor air to ensure Ohio statewide cumulative risk and hazard goals are met.

8.2 Bulk Soil Data

Soil data are less than ideal for evaluating vapor intrusion risk and the need for early or interim measures because of the uncertainty associated with using partitioning equations and the potential loss of VOCs during sample collection (see Section 7.0). In general, identification of elevated levels of VOCs in soil indicate the need for sub-slab vapor and indoor air sampling when buildings are present, or soil gas data in areas where buildings do not exist. Bulk soil detections of VOCs may be used to define the location of a VOC source and extent of soil contamination, to assess the risk from direct contact with soils, and to evaluate leaching to ground water.

8.3 Ground Water Data Screening

Ohio EPA recommends comparing ground water concentrations to U.S. EPA screening values calculated through the U.S. EPA VISL calculator (Section 8.1). Ground water sample data should be compared to screening values developed for the appropriate exposure scenario (*i.e.*, residential or commercial/industrial exposures), utilizing a default or site-specific attenuation factor (AF), and a default or site-specific ground water temperature.

The U.S. EPA VISL calculator uses AFs to calculate target ground water vapor intrusion screening levels from toxicity-based target indoor air concentrations. Ground water data should be compared with the appropriate VISL calculated with the recommended default ground water AF appropriate to the CSM for the site. A generic ground water AF of 0.001 can be applied for most site scenarios with the exception of shallow water tables less than five feet below the foundation of a building or when preferential vapor migration routes are present in vadose zone soils (U.S. EPA, June 2015b). A default ground water AF of 0.0005 can be applied at sites with fine-grained (low permeability) vadose zone soils when laterally extensive layers are present (U.S. EPA, June 2015b). Site-specific soil and geologic information are needed to support the use of non-default AFs.

In addition to adjusting the default AF, the ground water temperature in U.S. EPA's VISL calculator can be adjusted to Ohio EPA DERR's default ground water temperature of 11 degrees Celsius, or a verified property-specific value, to generate Ohio or site-specific target ground water vapor intrusion screening levels.

Areas with ground water COC concentrations exceeding the ground water VISLs warrant further evaluation of the VI pathway, including sampling of soil gas, sub-slab vapor and indoor air, depending on the presence and location of buildings. If buildings are not currently present at the site, it is recommended that a pre-emptive remedy requirement or future evaluation of potential VI pathway be recorded in an Environmental Covenant to avoid exposure to future receptors in the form of an institutional control (see Section 13.0, Remedy).

8.4 Soil Gas and Sub-Slab Vapor Data Screening

Soil gas and sub-slab vapor data for each area of concern should be compared individually to the VISLs. The recommended generic AF of 0.03 should be used to develop sub-slab vapor and soil gas VISLs. However, soil gas VISL values should not be used for VI source areas that are present less than five feet below the ground surface or if preferential vapor migration routes are present in vadose zone soils (U.S. EPA, 2015b). Soil gas and sub-slab vapor data that exceed VISLs warrant further VI assessment. If buildings are not currently present in the area(s), additional assessment is warranted in the future if buildings are constructed, and an Environmental Covenant with a building occupancy limitation may be needed depending on the site conditions and reasonably anticipated future use.

For evaluating the human health risk associated with crawl space air, an attenuation factor of 1.0 should be used for crawl spaces, consistent with U.S. EPA guidance (2015b). The use of an attenuation factor of 1.0 indicates the indoor air quality is assumed to be equal to the crawl space air quality for evaluation purposes.

8.5 Indoor Air Data Evaluation

The indoor air data collected (Section 5.2) provides a time-weighted (*e.g.*, 8 or 24 hours) average concentration representing the reasonable maximum exposure to a receptor to be evaluated in a human health risk assessment. The indoor air data is used to determine whether there is a potential risk to human health posed from vapor intrusion. Exceedances of indoor air applicable risk and hazard levels require implementation of remedial activities, and a confirmation of the effectiveness of the remedial activities.

8.6 Background Source Evaluation

Many VOCs are also present in common household and industrial products and may contribute to VOC detections in indoor air. Sources of background indoor air detections need to be evaluated and documented to help interpret data when VOCs are detected in indoor air (see Section 5.1). An inventory of potential background indoor air sources should be conducted prior to or during indoor air sampling. If background vapor sources are found to be primarily responsible for indoor air concentrations, then response actions for vapor intrusion would generally not be warranted. Information on “background” contributions of site-related VOCs in indoor air are part of the data evaluation because vapor intrusion mitigation will not address VOCs generated within the building or that are from natural or anthropogenic background levels. However, it is not appropriate to subtract background or ambient air concentrations from the quantitative evaluation of indoor air exposure determinations when it cannot be determined that the concentrations are not also from a vapor intrusion pathway. Sub-slab volatile chemical levels should be used to estimate the contribution of sub-slab VI sources to indoor air levels. Confirmation sampling (*i.e.*, an additional or additional rounds) may need to be conducted in order to estimate the contribution from the environmental release.

8.7 Occupational Exposure Limits

The Occupational Safety and Health Administration (OSHA) is the primary regulatory agency tasked with protecting workers while on the job. OSHA regulations and initiatives encompass many aspects of worker safety, including, among others, fall risks, workplace violence, heat illness, and chemical safety. Ohio EPA investigates and has jurisdiction over releases of hazardous chemicals to environmental media, including releases affecting receptors at OSHA-regulated sites.

When it has been demonstrated that OSHA has jurisdiction at a site or property, OSHA will regulate using its own indoor air regulatory thresholds. However, changes in processes or OSHA’s jurisdiction must be considered for future exposure scenarios.

OSHA's indoor air regulatory thresholds for workers are called Permissible Exposure Levels (PELs). OSHA also has indoor air regulatory standards called Short-Term Exposure Limits (STELs) for 15-minute exposures, and ceiling limits above which no worker should be exposed for any period of time.

9.0 VAPOR INTRUSION FROM PETROLEUM RELEASES

Petroleum Vapor Intrusion (PVI) is the intrusion of vapors from subsurface petroleum hydrocarbons (PHC) and non-PHC fuel additives into overlying or nearby buildings or structures. PVI can occur from PHC-contaminated soil or ground water contaminant plumes with high concentrations of dissolved PHC contaminants, or if the plume is in contact with a building foundation, basement, or slab. In contrast to chlorinated solvents that degrade slowly under anaerobic conditions, PHCs generally biodegrade rapidly under aerobic conditions. The biodegradation intermediates from PHC are also less toxic than chlorinated compounds. Some petroleum hydrocarbons may also degrade anaerobically and may produce methane, particularly if the source is from an ethanol-blended gasoline (U.S. EPA, 2015a).

Due to the effectiveness and speed of aerobic biodegradation in biologically active soils, Ohio EPA DERR recommends different lateral and vertical separation distances PVI sites with relatively small petroleum releases, such as underground storage tank (UST) sites, than VOC release sites to streamline the VI evaluation. Petroleum contamination at sites with a potential for larger petroleum releases, such as refineries, petrochemical plants, terminals, aboveground storage tank farms, bulk plants, pipelines, and large scale fueling and storage operations at federal facilities, sites where lead scavengers were used or stored, or sites with releases of non-petroleum chemicals including comingled plumes of petroleum and chlorinated solvents regardless of the source, should be addressed under more general vapor intrusion guidance such as other chapters of this guidance or U.S. EPA. (US EPA, 2015b) and should use the 100 feet lateral separation distance recommended for non-PHC VOCs.

A variety of petroleum products may be present at a site, such as gasoline, diesel, kerosene, jet fuels, and mineral oils, with varying potential for volatilization. Generally, less dense petroleum fractions such as benzene, toluene, ethylbenzene, and xylenes (also known as BTEX) will volatilize more easily than heavier fractions such as lubricating oils, waxes, asphalts and pitch and thus have a higher potential for vapor intrusion. Figure 6 shows petroleum fractions from light to heavy. Generally, lighter fractions are more volatile, and heavier fractions are less volatile. Sample analysis should correspond to the chemicals expected from the release.

Petroleum products are potentially flammable, and investigators should identify if there is a potential threat of explosion due to the presence of flammable PHCs, non-PHC fuel additive vapors, or methane. Methane cannot be detected based on odor, taste, or visible signs, so methane-detecting devices must be used if the presence of methane is suspected.

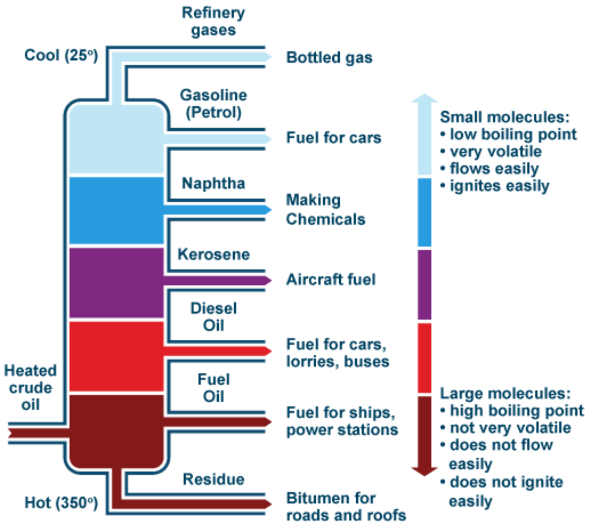

Figure 6. Petroleum Distillation (GlobalSpec.com)

9.1 Petroleum Release Characterization and Phase Partitioning

The PVI site characterization should consider the hydrologic and geologic characteristics of the site, identify potential receptors, and assess the potential for biodegradation of the PHCs and non-PHC fuel additives. A primary objective of site characterization is delineation of the lateral and vertical extent of contamination in the subsurface so that lateral and vertical separation distances can be accurately determined. It is also important to determine whether preferential transport pathways are present and, if so, delineate them to determine if they connect vapor sources directly to potential receptors. (U.S. EPA, 2015a)

The site characterization should address the potential for biodegradation of PHCs in soil. However, care should be taken if the vadose zone is not well-oxygenated as PHC degradation may be incomplete, thus posing a greater potential for PVI. Additionally, ethanol-blended gasoline (blends greater than E-20) may degrade anaerobically and may produce methane, which may result in methane buildup inside buildings and a risk of explosion (U.S. EPA, 2015a). See Section 11.2 if site conditions indicate the potential of an imminent explosive threat.

When petroleum fuels are released to soils from a leaking UST, PHCs partition into several phases: a light non-aqueous phase liquid (LNAPL), an accumulation of mobile LNAPL on and in the capillary fringe, an immobile residual phase, a phase dissolved in ground water, a phase dissolved in soil moisture, a phase adhered onto or absorbed into soil solids, and a phase of vapors in soil gas. While it is important to keep in mind the various PHC phases potentially present at the site, the vertical and lateral separation distance described in this document apply to the LNAPL and dissolved phase of PHCs.

The LNAPL phase floats at the water table. However, if a sufficient amount of LNAPL accumulates the LNAPL can become mobile and flow downgradient. Conversely, if it is a small release of LNAPL it can become immobile in the capillary fringe or smear zone as the elevation of the water table fluctuates due to seasonal changes. This is referred to as residual LNAPL. Residual LNAPL is not free-flowing and can represent a significant source of contaminants that may persist and generate PHC vapors, as well as a source of dissolved-phase contaminants, and thus should not be overlooked in a CSM or when developing DQOs.

Dissolved-phase sources in ground water consist primarily of BTEX, other aromatic hydrocarbons, and relatively water-soluble PHCs. Vapors emanating from LNAPL sources contain these petroleum fractions as well as aliphatic and relatively insoluble hydrocarbons, such as naphthalene, especially if the source is large or unweathered. (U.S. EPA, 2015a)

9.2 Lateral Inclusion Zone

The Lateral Inclusion Zone is the area surrounding a contaminant mass through which petroleum vapors may travel, move into buildings, and potentially pose a threat to human health and the environment. Buildings within 30 feet laterally of relatively small petroleum contaminated sources, whether as mobile LNAPL, residual LNAPL, or PHCs dissolved in ground water, are considered to be in the lateral inclusion zone. Buildings outside this zone generally may be excluded from further assessment unless site conditions change, preferential transport pathways are present connecting vapor sources to receptors, impermeable surface cover is so extensive that there is a concern whether sufficient oxygen is present to support biodegradation, or soil conditions are inhospitable to microorganisms (*i.e.*, dry soils with less than 2% soil moisture by dry weight).

9.3 Vertical Separation Distance

The vertical separation distance is the thickness of clean, biologically active soil between the highest vertical extent of a contaminant source and the lowest point of an overlying building (basement floor, foundation, or crawlspace surface). For a petroleum vapor intrusion investigation, clean soil does not necessarily mean that it is contaminant-free, but rather that the level of any contamination present is low enough that the biological activity of the soil is not diminished, and the subsurface environment will support sufficient populations of microorganisms to aerobically biodegrade PHC contamination. The highest vertical extent of contamination for dissolved sources is the historical high-water table elevation; for LNAPL sources this is the top of the smear zone or residual LNAPL in the source area.

LNAPL sources are capable of producing higher vapor concentrations than dissolved sources. Thus, the necessary vertical separation distance between PHC contamination and an overlying building foundation, basement, or slab is 6 feet for dissolved vapor sources and 15 feet for LNAPL sources beneath buildings that are less than 66 feet on the shortest side. Additional investigation, including sampling, is recommended if the vertical separation distance is less than this minimum. Where the vertical separation distance between a dissolved contaminant plume and the lowest point of a building is met or exceeded, no further investigation for PVI is necessary if there are no precluding factors present.

9.4 Ground Water Flow and Dissolved Plumes

Contaminants dissolved in ground water can migrate with flowing ground water and create three-dimensional distributions of contaminants called plumes. In aquifers where the direction and speed of ground water flow are stable, the plumes are usually long and narrow. Other plumes appear to spread in both the transverse as well as the longitudinal direction. This apparent transverse dispersion may be the result of changes in the direction of ground water flow. What may appear to be transverse dispersion is longitudinal dispersion occurring in different directions and the direction of flow changes. Plume movement and dispersion must be considered when applying lateral and vertical separation distances to a site. Figure 7 shows a typical PVI scenario with LNAPL, dissolved phase petroleum contamination in ground water, LNAPL smear zone, and vertical separation distances.

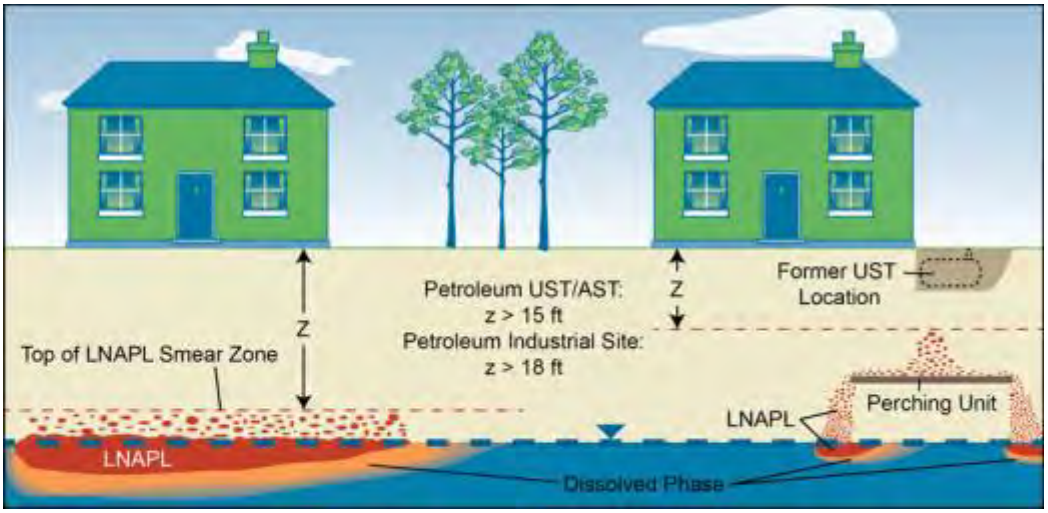

Figure 7. Schematic of PVI Scenario with LNAPL (ITRC-PVI, 2014)

9.5 Compliance with BUSTR

The State Fire Marshal, Bureau of Underground Storage Tank Regulations (BUSTR) program has regulatory primacy for UST petroleum cleanups. Entities undertaking PHC cleanup must consult with BUSTR in addition to, or instead of, Ohio EPA.

10.0 MODELING THE VAPOR INTRUSION PATHWAY

Predictive modeling has historically been extensively utilized by Ohio EPA DERR programs as a tool to predict contaminant concentrations and exposures at a site, often used to estimate the changes in concentrations and future movement of contaminants in ground water. Predictive models have also been developed to estimate the indoor air or soil vapor concentration of a contaminant in soil or ground water by using default and user-input chemical, soil, physical and building construction parameters, such as the U.S. EPA's Johnson and Ettinger Model (J&E). Recently, the U.S. EPA created and supports the Vapor Intrusion Screening Level (VISL) calculator, which uses exposure estimates, attenuation factors, volatility factors and inhalation toxicity in equations to develop screening levels below which vapor intrusion is not expected at a site. Lastly, due to the different nature of PHC vapor intrusion, the American Petroleum Institute created a model called BioVapor that estimates the potential for vapor intrusion of petroleum constituents in soil gas and ground water. While all three of these models are fundamentally different in nature, each is a predictive tool that can be used as part of a vapor intrusion evaluation and are discussed further in the subsections below.

Generally, Ohio EPA DERR requires that any use of modeling be confirmed with empirical data. Ohio EPA DERR RP sites can use VISL to make determinations of incomplete exposure pathways from subsurface contamination of volatile chemicals to indoor air, but this is a limited application. Ohio EPA DERR considers the use of models as one line of evidence when evaluating the vapor intrusion pathway, and generally requires that empirical data be provided at the point of exposure in order to determine that risk and hazard goals have been, and will continue to be met, and to eliminate the vapor intrusion pathway as a potentially complete exposure pathway.

10.1 U.S. EPA Vapor Intrusion Screening Level Calculator

Ohio EPA DERR recommends the use of U.S. EPA's VISL calculator to preliminarily evaluate the potential for vapor intrusion at remedial sites. While the VISL calculator may be used as a screening method to determine whether vapor intrusion is likely to occur at sites, in most situations, Ohio EPA requires empirical data to be used to eliminate vapor intrusion as a potentially complete exposure pathway. Please refer to Sections 3.0, 8.0 and 10.0 of this guidance for more information on data collection, data screening and general modelling.

The VISL calculator applies attenuation factors (AF) to toxicity-based indoor air concentrations to provide screening levels for soil gas and ground water. VISL can also be utilized to calculate risk and hazard estimates to receptors from chemical concentrations in ground water, soil vapor, and indoor air. These default attenuation factors were developed from measured vapor intrusion data. The default ground water to indoor air exposure pathway AF used by VISL calculator is 0.001, while the soil gas to indoor air exposure pathway default AF is 0.03. When the AFs are applied with the appropriate target risk and hazard levels and exposure scenarios, the resulting VISLs are levels below which soil gas or ground water concentrations are unlikely to provide the source strength to drive indoor air concentrations above health-based indoor air standards. While VISL uses default AFs, site-specific AFs may be developed and used to meet remediation goals at a site.

The VISL calculator allows the user to alter other select parameters in addition to the attenuation factors, including the target risk or hazard, exposure scenario, and ground water temperature. If any default VISL parameters are changed when determining site-specific VISLs for Ohio EPA DERR sites, the changes must be disclosed to Ohio EPA.

Specific factors may result in unattenuated or enhanced transport of vapors towards receptors and are likely to render the default assumptions of the VISL calculator, and thus its effectiveness as a predictive modeling tool, inappropriate. These factors include: 1) very shallow ground water sources, for example less than 5 feet below foundation level; and 2) buildings with significant openings to the subsurface, for example, sumps, unlined crawlspaces, earthen floors, or significant preferential pathways. In addition, certain vapor sources invalidate the recommended attenuation factors and screening levels used in the VISL: 1) sources originating in landfills where methane is generated in sufficient quantities to induce advective transport in the vadose zone; 2) sources originating in commercial or industrial settings where volatile chemicals can be released within an enclosed space and the density of the chemical’s vapors may result in significant advective transport of the vapors downward through cracks and openings in floors and into the vadose zone; and 3) leaking vapors from pressurized gas transmission lines. In all of these scenarios the use of VISL calculator may not accurately predict movement of vapors from the subsurface to indoor air and indoor air sampling is recommended.

10.2 Overview of the Use of Fate and Transport Models in Ohio EPA

Fate and transport models can assist in evaluating the intrusion of subsurface volatile contaminants into enclosed spaces. However, models are not intended to serve as the exclusive approach for evaluating human health risk from vapor intrusion. When used in combination with site-specific empirical information, the results of modeling will add to the multiple lines of evidence for the exposure pathway, and to develop risk management decisions. As stated above, Ohio EPA DERR considers the use of models as one line of evidence when evaluating the vapor intrusion pathway, and generally requires that empirical data be provided at the point of exposure in order to determine that risk and hazard goals have been, and will continue to be, met, and to eliminate the vapor intrusion pathway as a potentially complete exposure pathway.

10.3 Overview of U.S. EPA’s Johnson and Ettinger Model

The U.S. EPA’s Johnson & Ettinger (J&E) model spreadsheets may be used as a predictive tool for evaluating subsurface vapor intrusion into buildings. However, the J&E model should not be used to estimate indoor air values for a demonstration that applicable standards or that risk and hazard goals have been met. The most current version should be used for predictive site-specific use only. As of the date of this guidance, the most current is Version 6.03.1, dated February 2017, updated September 2017.

The current version of the J&E model does not allow for vapor intrusion estimates to be made from bulk soil concentrations, which is a change from previous versions of the J&E

model. The current version of J&E may be used to predict vapor intrusion to indoor air from soil gas and ground water concentrations.

This guidance does not provide recommended J&E model input values and uses. Ohio EPA recommends appropriately applying the model recommendations provided in the U.S. EPA Johnson and Ettinger Model support documents and user's guide.

Again, given the uncertainty and variability in the VI pathway and the constraints to the J&E model, the model has limited use in the characterization of risk and should only be used as a tool to estimate or predict indoor air concentrations of hazardous constituents at sites where empirical data has not yet been gathered. Modeling results must be verified with empirical data.

10.4 BioVapor

The American Petroleum Institute's model BioVapor estimates the potential for vapor intrusion of petroleum constituents in soil gas and ground water. Petroleum constituents differ from chlorinated VOCs in that they degrade relatively rapidly in soil with the presence of oxygen. BioVapor is a steady-state 1-D analytical model designed to help the user understand the potential effect of aerobic biodegradation in the vadose zone on the vapor intrusion pathway. BioVapor does not directly account for spatial or temporal variations in parameter values.

BioVapor is an algebraic model that incorporates a steady-state vapor source, diffusion-dominated soil vapor transport in a homogeneous subsurface soil layer with vapor mixing in a building. The soil is divided into a shallow aerobic layer including first-order biodegradation and a deeper anaerobic layer where biodegradation does not occur. The user has three options for specifying the oxygen supply below the building foundation: 1) concentration below the building foundation; 2) constant oxygen concentration below the building foundation; or 3) constant flow of atmospheric air below the building foundation.

In the absence of aerobic biodegradation, the BioVapor model is essentially equivalent to the J&E Model. All model outputs should be verified with empirical data. BioVapor does not evaluate other potential exposure routes, migration pathways, or risks from fire or explosion. For more information on the BioVapor model, see the BioVapor User's Manual (GSI Environmental, 2012). For more information on other ways to address the potential for petroleum vapor intrusion, see Section 9.0 of this guidance.

11.0 EVALUATION OF IMMINENT HAZARD IN AN EXISTING BUILDING

For the purposes of this guidance, imminent hazard is defined as any condition which poses an immediate risk of harm to public health, safety, or the environment. Imminent hazards require an expeditious response to mitigate or end the exposure. Typically, prior to sampling, the potential threat level is unknown. There are situations where available historical sampling data or current conditions indicate that immediate actions are warranted.

11.1 Potential Imminent Hazard Conditions

Possible imminent hazards due to vapor intrusion include direct exposure to concentrations of vapors at risk of explosion or immediate danger to life and health, as well as exposure to chemical concentrations that may cause deleterious effects from short term exposures. If evaluation of data or current conditions indicate the possibility of an imminent hazard from a known or suspected nearby source, prompt action is necessary to verify or abate threats to human health.

The following conditions may indicate a potential imminent hazard and thus warrant prompt actions and early or interim measures for occupied structures:

- Known spill in a structure that may affect environmental media (*e.g.*, a release from a heating oil tank);
- Odors, particularly if described as “chemical,” “solvent,” or “gasoline”;
- Reports of physiological effects (*e.g.*, dizziness, nausea, vomiting, confusion);
- Wet basement or sump in areas with known contaminated ground water;
- Free product at the water table under or immediately adjacent to a structure;
- Exceedance of one-tenth (10%) of a lower explosive limit; or,
- Vapor intrusion-caused indoor air concentrations of a chemical with an unacceptable human health risk for an acute or short-term exposure scenario.

Professional judgment should be applied to these criteria and the timeframe appropriate to evaluate whether an imminent hazard is present. Please note that spills not affecting environmental media may pose an imminent hazard or unacceptable human health risk and, as a result, may be under the jurisdiction of regulatory agencies other than Ohio EPA (*i.e.*, OSHA or ODH).

Where vapor intrusion is of concern and indoor sources of volatile chemicals are present (for either occupational use or any other identifiable indoor source), sub-slab vapor or soil gas data may be utilized to evaluate the relative contribution to the indoor concentrations from environmental media. The presence of identifiable indoor air sources may alter the need for or type of early or interim response action taken.

11.2 Explosive Hazard

Commonly encountered chemicals that can exhibit explosive hazard are generally petroleum hydrocarbons (PHCs) and the landfill gas methane. Prompt action is required when the concentration of a combustible chemical exceeds 10% of its lower explosive limit (LEL). If data collected from inside buildings, below buildings, or utility conduits indicate an exceedance of 10% of the LEL, immediate action may be needed whether the building is inhabited or not. If concentrations in indoor air indicate the potential for explosion or imminent danger to life or health, building occupants should be evacuated and building owners and the fire department should be notified immediately. Also notify, Ohio EPA DERR immediately via Ohio EPA’s Spill Hotline at 1-800-282-9378. For

BUSTR-regulated releases, notify BUSTR immediately via the BUSTR hotline at 1-800-589-2728.

Flowchart Step 6: Evaluate the potential risk and hazard from the vapor intrusion pathway

12.0 RISK CHARACTERIZATION

Risk characterization for the vapor intrusion pathway compares measured indoor air concentrations to chemical-specific target cancer and noncancer concentrations considered protective for the anticipated land use exposure. The primary scenarios evaluated are residential and worker/commercial exposures. Additionally, in the VAP, a characterization of the vapor intrusion risk may be developed by a proportional estimation of a VISL from media other than indoor air. For example, if carbon tetrachloride is the only COC that has been measured in sub-slab vapor, and the concentration is half of the VISL based on a hazard quotient of 1, the VAP volunteer can assume a HQ contribution to the site-wide non-carcinogenic risk characterization of 0.5 from the vapor intrusion to indoor air pathway. Please refer to Section 8.1 for further information on vapor intrusion screening levels. Risk characterization serves to bridge risk assessment and risk management and therefore assist in the decision-making process. The appropriate media target concentrations and risk and hazard goals must be utilized. Please refer to Section 8.0 concerning data evaluation.

The investigator should be aware of imminent hazards involving explosive gasses, unacceptable human health risk from an acute or short-term exposure scenario, and gasses that may collect and create a deadly environment. Please refer to both Sections 11.0 and 13.0, for more information on evaluation of imminent hazards in an existing building and remedies, respectively.

12.1 Determining Applicable Risk Goals and the Need for Further Evaluation

For Ohio EPA DERR sites, the excess lifetime cancer risk (ELCR) goal is 1E-5 and the noncancer hazard quotient or index is 1, accounting for exposure to multiple contaminants, as appropriate. For all Ohio EPA DERR sites, if the complete pathways, including direct contact, ingestion and vapor intrusion, from soil and ground water releases are well-characterized, and meet a cumulative ELCR of 1E-5 and a hazard index of 1, then no further evaluation of the vapor intrusion pathway may be warranted. If media other than indoor air are not well characterized or exceed an ELCR of 1E-5 or a hazard index of 1 on a multiple chemical and multiple pathway (if applicable) basis, then further sampling or preemptive remediation may be necessary.

In the VAP, all site-related COCs must undergo a multiple chemical adjustment and the resulting ELCR and hazard values are carried through as a contribution to site-wide risk and must meet Ohio EPA risk and hazard goals of an ELCR of 1E-5 and a Hazard Index of 1. Thus, risk and hazard contributions from vapor-forming chemical detections in indoor air due to vapor intrusion should be calculated in a multiple chemical adjustment and pathway summation for a complete exposure pathway. If indoor air data was not collected, the risk and hazard contributions from the vapor-forming chemicals detected in an alternative media sampled to evaluate vapor intrusion (*i.e.*, either soil gas, sub-slab vapor or ground water) should be included in a multiple chemical adjustment and pathway summation. This is because the VAP requires the incremental risk and hazard from all COCs be aggregated within each complete exposure pathway and then summed across all complete exposure pathways.

12.2 Use of Maximum Contaminant Levels (MCLs)

Screening and cleanup levels for other exposure pathways are not necessarily protective of the vapor intrusion pathway. Since the MCLs and VAP risk-based unrestricted potable use standards (UPUS) address the potable ground water pathway, additional sampling may be necessary even if ground water concentrations meet MCLs or VAP risk-based UPUS values.

12.3 Use of BUSTR Petroleum Standards

At VAP sites, a volunteer may use BUSTR action levels, including action levels for soil and ground water to indoor air contained in look-up tables found in OAC 1301:7-9-13(J)(3), as the generic numerical standards for petroleum at residential, commercial, and industrial properties in the VAP. For more information on applying BUSTR action levels as VAP applicable generic standards, please see VAP Technical Guidance Compendium Applying Generic Petroleum Standards under the VAP.

At RP sites the potential for using BUSTR action levels for addressing the VI pathway for petroleum and petroleum constituents is something the responsible party may contemplate, however coordination with Ohio EPA is recommended.

Flowchart Step 7: If data evaluation indicates risk or hazard goals are or may be exceeded, then additional data may be collected, or a remedy may be implemented

If data from environmental media other than indoor air exceed risk or hazard goals, then additional data may need to be collected and/or a remedy may need to be implemented. If indoor air exceeds risk or hazard goals, then mitigation must be implemented and maintained to reduce the concentrations of COCs in indoor air to acceptable levels until the final remedy has rendered the VI pathway incomplete. If indoor air concentrations meet risk or hazard goals for commercial/industrial land use but not residential land use, then a land use restriction may be necessary to ensure the site remains protective of future receptors. Communication with Ohio EPA DERR is recommended when a site does not contain buildings, but a potential future VI problem is identified, and for sites with current vapor intrusion problems.

Flowchart Step 8: Remediation, mitigating indoor air exposure and/or conducting long-term monitoring

13.0 REMEDY

This chapter provides an overview of considerations when selecting and implementing a remedy to mitigate or eliminate risk from the VI pathway.

Remedies may be short-term interim actions meant to mitigate acute exposures to receptors over the near term, and long-term actions meant to provide ongoing mitigation by rendering the VI pathway incomplete until a remedy addressing the source of contamination is completed. These remedies can be to prevent a potentially complete VI pathway. A combination of the remedies discussed in the following sub-sections can be implemented to mitigate or eliminate risks from VI. Please note, additional remedial actions may be required on a site-specific basis. Confirmatory sampling is often required to determine if further remedial actions are necessary to protect human health.

13.1 Remedy Selection and Implementation Considerations

Remedy selection should consider the type of risk present at the site, site-specific building conditions, and the proximity and nature of current and future receptors. The following site conditions should be considered:

- Sensitivity of receptor;
- Type of contaminant – total petroleum hydrocarbons (TPH) vs. chlorinated solvents;
- Type of exposure risk (acute vs. chronic);
- Cumulative risk from multiple chemical exposures;
- Time frame or length of exposure (current or future exposure);
- Temporary, interim or permanent mitigation measures;
- Source strength;
- Media contaminated (soil vs. groundwater);
- Foundation type;
- Building age;
- Preferential pathways;
- Agency jurisdiction (U.S. EPA, Ohio EPA, OSHA, health department); and,
- Potential future receptors.

When implementing a remedy several items should be considered such as:

- Immediate response requirements;
- Interim response;
- Short-term mitigation until a more permanent fix is completed;
- Long-term response;
- On-going sampling;

- System installation;
- System monitoring; and,
- Confirmatory sampling after disturbance.

Some examples of available mitigation technologies are provided in Table 3, along with typical applications and challenges of each (ITRC, 2007).

Table 3. Comparison of Mitigation Technologies

Technology	Typical Applications	Challenges
Passive barrier	New construction. Crawl spaces (existing homes). Often combined with passive or active venting, sealing openings in the slab, drains, etc.	Preventing tears, holes. May not suffice as a stand-alone technology. Ensuring caulking seals cracks in floors and preferential pathways. On-going monitoring and maintenance.
Passive venting	New construction. Low soil gas flux sites. Should be convertible to active system if necessary.	Relies on advective flow of air due to wind and heat stack effects. Air flows and suctions typically far less than achieved by fans (active venting).
Passive aerated floor	New construction or extensive remodeling. May be useful for large commercial structures.	Not yet widely used. May not be suited for all soil types.
Active sub-slab depressurization (ADS)	New and existing structures. Sumps, drain tiles, and block wall foundations may also be depressurized if present.	Low permeability and wet soils may limit performance. Incurs operating cost. Requires monitoring and fan upkeep.
Passive sub-membrane	Existing structures. Crawl spaces.	Sealing to foundation wall, pipe penetrations. Membranes may be damaged by occupants or trades people accessing crawl space.
Active sub-slab pressurization	Same as ADS. Most applicable to highly permeable soils.	Higher energy costs and less effective than ADS. Potential for short-circuiting through cracks.
Active building pressurization	Large commercial structures, new or existing. Specialized cases only.	Requires regular air balancing and maintenance. May not maintain positive pressure when building is unoccupied. Incurs cost to operate.
Active indoor air treatment	Indoor air spaces. Special cases where other remedies cannot be applied.	May generate waste disposal stream. May not effectively capture all air contaminants. May be subject to tampering.
Sealing the building envelope	Cracks and holes in existing building.	Access to perforations. Lack of permanence.
Active heat recovery ventilator	Useful in crawl spaces or basements that cannot be sealed or depressurized.	Incurs higher energy loss. Higher costs to operate.

13.2 Remediation of Environmental Media

An environmental media source of VI can be addressed through application of a soil or ground water remedy. Remediation of soil and ground water contamination may include source removal, technologies to reduce contaminant concentrations in soil and soil gas, such as soil vapor extraction (SVE), or technologies to reduce concentrations in ground water such as in-situ bioremediation (chemical oxidation or reductive de-chlorination), thermal desorption, or air-sparging. In general, source removal and SVE remedies are likely to be the most successful to reduce or eliminate soil gas migration and this may prevent the need for institutional or engineering control remedies.

Environmental media should be monitored during the remedial process to assess breakdown products that may form as a result of natural attenuation or chemical treatment processes and may pose risks to receptors, and to determine when remediation efforts can be terminated.

13.3 Institutional Controls

Institutional controls are activity and use limitations that are recorded in an environmental covenant within the property deed that restricts how a site can be used or what activities can occur at the site. Examples of institutional controls include:

- Restriction of a property to commercial or industrial uses only;
- Prohibition against constructing habitable structures in areas with VI risk;
- Prohibition of building occupancy unless indoor air concentrations are below screening levels; and,
- Building-specific conditions, such as prohibitions of basements.

Generally, two rounds of indoor air sampling collected at least 30 days apart are needed prior to occupancy of a building located within a vapor intrusion activity and use limitation area.

13.4 Engineering Controls

Engineering controls, also known as building controls for vapor intrusion, can be considered interim remedial measures as they usually do not address the reduction of the source contamination. They can be implemented in both new and existing buildings. Engineering controls can be separated into two groups: active or passive. An active engineering control usually involves a mechanical system, such as a sub-slab depressurization system. Engineering controls that do not involve mechanical systems, such as a floor slab, are known as passive controls. Future conditions must be considered when choosing an appropriate engineering control. Maintenance, repair, failure monitoring, and termination criteria should be considered when selecting an engineering control. These considerations are contained within an operating and maintenance (O&M) plan and an O&M agreement between Ohio EPA and the property owner. This agreement identifies and ensures that the responsibility for the engineering control and liability for the contamination is maintained while vapor intrusion remedial goals are exceeded in the subsurface.

13.5 Active Sub-Slab Depressurization Systems

Active Sub-Slab Depressurization Systems (ADS) are defined as systems that rely on motor-driven fans to maintain a negative pressure below the building floor, evacuating contaminated vapors before they enter the building. ADS can have a variety of configurations, both designed as standalone systems or as components in a mitigation engineering system.

There are generally two types of active sub-slab depressurization systems, those for newly constructed buildings and those installed in existing buildings. Systems for newly constructed buildings usually consist of a sub-slab layer of granular fill coupled with a network of slotted pipes that vent to the roof with the aid of a fan. The granular layer is overlain by an impermeable barrier layer. The motorized fans are used to draw a vacuum on the sub-slab granular layer, assuring the necessary vacuum differential. The number, size and spacing of the slotted pipes are building-specific with the performance standard being an adequate pressure differential generally across the floor of the entire building. The exhaust points of the discharge pipes should be positioned to avoid ingress to the surrounding buildings through windows, vents, or HVAC system intakes. Generally, the granular bed and barrier layers should cover the entire footprint of the building unless the owner can demonstrate that less coverage is needed.

For existing buildings, the sub-slab system generally consists of pits under the floor, filled with granular material and connected to the extraction system. The major obstacle to performance of these systems is low permeability soil, since installation of a granular layer under the entirety of an existing building is usually impossible. Again, the number and placement of the suction points is site-specific and performance driven. A lower permeability soil may require more extraction points. Another concern with preexisting buildings is the presence of subsurface barriers, such as building footers, that might impede airflow. The placement of suction points must consider such barriers.

ADS are most effective if the building is isolated from the environmental media. This condition increases the efficacy of the sub-slab depressurization and removal of vapors beneath the slab. Therefore, Ohio EPA recommends that sealing of foundation crack and other conduits into the building be included with the construction of an ADS. The building floor should be examined for competency and building construction diagrams should be evaluated for utility and plumbing penetration points. These seals should be identified and maintained throughout the active life of the ADS. Seals that are a component of an ADS should be labeled to identify that these seals should be maintained in any operation and maintenance plan.

In regard to sealing, the following should be considered when reviewing work and design plans for ADS systems:

- Caulks and sealants should be reviewed thoroughly prior to use for volatile content. Sealants that are selected should be durable and designed for minimal maintenance over the expected lifespan of the ADS (ASTM C1193-16).
- Sumps, other pit openings in the slab, and utility corridors that need to maintain their accessibility should use sealants such as silicone caulks that may easily be re-applied. Sump covers should remain accessible by utilizing gasket or non-permanent sealants. Piping emanating from sumps should also be sealed to prevent vapor migration.
- Cracks less than 1/16-inch in width may be sealed using selected sealants or caulks.
- Cracks greater that 1/16-inch in width may require special backing material or expandable foam sealants.
- Expansion joints.
- Wall/floor junctions.
- Utility lines, drains, and other plumbing features that penetrate the building slab offer a direct conduit to soil gas. To seal these penetrations, practitioners may have to wrap these features with membrane material and seal these to competent flooring. Specialty spray on products, such as Liquid Boot™, may have to be applied if the penetration points are too difficult to seal via normal means.
- Drains may provide a vapor intrusion pathway that can be prevented using one-way flow valves that retard or prevent vapor entering buildings. Drains used to draw water from basement areas to sumps need to be covered, sealed and tied into the ADS to draw vapors to the outside air.

In some cases, a competent floor is not present or may only cover a portion of the building footprint. An example of this condition is a home that has an open crawl space. Conditions such as these require special consideration as an ADS may not be capable of providing adequate mitigation unless the building floor and walls are sufficiently sealed.

Dug basements with open areas or crawl spaces will require covering to prevent soil gas migration and to provide a seal for the ADS to depressurize the lower area of the building. A soil gas barrier can be installed over open soil in a crawl space or dug basement to prevent vapor migration and provide a plenum that will be evacuated using the ASD. The membrane should be sealed to competent walls. Seams between membrane sheets should be overlapped at least 12 inches and sealed with sealant or caulk. Membrane material should be designed to prevent vapor migration. Common moisture barriers used in construction may not be adequate as a vapor intrusion membrane. This is especially true if the space may be used to store heavy objects. Ohio EPA recommends that membranes be at least 10-mil thick and may range up to 60-mil depending on the occupancy requirements for the area being covered. Vapor barriers should have a permeance of at least 0.1 perms as defined by ASTM E96/96M. Pipe penetrations or drains penetrating the membrane should be sealed as described previously in this section.

If the floor is generally soil and without rubble, concrete can be poured to provide adequate cover. This option may be desirable if the floor space is used to store heavy materials or heavy use would puncture membrane materials.

Ohio EPA has encountered rubble-filled or dug basements that are inaccessible that prevent the use of membrane or cementitious coverings. In these cases, the open space itself may need to be ventilated and have fresh air brought in from the outside and stale air vented (see Section 13.6 for more information).

Water tables that seasonally intersect the building slab, wet basements, or contaminated pore water infiltrating directly into buildings requires an additional engineering control before the installation of an ADS. These conditions can be mitigated by foundation drainage systems and treating surfaces to prevent water infiltration. Consideration of these conditions should be made before an ADS is installed.

Back drafting from indoor heating sources may be problematic in some basements where furnaces or water heating equipment is used. The ADS should be checked by local HVAC personnel and local fire marshals before the initial system demonstration. There may be some situations where an ADS cannot be installed due to homeowner requirements. Any site where back drafting could be a problem should have CO_2 monitors installed as part of the ADS.

13.6 Heating, Ventilation, Filtration Units and Air Conditioning (HVAC) Measures

Ventilation system modifications can be made in a variety of ways, but the general approach is to increase the intake of make-up (fresh ambient) air. In commercial buildings, HVAC systems can be modified to increase the amount of make-up air. These modifications should be made by experienced HVAC professionals. Systems in residential properties may be limited in the degree of modification for make-up air. In these cases, the addition of a Heat Recovery Ventilation (HRV) unit may be necessary to increase the intake of fresh air. HRV systems can be installed independently of existing HVAC systems and may be beneficial to residential properties that need to vent crawlspaces or basements that can't be incorporated into an ADS. HRVs are designed with two fans. One fan brings in fresh air from outside the building, the second fan vents stale air from inside the structure. A heat exchanger equalizes the temperature between these two independent air streams which are not allowed to physically mix. The net result in an increased air exchange rate that can significantly reduce concentrations of contaminants. HRVs can be costly to install and must be powered which can increase the average cost for heating a home or small business.

Filtering of air can be an option for vapor mitigation. These systems are designed to pass contaminated air through filtering media, usually granular activated carbon, thereby removing VOCs from the air. Industrial-sized units can be designed, but generally these filters are used on a temporary basis before permanent systems can be installed. Filter use requires regular monitoring to ensure breakthrough of contaminants from the filter has not occurred. Costs for units vary by size, electrical costs, costs for the filter media and monitoring.

HVAC systems can sometimes be modified to create a positive pressure within a building or room to resist vapor ingress from the sub-slab, or to maintain sufficient air flow through the building to dilute indoor air concentrations to acceptable levels.

The ultimate standard of performance must be the measured indoor air concentrations rather than analyses based on flow calculations. Indoor air samples should be collected several times during the year to assess the effects of heating and air conditioning on the system's performance. Caution should be exercised choosing these types of methods as the high air flow rates needed to achieve remedial goals may greatly increase heating and cooling costs and have the potential to decrease occupant comfort.

13.7 Passive Engineering Controls

Passive Depressurization Systems (PDS) are similar to active systems except the extraction fans are not motorized. Rather, PDS use wind-driven turbines or venturi systems to maintain a vacuum on the extraction pipes. The major issue for PDS is maintenance of an adequate sub-slab vacuum. Passive systems are best used in new construction with highly permeable granular layers. PDS are not as effective for existing structures with low permeability soils. The performance standard for passive systems is consistent maintenance of adequate pressure differentials under the building.

Barrier systems are typically installed during new building construction and consist of an impermeable barrier between the granular collection bed and the floor of the building. The barrier can either be laid out in overlapping sheets or sprayed in-place. Some sheet systems consist of multiple layer laminates to achieve both strength and vapor resistance. A critical requirement for any vapor barrier is resistance to the chemical contaminants in the underlying soil. Installation should strictly follow the manufacturer's directions with particular attention to adequate joining and sealing of sheet materials and adequate thickness of sprayed materials. Any penetrations through the barrier, such as plumbing or utility conduits, must be properly sealed. Typically, the finished system is subject to smoke testing to locate any breaches in the barrier. Long-term operation and maintenance plans must require proper sealing of any future breaches through the barrier layer.

Barrier systems can also include building slabs. Proper sealing of cracks in floors or around the bases of walls to break ingress routes should be conducted as necessary for preferential pathways to improve the effectiveness of the passive slab engineering control. This approach is more applicable for older existing buildings. Such repairs will require long-term monitoring and maintenance to assure their reliability (Section 14.3), which may need to be recorded in an operation and maintenance plan. Low permeability flooring materials have sometimes been installed in existing buildings to reduce vapor ingress. Such coatings should be durable enough to withstand expected industrial activities including chemical spills and would also require careful installation and sealing.

13.8 Monitoring Requirements for Engineering Controls

For ADS, Ohio EPA recommends that the depressurization field be mapped to demonstrate that depressurization is occurring across the building footprint for residential structures and commercial buildings or is of sufficient aerial extent under a large building to effectively remove sub-slab vapors. Any sub-slab depressurization systems should be equipped with sampling ports in the floor to allow measurement of the pressure differential between the building and the sub-slab space. Differential pressure gauges should be capable of reading to 1/1000-inch water column or 0.25 pascals with + 25% accuracy. There should be adequate sample ports to cover the entire floor space of the building. If it is proposed that only a small portion of the structure needs to be covered by the sub-slab system, then the owner/operator will have the burden of proving that only limited coverage is needed. Based on a review of the available guidance and state standards, a presumptive minimum pressure differential across the slab should be 5 pascals or 0.02 inches of water. That standard should be applied if there is no granular backfill under the slab or if the soil composition under the slab is unknown. If the slab has been underlain with a permeable, granular backfill then a lower pressure differential could be considered based on a demonstration that the flow through the backfill is sufficient to capture vapors emanating from the underlying soil.

Depressurization field monitoring should be followed with indoor air measurements to complete the demonstration that the remedy is effective. A sufficient number of indoor air samples should be taken to demonstrate that indoor air quality meets the standards for a residential or commercial/industrial setting. The number of indoor air samples will be dependent on the building size or footprint, the presence of a basement or crawlspace or occupancy conditions. The typical approach is to sample at the same locations as used to determine that the vapor intrusion pathway was complete. Ohio EPA DERR recommends that the number of samples and locations be reviewed and discussed with agency personnel prior to implementation.

The collection lines for a sub-slab system should be equipped with sampling ports to analyze the sub-slab vapors. The initial performance evaluation of a sub-slab system should include indoor air sampling. If the performance evaluation is not being met, sampling must be repeated until corrective actions have met remedial goals.

13.9 Post-Mitigation and Seasonal Monitoring

Once indoor air sampling shows acceptable COC concentrations and, if applicable, vacuum ports show adequate depressurization, then the remedy monitoring program may be reduced to periodic pressure differential measurements at the vacuum sampling ports and/or indoor air samples to demonstrate system effectiveness through seasonal variations in temperature, pressure, humidity and building occupancy conditions. Prior to sampling frequency reduction, vacuum differentials should be measured several times a year to account for variations caused by seasonal heating and air conditioning.

The effect of seasonal variations should be considered in both the heating and cooling seasons. This evaluation is especially important if modifications to the HVAC system were made as a mitigation measure. In addition, in cases where seasonal high-water tables are present, sub-slab differential pressure measurement should be made to determine if the sub-slab conditions are present to maintain the depressurization requirements.

The results of these seasonal post-mitigation tests should be carefully evaluated to determine the degree of variability in results. If the system is functioning adequately to mitigate vapor intrusion issues, it is possible that only periodic checks will be needed in the future. If HVAC modifications are not protective in all seasons, additional engineering measures will need to be installed. Ohio EPA should be consulted if results show break-through of vapors into indoor air. In these cases, additional indoor air sampling on a frequent basis may be needed in the post-mitigation period.

13.10 Termination of Engineering Controls

Termination of mitigation systems should only be considered if the contamination source has been remediated to the point where vapor intrusion is not an on-going concern. Any request to terminate monitoring should contain a demonstration that sub-slab vapor concentrations are below VISLs during several sampling events.

Any site with methane should include combustible gas monitors. The combustible gas monitors should have alarms if safe levels are exceeded.

The precise details of sampling and maintenance of the system should be specified in an O&M plan whose requirements are included in an environmental covenant.

13.11 Owner Documentation/Notification of Engineering Controls

The building owner should be provided with information on the mitigation system, which should be passed on to future owners during property transfers. This information should include, at a minimum:

- The pre-mitigation concentrations of constituents of concern;
- The post-mitigation concentrations of constituent of concern; and,
- The regulatory standards used for each constituent.

The mitigation system installation should be described. This should include:

- System diagram showing the individual components of the system (*e.g.*, slab, SSDS, vapor barrier);
- As built diagrams, if available; and,
- The operational requirements, such as inches of water vacuum, slab competency, fan or filter life.

The schedule for replacing system components, such as filters, should be described, including:

- The schedule for monitoring the system, such as review of manometer readings; and,
- Any warranty information should be included with the system documentation package.

The owner, either through O&M agreements or self-initiated investigation, should describe and document any system disruption and subsequent corrective actions taken and provide the documentation to Ohio EPA DERR, if required. Information on the mitigation system (*e.g.*, environmental covenants, remedial design/remedial action judicial consent decrees, O&M plans and agreements) should be disclosed to future property owners as required by the RP or VAP (see Section 14.4 for more information).

14.0 LONG-TERM MANAGEMENT AND EXIT STRATEGY AT VAPOR INTRUSION SITES

Remediation of a vapor intrusion source can take a long time, often months or years. Therefore, when vapor intrusion has been determined to be a significant risk pathway at sites, mitigation measures such as ADS systems or institutional controls are needed to prevent exposure to current occupants and to make sure that future occupants are protected. Many sites have the long-term goal or requirement to eliminate the source of the vapor intrusion and termination of the mitigation systems. Therefore, the need to address long-term management and pathway mitigation should be understood, discussed with Ohio EPA, and plans formulated to make sure that occupants remain protected.

14.1 Long-Term Management

Long-term management at vapor intrusion sites may consist of the one or more of the following:

- Ground water or soil gas monitoring;
- Sub-slab vapor or indoor air monitoring;
- Contingency plans if monitoring shows exceedance of indoor air standards;
- Land use restrictions recorded in an environmental covenant;
- Inspections or audits of environmental setting and slab competency if used as an engineering control;
- Periodic review of the protectiveness and/or efficiency of the remedy or mitigation system;
- Inspection and corrective action of mitigation systems;
- Notification plan to inform new occupants/potential purchasers of need to maintain mitigation systems; or,
- Development of an exit strategy for turning off active mitigation.

Ohio EPA DERR does not have a single approach for long-term management because there are many site-specific variables and unique requirements for each administrative program, Ohio EPA DERR will work with responsible parties through orders, permits and the VAP to develop appropriate controls and monitoring strategies and to develop administrative requirements. Several of the above referenced items will be discussed in the following sections.

14.2 Ground Water, Soil Gas, Sub-Slab Vapor and Differential Pressure Monitoring/Sampling

Sites that are undergoing an environmental response for vapor intrusion may require long-term ground water or soil gas monitoring to verify that new or un-mitigated buildings within the area of influence of contamination are protected and that mitigation or remedial systems are functioning properly. In these cases, the type of monitoring (*e.g.*, soil gas or ground water), frequency of monitoring, applicable screening levels and appropriate secondary actions if data is above screening levels will need to be recorded in an O&M Plan and O&M Agreement. Demonstrations of ongoing remediation may also include statistical analysis for trend monitoring which can help in determining if the contaminated area is increasing or decreasing.

Where appropriate, sub-slab monitoring ports may be installed and used for routine monitoring of vapor concentrations and differential pressure. For example, where the slab of the building has been designated as an engineering control, sub-slab samples can establish the need for continued maintenance of the slab or indicate when indoor air sampling should be conducted to determine if risk and hazard goals continue to be met. Differential pressure monitoring may be considered when facilities have increased the intake of air to create positive pressure conditions. The monitoring ports can also be used to monitor differential pressure between the sub-slab and indoors with the use of a manometer to help determine whether a differential pressure remedy is being maintained.

Once the efficacy of the engineering system is verified by a qualified professional, system maintenance should be recorded in an O&M plan that details the system’s components, operation and maintenance schedule and system performance standards. Sub-slab vapor and/or periodic indoor air monitoring should be considered to demonstrate continued system efficacy. The plan should also include the corrective measures to be taken if the system unexpectedly fails and the interim measures to be used to protect human health while the system is not functional.

14.3 Passive Mitigation System Efficacy Verification

If the mitigation system involves vapor barriers, seals or passive venting, the building conditions must be carefully checked periodically to determine that these passive components remain in place and are effective. Building operations change through time and altering structural components can provide less of a barrier to vapor migration. In addition, sealants also degrade through time. On-going review of these components must be made, and it is highly recommended that periodic indoor air monitoring be considered while volatile chemicals remain above screening levels in the sub-surface.

Data generated during the monitoring period may also provide evidence of favorable conditions for termination of monitoring and any associated mitigation systems once sources have been remediated or risk and hazard goals have been met.

14.4 Environmental Covenants and Deed Restrictions

Environmental covenants (EC) and deed restrictions compliment engineering and institutional controls for addressing vapor intrusion exposure. Ohio’s Environmental Covenant Law is found in Ohio Revised Code (ORC) 5301.80 - 5301.92. The law states that an owner of a real property may enter an EC with the State of Ohio if an environmental response project has occurred on that property. In many cases, vapor intrusion investigations can be considered an environmental response project. The EC may contain restrictions for land use or occupancy status, such as restricting a property to commercial/industrial land use or prohibiting building occupancy until certain conditions are met. Environmental covenants require the property owner to report compliance with the restrictions to Ohio EPA once a year. Ohio EPA also reviews sites with ECs at least every three years to verify compliance. ECs provide information to future occupants that vapor intrusion is a concern at the site. Deed restrictions are not reviewed or enforced by Ohio EPA; therefore, even if a site has a deed restriction Ohio EPA requires an EC.

Ohio EPA legal and technical staff can provide more information on how ECs can be utilized to address vapor intrusion exposure.

14.5 Exit Strategy

The time period for remedial efforts can vary and actions taken to mitigate exposure from vapor intrusion may continue for some time. Nevertheless, an exit strategy to terminate active mitigation should be contemplated by site managers. The Ohio EPA expects that RP sites continue to work on decontamination until sources for vapor intrusion are abated. RP sites can build exit strategies into orders, records of decision or permits so that responsible parties can approach the agency to terminate vapor intrusion mitigation when the source(s) has been reduced to appropriate levels. VAP sites need to plan for how to determine when remedial activities can be terminated as well; however, the remedial goals for VAP sites may not include source removal. In these cases, the on-going mitigation of the vapor intrusion pathway is tied to an operation and maintenance plan. Specific requirements for termination outlined in the O&M Plan are then followed and Ohio EPA is notified and provided a demonstration when applicable standards are met and will continue to be met at the time termination is requested.

The exit strategy should clearly identify what criteria will be used to determine that the site no longer poses an unacceptable vapor intrusion risk. The exit strategy should be developed early in a vapor intrusion project so as to provide defined criteria for when risks at a site have been adequately mitigated or controlled. Factors such as mitigation or remediation techniques, final cleanup goals, land use, and future building construction, should be considered when developing the exit strategy. The exit strategy should be recorded in a decision document with specific, reasonable and achievable outcomes defined.

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APPENDIX A. Vapor Intrusion Conceptual Site Model Checklist

Utilities and Process Piping

☐ Identify on a site plan all underground utilities near the soil or ground water impacts; pay particular attention to utilities that connect impacted areas to occupied buildings.

☐ Identify on a site plan all underground process piping near the soil or ground water impacts.

Buildings

☐ Identify on a site plan all existing and future buildings under investigation.

☐ Identify the occupancy and use of each building (*e.g.,* residential, commercial)

☐ Describe building construction materials (*e.g.*, wood frame, block,), openings (*e.g.,* windows, doors), and height (*e.g.*, one-story, two-story, multiple-story); identify if there is an elevator shaft in the building.

☐ Describe building foundation construction including:
Type (*e.g.,* basement, crawl space, slab on grade)

Floor construction (*e.g.,* concrete, dirt)

Depth below grade.

☐ Describe the building HVAC system including:

Furnace/air conditioning type (*e.g.*, forced air, radiant)
Furnace/air conditioning location (*e.g.*, basement, crawl space, utility closet, attic, roof)
Source of return air (*e.g.,* inside air, outside air, combination)
System design considerations relating to indoor air pressure (*e.g.*, positive pressure is often the case for commercial buildings).

☐ Identify sub-slab ventilation systems or moisture barriers present on existing buildings.

Source Area

☐ Identify the COC’s related to the vapor intrusion pathway.

☐ Describe the distribution and composition of any NAPL at the site.

☐ Identify on a site plan all source areas for the COC's related to the vapor intrusion pathway.

☐ Identify on a site plan soil and ground water results for the COC's, between the source area and the buildings under investigation.

☐ Identify on a geologic cross section soil and ground water results including depth.

☐ Describe the potential migration characteristics (*e.g.,* stable, increasing, decreasing) for the distribution of COC's.

Geology/Hydrogeology

☐ Review all boring logs and soil sampling data to understand the locations of:
Sources: NAPL, soil, ground water, suspected vapor leaks.
Soil types:
Finer-grained soil layers
Higher-permeability layers that may facilitate vapor migration.

☐ Identify on a geologic cross section distinct strata (soil type and moisture content, *e.g.*, "moist," "wet," "dry") and the depth intervals between the vapor source and ground surface, and include the depth to ground water.

☐ Describe ground water characteristics (*e.g.*, seasonal fluctuation, hydraulic gradient).

Site Characteristics

☐ Estimate the distance from the ground water concentration contour interval for each COC to buildings under investigation.

☐ Estimate the distance from vadose zone source area to buildings under investigation.

☐ Describe the surface cover between the vapor source and buildings under investigation.

APPENDIX B. Special Considerations for Evaluating Residential Properties

Ohio EPA generally recommends evaluating the vapor intrusion pathway using the prescribed stepwise approach listed in Figure 1. Sub-slab vapor and indoor air samples should be collected to assess the vapor intrusion pathway if site ground water or soil gas data indicates hazard and risk goals may be exceeded. If available data indicates there may currently be unacceptable risk to residential receptors, Ohio EPA should be contacted promptly and potential exposures to residential receptors evaluated in an expedited manner. If it is determined that no current unacceptable risk exists to residential receptors, the stepwise approach shown in Figure 1 may resume.

Prior to conducting residential sampling, the person undertaking the vapor intrusion investigation should consider how the potentially impacted community and local government should be notified. Proper community involvement efforts are critical to the effective implementation of sample collection, evaluation, and risk communication. Ohio EPA should be involved early in the risk communication planning process to ensure proper interagency notification and coordination with the U.S. EPA, Ohio Department of Health, and local health departments, as appropriate.

Public meetings may be necessary, including a pre-sampling meeting to explain results from previous sampling and the vapor intrusion sampling workplan, and a post-sampling meeting to explain any findings. Meetings may also be necessary to discuss additional and/or follow-up air sampling or the determined remedy. Please contact Ohio EPA DERR for assistance or additional guidance on informing property owners and/or tenants about sampling results and possible next steps.

The quality of outdoor air is important to consider in the CSM and remedy selection. Thus, collecting outdoor ambient vapor samples concurrently with indoor air sampling is required. Additionally, the indoor air/sub-slab sampling form found in Appendix E should be completed prior to indoor air or sub-slab vapor sampling at residential properties. Ohio EPA DERR's FSOP for indoor air sampling also includes instructions for building occupants prior to indoor air sampling.

For further guidance on community outreach, please see Appendix A (Community Stakeholder Concerns) of ITRC's Vapor Intrusion Pathway: A Practical Guide 2007, and Chapter 9 (Planning for Community Involvement) in U.S. EPA's June 2015 VI Guidance.

APPENDIX C. FSOPs

Procedure for Active Soil Gas Sampling Using Direct Push Systems

FSOP 2.4.1 (March 9, 2017)

Ohio EPA Division of Environmental Response and Revitalization

1.0 Scope and Applicability

1.1 Vapor intrusion (VI) is defined as vapor phase migration of volatile organic compounds (VOCs) into occupied buildings from underlying contaminated ground water and/or soil. Soil gas surveys provide information on the soil atmosphere in the vadose zone that can aid in assessing the presence, composition, source, and distribution of contaminants. The purpose of this document is to provide guidance for conducting soil gas sampling, and shall pertain to active soil gas surveys, whereby a volume of soil gas is pumped out of the vadose zone into a sample collection device for analysis.

1.2 U.S. EPA's OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air (U.S. EPA June 2015) states that the chemicals in the subsurface must be both sufficiently volatile and toxic to present a vapor intrusion risk. A chemical is considered volatile if its vapor pressure is greater than 1 millimeter of mercury (mmHg) or if its Henry's Law constant is greater than 10^{-5} atmosphere-meter cubed per mole (atm M^3 mol^{-1}). Please refer to the Vapor Intrusion Screening Level (VISL) calculator to determine whether to include a chemical in a vapor intrusion investigation. For additional information refer to Chapter 3 of U.S. EPA June 2015. A volatile organic chemical may present a vapor intrusion risk if:

- The vapor concentration of the pure compound exceeds the target indoor air concentration when the subsurface vapor is in soil, or
- The maximum ground water vapor concentration (*i.e.*, the vapor concentration above the ground water from the Henry's Law constant and water solubility) exceeds the target indoor air concentration for a ground water vapor source.

1.3 Results from soil gas surveys are used in both qualitative and quantitative evaluations. The quality and application of the data is dependent upon many factors, including but not limited to: the DQO's used to develop the sampling plan, the number of sample locations and data points, the selection of the sample locations, the soil characteristics of the site, the distribution of the contaminants in both the vadose and saturated zones, the equipment and personnel used to gather the data, etc. The work plan should be finalized before any sampling is conducted. The work plan will provide specific information on the type and quality of data gathered during the soil gas sampling event. Any questions regarding data needs and usage should be resolved prior to sampling.

1.4 The evaluation of the indoor inhalation pathway at contaminated sites is a significant concern at sites/properties where contamination is known or expected to exist. As a result, procedures and technology related to evaluating the pathway continue to evolve. This procedure pertains to the active collection of soil gas using direct-push techniques (*i.e.*, driven probe rods/tooling). With respect to the use of other appropriate methods, procedures, and equipment for measuring concentrations of chemicals of concern in soil gas, please refer to Appendix D, Section 4 of the Vapor Intrusion Guidance: A Practical Guide (ITRC, January 2007).

2.0 Definitions

Terms specific to soil gas sampling using direct-push systems are defined throughout this FSOP.

3.0 Health and Safety Considerations

3.1 Follow the site-specific health and safety plan (HASP). If a site-specific HASP is not available, follow the health and safety procedures in FSOP 1.1, Initial Site Entry.

3.2 The use of direct push systems on a site within the vicinity of electrical power lines and other utilities requires that special precautions be taken by the operators. Underground electrical utilities are as dangerous as overhead electricity. Be aware and always suspect the existence of underground utilities (water, natural gas, cable and phone lines, fiber optic cables, storm water and sewer lines, etc.).

REMEMBER....Call B-4-U Dig:
Ohio Utilities Protection Service (OUPS): 800-362-2764
&
Oil & Gas Producers Underground Protection Service (OGPUPS):
800-925-0988

4.0 Procedure Cautions

A soil gas survey is only applicable to volatile contaminants. Geological barriers may exist that interfere with vapor migration such as perched water, clay or man-made structures. Interference from these geological barriers can lead to non-representative sampling with low or false negative readings or may produce localized areas of high concentrations. In addition, heavy precipitation, 24 to 48 hours prior to sampling can result in a significant reduction in volatile concentrations.

5.0 Personnel Qualifications

Ohio EPA personnel working at sites that fall under the scope of OSHA's hazardous waste operations and emergency response standard (29 CFR 1910.120) must meet the training requirements described in that standard.

6.0 Equipment and Supplies

Personal Protective Equipment (PPE):

6.1 Hearing protection
6.2 Safety glasses
6.3 Nitrile (or similar) disposable gloves
6.4 Steel-toed boots

Equipment/Tooling/Supplies for Probe Installation:

6.5 Direct push rig
6.6 4-foot probe rods
6.7 2-foot probe rods
6.8 Inner Extension Rods (48")
6.8 Rod Grip Pull System
6.10 Drive Cap
6.11 Miscellaneous tools
6.12 Log book/Data sheets
6.13 Bentonite granules

Soil Gas Sampling:

6.14 Expendable Point Holder
6.15 Implant Expendable Point Holder
6.16 Expendable Drive Points (w/ O-ring)
6.17 6.25 Expendable Point Popper
6.18 PRT Adapter for ¼" tubing w/ O-ring
6.19 ¼" OD x 3/16" ID tubing (Teflon^{TM} or Nylon)
6.20 20/40 grade sand (#5 quartz silica sand, or equivalent)
6.21 1L Evacuated canisters (*i.e.*, Summa canisters), with grab flow-choke regulators
6.22 Implants (stainless steel, aluminum, ceramic, or plastic)
6.23 Funnel
6.24 Tubing cutter
6.25 Polycarbonate 2- & 3-way valves
6.26 Disposable 60cc Syringe
6.27 Photoionization detector (FSOP 3.1.1, Photoionization Detector), ppb capable
6.28 Multi-gas meter (FSOP 3.1.2, Multiple Gas Detection Meters)
6.29 Field documentation equipment and supplies, including pens, markers, field logbook and data sheets, chain-of-custody forms, camera, etc.

7.0 Procedures: Summary of Probe Installation Methods

7.1 Using the Post-Run Tubing System for Grab Sample Collection

This is a temporary, single use application for collecting a soil gas grab sample. Using the post-run tubing system (PRT), probe rods are driven to the desired depth, and then internal tubing, with PRT fitting attached, is inserted and seated for soil gas sampling. Using the inner tubing for soil gas collection has many advantages - potential for leakage is reduced, dead air volume that must be purged is reduced, and decontamination problems are reduced as the sample does not contact the rod bore.

7.1.1 Clean all parts prior to use. Inspect all probe rods and clear them of obstructions. Install O-ring on the PRT expendable point holder and the PRT adapter.

7.1.2 Test fit the adapter with the PRT fitting on the expendable point holder to assure that the threads are compatible and fit together smoothly. Ensure the threads are clean of debris.
NOTE: PRT fittings are left-hand threaded and must be rotated counter-clockwise to engage the point holder threads.

7.1.3 Push the PRT adapter into the end of the selected tubing. Tape may be used on the outside of the adapter and tubing to prevent the tubing from spinning freely around the adapter during connection - especially when using Teflon^{TM} tubing.

NOTE: The sample will not come into contact with the outside of the tubing or adapter.

7.1.4 Attach the PRT expendable point holder (with O-ring) to the female end of the leading probe rod.

7.1.5 Attach an O-ring to an expendable soil vapor drive point and insert into the expendable point holder. Attach the drive cap to the male end of the drive rod and position rod under probe.

7.1.6 Drive the PRT rod configuration into the ground, connecting probe rods as necessary to reach the desired depth.

7.1.7 After desired depth has been achieved, disengage the expendable drive point. Using the inner extension rods, insert the expendable point popper to the bottom of the rod string and then slowly pull up on the probe rods using the rod grip pull system. Retract the rods approximately 4"- 6" up to create a void from which to sample the soil gas. Position the probe unit to allow room to work around the sample location.

7.1.8 Insert the PRT adapter end of the tubing down the inside diameter of the probe rods.

7.1.9 Feed the tubing down the rod bore until it hits bottom on the expendable point holder. Allow approximately 4-6 ft. of tubing to extend out of the hole before cutting it. Grasp the excess tubing end and lightly apply downward pressure while turning it in a <u>counter-clockwise</u> motion to engage the adapter threads with the expendable point holder. Continue turning until the PRT adapter O-ring bottoms out in the expendable point holder.

7.1.10 Pull up lightly on the tubing to test the engagement of the threads. Failure of the PRT adapter to thread could mean that intrusion of soil may have occurred during driving of the rods or disengagement of the expendable drive point. Once tubing has been connected, finish the surface end with a 2-way valve in the closed position.

7.1.11 Sampling at the location can commence following an equilibrium period (minimum of 15 minutes). Connect the sampling tubing and follow appropriate purging and sampling procedures. Refer to "Procedures for Collection of Indoor Air, FSOP 2.4.3" for reference for use of evacuated canisters for sample collection; and refer to Section 7.3.1 below, for sampling procedures using the bag sampler (*e.g.*, Lung Box).

7.1.12 Prior to sample collection and screening, ensure that the implant is in a porous soil zone that will freely give up soil gas. Connect a 60 cc syringe to the implant tubing, open the 2-way tubing valve, and gently pull the plunger out to fill the syringe with gas. Let go of the plunger and observe whether it holds position where released, or if it can be observed moving back due to an induced vacuum. Should a vacuum be present, the soil zone at the end of the probe rods may be too tight to get a representative soil gas sample. Should this occur, the probe rods can be pulled up 1 to 2 feet at a time, retesting each interval until soil gas can be freely obtained. If not, abandon the location, seal the borehole with bentonite, and reposition the probe; or relocate to another position.

7.2 Installation of Soil Gas Implants

For long-term soil gas monitoring applications (multiple sampling events from the same location), a stainless steel, aluminum, polycarbonate or ceramic implant can be installed at any depth by direct push. Implants are inserted down inside the probe rods when the appropriate sampling depth has been achieved. When installing soil gas implants, knowledge of the local geology and soil types is paramount to the success of any soil gas survey. For sites where geology or soil characteristic information is not available, the collection of soil borings to target depth may be helpful in identifying zones or soil horizons in which to set soil gas implants.

7.2.1 Drive probe rods to the desired depth using the implant expendable point holder and an expendable drive point. Disengage the drive point using the point popper. Using the inner extension rods, insert the expendable point popper to the bottom of the rod string and then slowly pull up on the probe rods using the rod grip pull system. Retract the rods approximately 1”- 2” to push the expendable point out with the point popper. Remove all extension rods and point popper. Check end of last inner rod or point popper for evidence of moisture. Implants should not be installed in moist zones as these can inhibit vapor migration as well as, given enough time for water to accumulate, may result in water being drawn up and into sample containers (evacuated canister or Tedlar® bag).

7.2.2 Attach implant to one end of appropriate sample tubing (Teflon™, or nylon). Depending on implant type and diameter of sample tubing, a very short length of silicone tubing of appropriate size may be used to securely connect the implant to the sample tubing.

7.2.3 Lower the implant and tubing down the inside of the probe rods until the implant hits the top of the anchor/drive point. Note the length of the tubing to assure that proper depth has been reached. Cut the tubing flush with the top of the probe rod.

7.2.4 Using an inner extension rod, place one end of the rod on top of the fresh cut tubing. While holding the rod in place, slowly retract the rods, 4 feet at a time, and remove the drive rod. Continue this action of using the extension rod to hold the tubing in place until all the drive rods have been removed from the borehole.

7.2.5 Slowly pour sand (20/40 grade or #5) down the borehole around the outside of the tubing so that the sand extends several inches above the implant. Use the tubing to “stir” the sands into place around the implant. Do not lift up on the tubing. It should take less than 250 mL of sand to fill the space around the implant. The sand therefore will act as a grout barrier, inhibiting the grout from impacting the implant. Slowly pouring sand and bentonite will lessen the chance for the materials to bridge in the borehole.

NOTE: Implants come in various sizes and the drive rods can vary in diameter, so it is best to calculate the necessary volume of sand for each implant installation. Placement of the grout barrier by backfilling the borehole can only be performed in the vadose zone, not below the water table.

7.2.6 Once the sand is in place, slowly add the bentonite granules on top of the sand. After approximately 0.5 L of bentonite has been added, hydrate the bentonite in the hole. Hydration can be accomplished using a pump sprayer, or by using a section of tubing connected to the 60 cc syringe filled with water. Depending on borehole depth, the bentonite should be hydrated at a minimum of 3-5 intervals. Allow bentonite to come to ground surface, saturate the bentonite with water to create a bentonite "mud" and, using a finger, push this mix around the tube and back down the hole to enhance the closure. This results in a tight seal preventing gas migration down the column.

NOTE: Use caution not to over hydrate, as the water may flow out into the soil formation and travel down to the implant, causing it to become wet and potentially loose diffusivity

7.2.7 After sealing the borehole, cut the tubing to a manageable length (~12" - 18"), attach a 2-way valve connector (in the OFF position) or air tight (e.g., Swagelok®) plug, and mark the location with a pin flag or stake. Attach a label or tag to the tubing indicating the sample location identifier and depth at which the implant was set for future reference when sampling. Example: SG-3-18, meaning a soil gas point at location #3 with an implant set at 18 feet bgs.

7.2.8 Check the viability of the sample point just installed following the procedures outlined in Section 7.1.12 using a 60 cc syringe. A multi-gas meter with a PID is also a very good way to purge and check the sample point's viability and usefulness. Stable field screening measurements for VOC's, oxygen, and hydrogen sulfide can be good indicators on a well-sealed and sampling-ready implant. Should the meter's pump motor labor, or if the syringe plunger recedes back into syringe after pulling, a vacuum has been induced and the point is not viable for sample collection. The induced vacuum would be too much to overcome to obtain a gas sample using either an evacuated canister or a bag sampler.

7.2.9 A minimum equilibrium time should be established prior to sampling the implant (preferably stated in the work plan). While a 24-hour equilibrium period will ensure adequate equilibration, four to eight hours is generally sufficient. After equilibration, the implant is ready for sampling. Refer to Section 7.3 for sampling procedures using a vacuum canister (*e.g.,* Summa or Silco).

7.2.10 To provide long term security to the sampling port, the installation of a flush mount or above ground protective casing with a cap can be installed and finished with a concrete pad. For temporary, short-term finishing of a sampling port, 4-6" (ID) PVC pipe sections with associated caps can be installed.

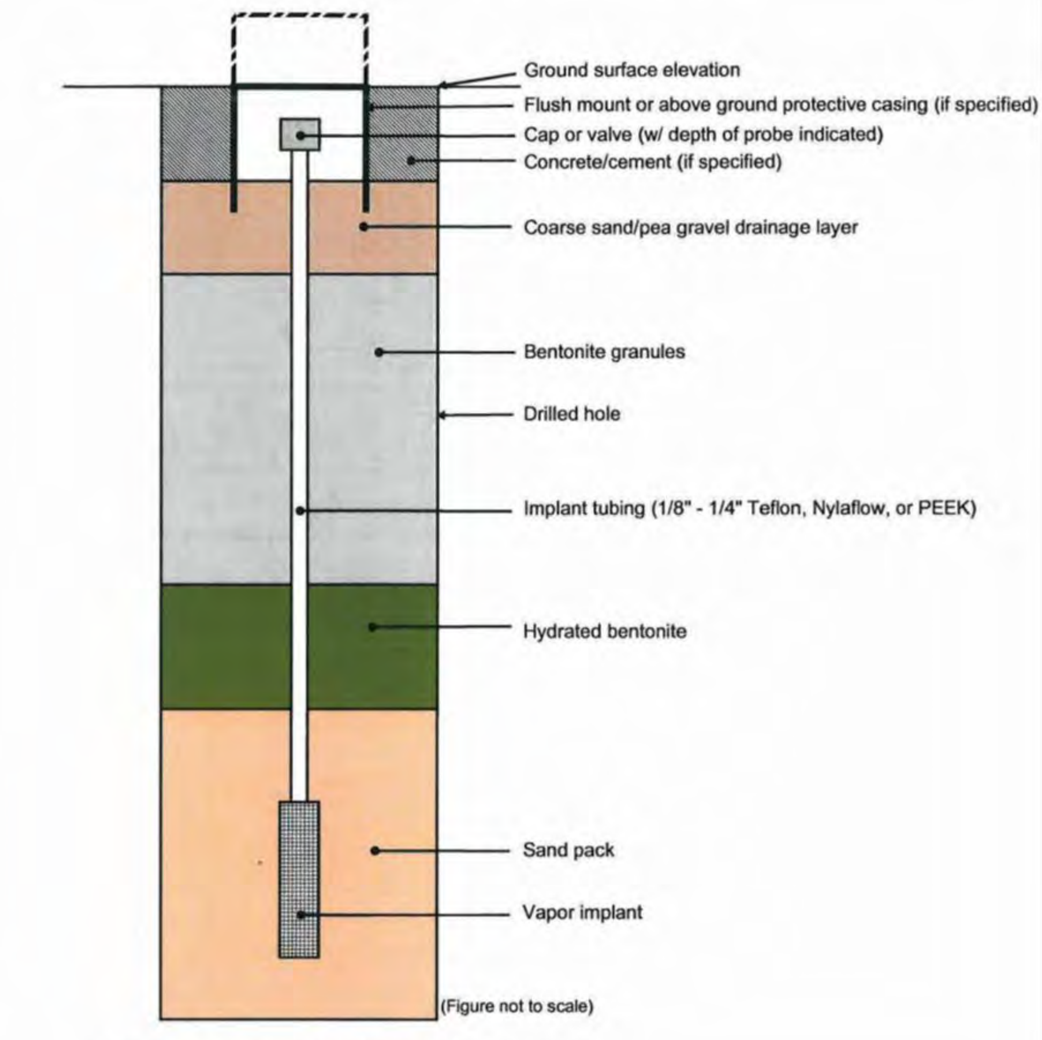

Figure 3: Permanent Soil Gas Probe Schematic

7.3 Sample Collection Methods

Two common methods of sample collection for vapor intrusion contaminants of concern (COCs) are discussed in this FSOP. The lung box sampler uses Tedlar® bags as sample containers. Collection of samples on adsorbents is performed by using a small external pump to pull air through adsorbent media cartridges and/or tubes. Data Quality Objectives (DQOs) for the project will determine which sample collection method to use. Field data should be recorded on the Soil Gas Sampling Data Sheet (attached) or in a field notebook.

7.3.1 The Lung Box Sampler (Bag Samplers)

The Lung Box allows direct filling of a Tedlar® air sample bag using negative pressure without passing gas through the pump. This eliminates the risk of contaminating the pump or the sample. The Lung Box, pictured below, includes an in-line pump. Other types of bag samplers may require the use of a separate air pump or hand pump.

The recommended holding time for samples collected into Tedlar® bags is 24 to 48 hours. Therefore, soil gas samples collected in Tedlar® bags should be analyzed as quickly as practical or samples can be transferred to another container with longer holding times (*i.e.*, Summa canister). If this method of sampling is performed, ensure that the laboratory can accept Tedlar® bags, and can meet the holding time requirements.

Semi-permanent soil gas probe location with multi-depth implants. The lung box sampler is used to collect soil gas samples using 1-liter Tedlar bags. Note that each tube is labeled with the sampling depth; the PVC pipe is used to protect the soil gas tubing.

7.3.1.1 Prior to sampling, and after an appropriate equilibrium period (typically 8 – 24 hrs. depending on DQOs), ambient air needs to be removed from the sample train by purging. Purging of the filter pack is required if sampling occurs within 24 hours of installation. At least three volumes should be removed. For example, the sample tubing can be purged using a 60 cc syringe with an attached 3-way valve (~4 cc/ft for ¼” ID tubing/volume). Other methods may be used as long as a minimum of 3 volumes are purged from the tubing. Once purging is complete, the sample may be collected.

Field screening may be performed using a direct reading instrument after sample collection.

7.3.1.2 Install new tubing in the bag sampler before collecting each sample. Place a new Tedlar® sample bag (already labeled) inside the bag sampler. Attach the inside portion of the tubing to the inlet valve on the sample bag. Open the sample valve on the sample bag following the manufacturer's instructions. Close sampler lid and secure. (DO NOT use any type of permanent marker, *i.e.*, "*Sharpie"* pens)

7.3.1.3 Attach external part of the inlet tubing to the sample tubing. Make sure that the purge valve on the side of the box is closed (closed for fastest fill rate, open for slower fill rate).

7.3.1.4 Turn on the sample pump or initiate hand pumping. While filling, watch through the observation window of the Bag sampler as the Tedlar® bag fills with gas. Avoid filling bag more than 80% of its maximum volume. Turn the pump off when the bag has filled to the desired volume. Do not over fill sample bags. The vacuum pump may be strong enough to break a sample bag.

NOTE: Be sure to watch the sample line for the first sign of water coming up the line. Pulling water up the line is not uncommon, especially in cases where the position of the water table is unknown. This is a good reason why ample lengths of tubing should be used for the sample line. If water is drawn up the tubing, the tubing can be cut before the water reaches the sampling equipment.

NOTE: Exercise extreme caution if filling sample bags with explosive gases.

7.3.1.5 Once filling of the sample bag is complete, turn off the pump, open the purge valve to equalize the pressures, unlatch the bag sampler lid and open. Close the sample bag inlet valve by holding the side stem and turning the entire upper portion of the fitting clockwise until snug. Remove the filled sample bag from the internal inlet tubing.

NOTE: In an effort avoid any photochemical reactions, keep filled Tedlar® bags out of sunlight. Store and ship bag samples in a protective box at room temperature. Do not chill to avoid condensation.

7.3.1.6 If measurements with a portable meter are to be made (*e.g.,* oxygen), conduct measurements after collecting the soil gas sample(s).

7.3.2 Collection of Samples on Adsorbents

7.3.2.1 An alternative approach to collecting soil gas in a sample container is to concentrate the soil gas on an adsorbent media. This type of method is required for SVOCs and is often used for mercury (generally compounds heavier than naphthalene). Typically, a pump is used to draw soil gas through the adsorbent matrix, and the adsorbent is then analyzed by a laboratory.

7.3.2.2 A variety of adsorbent cartridges and pumping systems are available from commercial vendors. In addition, it is essential that the soil gas be drawn through the adsorbent by the pump, not pumped through the adsorbent to eliminate the chance for cross-contamination by the pump. It is often recommended that two tubes be used in series to avoid breakthrough losses in areas of suspected higher concentrations. The adsorbent, purge rate, and sample volume must be determined by discussion with the analytical laboratory.

7.4 Soil Gas Sample Field Screening

7.4.1 Following sample collection, field-screen the borehole or soil gas probe atmosphere with a PID in accordance with FSOP 3.1.1, Photoionization Detector, to estimate the bulk concentration of VOCs present in the soil gas sample. The PID field screening data should be recorded with the sample information on the chain-of-custody form. The analytical laboratory needs to be aware of any samples potentially containing high concentrations of VOCs that may need to be diluted prior to analysis.

7.4.2 If desired, to perform the field-screening, attach an appropriate length of tubing to the PID sampling tip with a small piece of silicon tubing and extend it at least halfway into the boring or attach PID directly to tubing on a soil gas probe to obtain readings.

7.4.3 The PID field screening data may also be collected for sampler health and safety concerns or to use as real-time screening information to help evaluate the need for additional sampling or other site assessment activities while in the field.

7.4.4 In addition to a PID, a multi-gas meter (FSOP 3.1.2, Multiple Gas Detection Meters) may be used to field screen the borehole or soil gas probe atmosphere to collect gas concentration field screening data. This information may be provided to the analytical laboratory, used to monitor health and safety concerns, or used as real-time screening information to help evaluate the need for additional sampling or other site assessment activities while in the field. Parameters often include VOCs (ppb), Oxygen (% O_2), Lower Explosive Level (% LEL), Carbon monoxide (ppm CO), and Hydrogen sulfide (ppm H_2S)

8.0 Data and Records Management

Refer to FSOP 1.3, Field Documentation.

9.0 Quality Assurance and Quality Control

Refer to the Site-Specific Work Plan

10.0 Attachments

Soil Gas Sampling Data Sheet

11.0 References

FSOP 1.1, Initial Site Entry

FSOP 1.3, Field Documentation

FSOP 3.1.1, Photoionization Detector

FSOP 3.1.2, Multiple Gas Detection Meters

Interstate Technology & Regulatory Council (ITRC) Vapor Intrusion Team, January 2007, Vapor Intrusion Pathway: A Practical Guideline

U.S. EPA, June 2015, OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air: OSWER Publication 9200.2-154

SOIL GAS SAMPLING DATA SHEET

GENERAL INFORMATION

Site Name:______________________________

Site Address:___________________________

City:__________________________________

County/District__________________________

Contact Name:__________________________

Phone #:_______________________________

Sampling Address:_________________________
(if other than site address)

Grab Sample:_______ **Canister Sample:**________

Sample ID #: ______________________________

If canister used, complete info below:

Canister ID #:_____________________________

Regulator ID #:____________________________

SAMPLING INFORMATION

(mm/dd/yy) ***(military)***

Soil Gas port installed: Date:_______**Time:**_______
Depth :_______

If canister used for sample collection, complete following info:

Sample Collection Start: Date:_______**Time:**_______

Sample Collection End: Date:_______ **Time:**_______

Regulator Calibrated for:

_____ **8-hr** _____ **12-hr** _____ **24-hr** _____ **grab (no regulator)**

Laboratory & Analytical Method: ________________

Sample Delivered: Date_________ **Time:**_________

Method of Delivery: ___________________________
(ex. Lab courier, UPS, delivered by sampler, etc.)

Canister Info:

Initial canister vacuum:

______ **"Hg or mm Hg**

Final canister vacuum:

_______**"Hg or mm Hg**

Temperature:

__________ **°F**

Field Screening Info:

PID (ppm):__________

% O_2 :_______________

CH_4 (%LEL):_________

CO_2:________________

CO:_________________

H_2S:________________

List instrument (and ID#) used to collect parameters:

____

NOTES: (include any information on the installation of the soil gas port, or problems with sampling/canister etc.)

Signature of Sampler: ____ **Date:**_______________

Note: If a diagram of the sample location(s) is sketched on the back of this data sheet, check here ☐

Construction, Installation and Decommissioning of Sub-Slab Vapor Ports
FSOP 2.4.2 (May 2, 2018)
Ohio EPA Division of Environmental Response and Revitalization

1.0 Scope and Applicability

Sub-slab vapor ports are used to sample the vapor contained in the interstitial spaces beneath the floor slab of dwellings and other structures for volatile organic compounds (VOCs) and other volatile chemicals. Sub-Slab vapor ports may be constructed using a custom fit stainless steel implant with Swagelok® fittings or a custom pre-manufactured Vapor Pin®.

2.0 Definitions

Summa Canister: Genericized trademark that refers to electro-polished, passivated stainless steel vacuum sampling devices (*i.e.*, evacuated canister). Sizes of canisters will vary with the most commonly used sizes being 6L and 1L. Canister size will depend on the pre-determined time-frame for sampling (*e.g.*, 24-hour vs. "grab"). A "Silco" canister is another name for a Summa canister.

3.0 Health and Safety Considerations

3.1 This activity involves accessing private residences and spaces in commercial buildings. Follow Ohio EPA Standard Safety Operating Procedure Number SP11-19 (Working Alone) to determine if working alone is appropriate given the site conditions and circumstances.

3.2 Never enter an OSHA-defined confined space for any reason. Only Ohio EPA Office of Special Investigation (OSI) staff or other appropriately trained staff are qualified to enter confined spaces for reconnaissance or sampling activities and will perform such work as necessary in accordance with Ohio EPA Standard Safety Operating Procedure Number SP14-4 (Confined Space Entry).

3.3 Follow the site-specific health and safety plan (HASP), which should identify the potential presence of asbestos-containing materials and other building-specific health and safety concerns. If a site-specific HASP is not available, follow the health and safety procedures in FSOP 1.1, Initial Site Entry.

3.4 This activity may result in the creation of silica dust when drilling through concrete. To prevent exposure to silica, a HEPA vacuum with an associated dust containment system must be used when drilling through concrete. Staff must be trained in the proper use of the silica dust collection equipment before installing sub-slab vapor probes.

3.5 When using electricity, be cautious of wet areas or areas with standing water, *e.g.*, wet basement floors, sump pumps, etc.

3.6 Be aware of potential vermin (fleas, rats, etc.)

3.7 Hearing protection should be worn while using a hammer drill.

3.8 A dust mask may be worn during drilling if desired.

3.9 Use a photoionization detector (PID) to evaluate VOC concentrations during vapor port installation in accordance with FSOP 3.1.1, Photoionization Detector.

3.10 Review available plans or documents before selecting sampling locations. Ensure that all sub-slab utilities (public and private or building specific) have been located and marked prior to installation.

3.11 Do not attempt to drill through steel-reinforcement (e.g., rebar) within a concrete slab.

4.0 Procedure Cautions

4.1 Review the site-specific work plan (SSWP), which should include a description of the building's size and use. In certain emergency circumstances a SSWP may not be available, and all necessary information for sub-slab vapor port installation and sampling will need to be obtained during the pre-sampling visit as described below. If a pre-sampling meeting cannot be held due to time constraints, please collect as much of the information as possible as listed below. This information can be obtained during a telephone call or in person.

4.2 A pre-sampling site visit should be conducted to meet with the building's owner and/or tenant and inspect the proposed vapor port sampling locations. During the pre-sampling visit, discuss sample location access and associated logistical concerns, including, but not limited to, lighting and electrical power, the need to temporarily move furnishings, the need to remove floor coverings (e.g., carpet or tile), the location of floor drains and/or other sub-slab utilities, and whether or not the sampling areas are occupied or unoccupied spaces.

4.3 The thickness of concrete slabs varies from structure to structure. A single structure may also have a slab with variable thickness. Drill bits of various sizes and cutting ability may be required to penetrate slabs of variable thicknesses. If a slab contains steel reinforcement (e.g., rebar), a sub-slab vapor port can only be installed if SIFU can find a location where steel reinforcement is not present. SIFU cannot drill through the steel reinforcement within a concrete slab.

4.4 There is a potential for high concentrations of VOC vapors to exist under the slab. Perform work quickly to ensure minimal exposure to VOCs.

4.5 When installing sub-slab vapor ports in commercial or industrial buildings, there is the potential to encounter sub-slab utility conduits (e.g., floor drains or electric, gas or water lines). Follow the procedures provided in Section 7.1 for sub-slab utility clearance before installing vapor ports.

4.6 Unless approved by Ohio EPA management and the building owner, sub-slab vapor ports should never be installed in the floor of a building with an existing sub-slab vapor barrier that is a component of a vapor mitigation system because vapor port installation could penetrate the barrier. However, sub-slab vapor ports may be installed through sub-slab moisture barriers that are typically not components of vapor mitigation systems, providing that the vapor port is decommissioned when it is no longer needed for sampling purposes.

4.7 When using the drill and HEPA vacuum, you will exceed 15 amps which is the standard for most household outlets. Therefore, be prepared to connect the drill and the HEPA vacuum to separate outlets.

5.0 Personnel Qualifications

Ohio EPA personnel working at sites that fall under the scope of OSHA's hazardous waste operations and emergency response standard (29 CFR 1910.120) must meet the training requirements described in that standard. Prior knowledge, training and experience with this sampling technique is strongly recommended before collecting samples.

6.0 Equipment and Supplies

General

6.1 Hammer drill or rotary hammer drill
6.2 Alternating current (AC) extension cord
6.3 AC generator, if AC power is not available on site
6.4 Hammer or rotary hammer drill bit, ⅜" diameter
6.5 Hammer or rotary hammer drill bit, 1" diameter
6.6 1 – ¾" open end wrench or 1 – medium adjustable wrench
6.7 2 – $^{9}/16$" open end wrench or 2 – small adjustable wrenches
6.8 Disposable cups, 5 ounces (oz.)
6.9 Disposable mixing implement (*i.e.*, popsicle stick, tongue depressor, etc.)
6.10 Vapor Sampling Data Sheet, Sub-Slab and Indoor Air (attached) or log book
6.11 Pens and markers
6.12 Flashlight or equivalent head lamp
6.13 Utility knife
6.14 Disposable syringe (60 cc)
6.15 Personal protective equipment appropriate for site-specific work activities\
6.16 Disposable mixing implement (*i.e.*, popsicle stick, tongue depressor, etc.)
6.17 Tap water, for mixing anchoring cement/grout
6.18 Hand broom and dust pan
6.19 Small bottle brush to remove loose debris clean side walls of borehole
6.20 Portable HEPA vacuum
6.21 Dust collector

Swagelok® Equipment and Supplies

6.22 Hex head wrench, ¼"
6.23 Tubing cutter and pipe cutter
6.24 Swagelok® SS-400-7-4 female connector, ¼" national pipe thread (NPT) to ¼" Swagelok® connector
6.25 Swagelok® SS-400-1-4 male connector, ¼" NPT to ¼" Swagelok® connector
6.26 Hose barb adapter, brass, 3/16" barb x ¼" male iron pipe (MIP)
6.27 ¼" NPT flush mount hex socket plug
6.28 ¼" outer diameter (OD) stainless steel tubing, pre-cleaned, instrument grade

6.29 ¼” OD Teflon™ or nylon tubing
6.30 Teflon™ or nylon washer ID ¼”, OD ¾”
6.31 ¼” OD stainless welded tubing, 12” to 24” length
6.32 Swagelok® tee, optional (SS-400-3-4TMT or SS-400-3-4TTM)
6.33 Appropriate size tubing

Vapor Pin® Equipment and Supplies

6.34 Cox-Colvin Vapor Pin® Kit
6.35 Dead blow hammer
6.36 Appropriate silicon tubing
6.37 Vapor Pin® protective cap to prevent vapor loss prior to sampling
6.38 Standard Operating Procedure Installation and Extraction of the Vapor Pin® https://www.vaporpin.com/resources/#SOP

7.0 Procedures

7.1 Review the SSWP, which should include a description of the building’s size and use. In certain emergency circumstances a SSWP may not be available, and all necessary information for sub-slab vapor port installation and sampling will need to be obtained during the pre-sampling visit as described below. If a pre- sampling visit is not feasible, call the owner and/or tenant prior to sampling to obtain the information.

7.2 A pre-sampling site visit should be conducted to meet with the building’s owner and/or tenant and inspect the proposed vapor port sampling locations. During the pre-sampling visit, discuss sample location access and associated logistical concerns, including but not limited to lighting and electrical power, the need to temporarily move furnishings, the need to remove floor coverings (e.g., carpet or tile), the location of floor drains and/or other sub-slab utilities and whether or not the sampling areas are occupied or unoccupied spaces.

7.3 Before installing sub-slab vapor ports in a commercial or industrial building, use the following procedures for sub-slab utility clearance:

7.3.1 Perform a visual inspection of the area(s) of the building where vapor ports are to be located for potential sub-slab utility lines.

7.3.2 Discuss the presence and location(s) of sub-slab utility lines with the building owner and/or operator and review any available building construction plans that may show the location of sub-slab utility lines.

7.3.3 If the presence or location(s) of sub-slab utility lines cannot be verified following the procedures in Sections 7. 1 and 7. 2, contract a private utility locating company to locate potential sub-slab utility lines before installing vapor ports.

7.4 Preparation and Drilling of the Vapor Port

7.4.1 Connect the dust collector to the HEPA vacuum. Ensure that all connections are tight.

7.4.2 Plug the HEPA vacuum into the outlet and place the dust collector on the floor. Turn on the HEPA vacuum and ensure that the dust collector has created a tight seal with the floor. If a tight seal is not present, turn off the vacuum and check to ensure that all of the connections between the vacuum and the dust collector are tight. If the connections are tight, check the filter. It may be full, and need replaced. Also make sure the rubber gasket on the dust collector is in good condition. Finally, reposition the dust collector to a smoother floor surface. Retest the seal between the dust collector and the floor.

7.4.3 After ensuring that there is a good seal between the floor and the dust collector, set-up the drill and make sure the dust collector is positioned over the location selected for the vapor port. Turn on the vacuum and then the drill.

7.5 Swagelok® Probe Assembly and Installation for Multiple Sampling Events

7.5.1 Drill a ⅜” diameter pilot hole to a depth of approximately 2” (Figure 1).

7.5.2 Using the ⅜” pilot hole as your center, drill a 1” diameter outer hole to a depth of approximately 1 ⅜” (Figure 1). Vacuum cuttings out of the hole.

Figure 1: Assembled sub-slab port ready for installation

7.5.3 Continue drilling the ⅜” inner or pilot hole through the slab and a few inches into the sub-slab material.

7.5.4 Determine the length of stainless steel tubing required to reach from the bottom of the outer hole, through the slab and into the open cavity below the slab. To avoid obstruction of the probe tube, ensure that it does not contact the sub-slab material. Using a tube cutter, cut the tubing to the desired length.

7.5.5 Attach a measured length (typically 3”-4”) of ¼” OD stainless tubing to the female connector (SS-400-7-4) with the Swagelok® nut. Make sure that the tubing rests firmly in the fitting body and that the nut is finger tight. While holding the fitting body firmly, tighten the nut 1¼ turns.

7.5.6 Insert the ¼” hex socket plug into the female connector. If using a stainless steel socket plug, wrap one layer of Teflon™ thread tape around the threads to prevent binding. If using a brass socket plug, Teflon™ tape is not needed. Tighten the plug slightly. Do not over tighten. If excessive force is required to remove the plug during the sample set up phase, the probe may break loose from the anchoring cement.

7.5.7 Place the completed probe into the outer hole to check fit and to ensure that stainless steel tubing is not in contact with the sub-slab material. Make necessary adjustments to the hole or probe assembly.

7.5.8 In a disposable cup or other container, mix a small amount of the anchoring cement or grout. Add water sparingly to create a mixture that is fairly stiff and moldable. Place a spoonful or two of the cement/grout around the stainless steel tubing adjacent to the female connector nut. Mold the cement/grout into a mass around the connector nut and up around the main body of the probe assembly. Slide the Teflon™ washer onto the stainless steel tube so that it rests next to the cement/grout mixture. The washer will prevent any anchoring cement/grout from flowing into the inner hole during the final step of probe installation.

7.5.9 Carefully place the probe assembly into the drilled hole, applying light pressure to seat the assembly. While inserting the probe assembly, work the concrete/grout mixture to fill voids. Clean up cement/grout that discharged out of the hole during placement; avoid getting any of the concrete/grout into fittings or on fitting threads. Allow the cement/grout to cure according to manufacturer’s instructions before sampling (typically 24 hours). This elapsed time also allows for subsurface conditions to equilibrate prior to sampling.

7.6 Swagelok® Sample Set-Up and Collection

7.6.1 Conduct a leak test prior to sampling. Follow project-specific DQO’s and/or the SSWP to determine which of the following method(s) are appropriate:

7.6.1.1 The water dam that is included in the Cox-Colvin Vapor Pin® kit is a simple means of determining if there are any leaks (see Cox-Colvin instructions, Figure 6). To use the water dam, simply attach the water dam to the floor using putty ensuring that there are no holes between the putty and the floor. Then add water to the dam and observe whether there are any air bubbles. If there are no air bubbles, the seal is tight. If there are air bubbles, refer to Section 7.7.

7.6.1.2 Another option is to evaluate the oxygen concentration by attaching an oxygen sensor (Multi-RAE Pro meter) to the vapor pin®. If the percent oxygen drops, it can be inferred that there is a tight seal. However, since this method draws in sub-slab vapor, a longer waiting period may be required before collecting the sample to allow for the sub-slab air to re-equilibrate.

7.6.1.3 A tracer gas can be used during sample collection to evaluate whether the connections between the vapor pin® and the sample container have any leaks. A tracer gas is very lightly sprayed on a paper towel and the paper towel is briefly laid around the fittings. As an alternative, the tracer gas can be lightly sprayed into the atmosphere near the sample train. Do NOT spray directly on the fittings. **Note**: you will not know if there were any leaks until after the sample has been analyzed. The recommended tracer gas is 1,1-Difluoroethane, which is present in some brands of dust cleaner for electronics.

7.6.2 Wrap one layer of Teflon™ thread tape onto the NPT end of the male connector OR wrap one layer of Teflon™ tape onto the threaded end of the hose barb adapter (3/16" barb x ¼" MIP).

7.6.3 Carefully remove the ¼" hex socket plug from the female connector. Refer to Section 7.7 if the probe breaks loose from the anchoring cement/grout during this step.

7.6.4 To ensure that the sub-slab port has not been blocked by the collapse of the inner hole below the end of the stainless steel tubing, a stainless steel rod, ⅛" diameter, may be passed through the female connector and the stainless steel tubing. The rod should pass freely to a depth greater than the length of the stainless steel tubing, indicating an open space or loosely packed soil below the end of the stainless steel tubing. Either condition should allow a soil gas sample to be collected. If the port appears blocked, the stainless steel rod may be used as a ramrod to open the port. If the port cannot be cleared, the probe should be reinstalled, or a new probe installed in an alternate location.

7.6.5 Screw and tighten the Teflon™ taped male connector into the female connector, or screw and tighten the hose barb adapter (3/16" barb x ¼" MIP) into the female connector. Do not over tighten. This may cause the probe assembly to break loose from the anchoring cement/grout during this step or when the male connector/hose barb adapter is removed upon completion of the sampling event. Refer to Section 7.7 if the probe breaks loose from the anchoring compound during this step.

7.6.6 If a co-located sub-slab sample or split sample is desired, a stainless steel Swagelok® T, may be used in place of the male connector.

7.6.7 Using a short piece of silicon tubing, attach a length of ¼" tubing (Teflon™ or nylon) to the sampling container (e.g., Summa canister) or system (e.g., lung box for Tedlar® bag) to be used for sample collection. Connect the other end of the tubing to the male connector with a Swagelok® nut or connect directly to the barbed hose adapter.

7.6.8 Refer to site-specific work plan for canister size and type of sample required (e.g., 6-liter canister with regulator for either 8-hour or 24-hour sample collection or a 1-liter evacuated canister for a grab sample). After sampling, use a PID to measure the VOC concentrations to provide the laboratory with an indication of how concentrated the VOCs may be in the sample. Provide this information to the laboratory. **Note**: PID readings are not contaminant-specific quantifications. Do not assume that the PID reading equates (or approximates) the concentration of the contaminant of concern.

7.6.9 After sample collection, remove the male connector or barbed hose adapter from the probe assembly and reinstall the ¼" hex socket plug. Make sure the plug threads are wrapped with Teflon tape. Do not over tighten the hex socket plug. If excessive force is required to remove the plug during the next sampling event, the probe may break loose from the anchoring compound. Refer to Section 7.7 if the probe breaks loose from the anchoring compound during this step.

7.7 Repairing a Loose Swagelok® Probe Assembly

7.7.1 If the probe assembly breaks loose from the anchoring compound while removing or installing the hex socket plug, the Swagelok® male connector, or the barbed hose adapter, lift the probe assembly slightly above the surface of the concrete slab.

7.7.2 Hold the female connector with the ¾"open-ended wrench.

7.7.3 Complete the step being taken during which the probe broke loose, following the instructions contained in this SOP (*i.e.*, do not over tighten the hex socket plug, the male connector, or the barbed hose adapter).

7.7.4 Push the probe assembly back down into place and reapply the anchoring cement/grout.

Figure 2: Swagelok® port connected to canister and ready for sampling

7.8 Vapor Pin® Probe Installation

7.8.1 Refer to attached Cox-Colvin Vapor Pin® Standard Operating Procedure for proper vapor pin installation and removal.

7.8.2 After installing a Vapor Pin® place the small rubber cap over the barbed inlet to prevent and gas from escaping.

7.8.3 Conduct a leak test. The project specific DQO's or SSWP may dictate which of the following method(s) may be followed. **Note**: There are other techniques beyond those listed that may be used.

7.8.3.1 The water dam that is included in the Cox-Colvin Vapor Pin® kit is a simple means of determining if there are any leaks (see Cox-Colvin instructions, Fig 6). To use the water dam, attach the water dam to the floor using putty ensuring that there are no holes between the putty and the floor. Then add water to the dam and observe whether there are any air bubbles. If there are no bubbles, the seal is tight. If there are air bubbles, remove the water and reset the vapor point. Test with the water dam again to see if the seal is now tight. Remove the water and dam once test is complete.

7.8.3.2 Another option is to attach an oxygen sensor (Multi-RAE Pro meter) to the vapor pin® and evaluate the oxygen concentration. If the percent oxygen drops, it can be inferred that there is a tight seal. However, since this method draws in sub-slab vapor, a longer waiting period may be required before collecting the sample to allow for the sub-slab air to re-equilibrate.

7.8.3.3 A tracer gas can be used during sample collection to evaluate whether the connections between the vapor pin® and the sample container have any leaks. A tracer gas is very lightly sprayed on a paper towel and the paper towel is briefly laid around the fittings. As an alternative, the tracer gas can be lightly sprayed into the atmosphere near the sample train. Do NOT spray directly on the fittings. **Note**: you will not know if there were any leaks until after the sample has been analyzed. The recommended tracer gas is 1,1-Difluoroethane, which is present in some brands of dust cleaner for electronics.

7.8.3.4 Allow 2 hours for the sub-slab vapor conditions to re-equilibrate prior to sample collection unless site-specific work plan requires a different equilibration time.

Figure 3: Vapor Pin® installed and ready for sampling

7.9 Vapor Pin® Sample Collection

7.9.1 Remove the rubber cap and attach a piece of ¼" tubing (Teflon™ or nylon) to the barbed hose adapter. The tubing must be long enough to span from the sample port to the sample container (e.g., Summa canister) or system (e.g., lung box for Tedlar® bag).

7.9.2 Refer to site-specific work plan for canister size and type of sample required (e.g., 6-liter canister with regulator for either 8-hour or 24-hour sample collection or a 1-liter evacuated canister for a grab sample). After sampling, use a PID to measure the VOC concentrations to provide the laboratory with an indication of how concentrated the VOCs may be in the sample. Provide this information to the laboratory. **Note:** this number is not contaminant specific. Do not assume that your contaminant of concern equates to the reading from the PID.

7.10 Vapor Port Decommissioning

Remove the vapor pin® according to the attached Cox-Colvin Vapor Pin® Standard Operating Procedure for proper vapor pin® installation and removal.

7.10.1 Prior to filling the vapor port hole, measure the slab thickness. One method is to use a "hole hook", a section of rigid wire (such as a stiff-wire coat hanger) with a small (0.25-inch) 90-degree crimp at one end. Insert the hole hook inside the drilled hole and catch the hooked end on the underside of the concrete slab. Mark the wire where it meets the top of the slab, remove the hole hook, and measure the distance between the hooked end and marked end of the wire to determine the slab thickness. Record the measured slab thickness on the log sheet or in a field note book. This information is necessary if a sub-slab treatment system is ever installed.

7.10.2 Gently pour dry granular bentonite into the hole to fill any void space in the gravel or soil below the underside of the slab that may have been created during the drilling of the slab or installation of the vapor port. Continue adding bentonite until the level is approximately one inch below the top of the slab.

7.10.3 Slowly add a small amount of water to hydrate the bentonite without creating a column of standing water in the hole. Use of a flashlight when adding water helps to visually determine when the bentonite stops absorbing water. If too much water is added, use a syringe or absorbent material (e.g., paper towels) to remove the standing water. While adding water, try to wet the hole side walls to help create good contact with the floor tile grout that will be used to fill and seal the hole as described below.

7.10.4 Mix approximately ¼ cup of floor tile grout with a small amount of water using a disposable spoon. Add water until the consistency of the grout mixture is a little stiffer than drywall or spackling compound.

7.10.5 Use a plastic knife, putty knife, tongue depressor or similar tool to add the tile grout mixture to the hole until it is completely full. Use a concrete trowel or similar tool to remove any excess grout and finish the top of the seal so that it is smooth and even with the surrounding floor.

7.10.6 Clean up the area around the sealed hole and complete any needed field documentation, including photographs if required.

8.0 Data and Records Management

Refer to FSOP 1.3, Field Documentation.

9.0 Quality Assurance and Quality Control

9.1 Clean Vapor Pins® and sampling ports prior to installation by washing in warm water with laboratory-grade detergent, followed by rinsing with hot water and then rinsing with deionized water. Always inspect equipment before use.

9.2 Leak testing should be conducted to document the quality of the sample.

9.3 Photographs of the sampling location and equipment may be required for project documentation.

9.4 Refer to the data quality objectives (DQOs) provided in the work plan.

10.0 Attachments

Cox-Colvin Standard Operating Procedure, Installation and Extraction of the Vapor Pin®

Vapor Sampling Data Sheet, Sub-Slab and Indoor Air (revised May 2018)

11.0 References

FSOP 1.1, Initial Site Entry

FSOP 1.3, Field Documentation

FSOP 3.1.1, Photoionization Detector

Ohio EPA Standard Safety Operating Procedure SP11-19 (Working Alone)

Ohio EPA Standard Safety Operating Procedure SP14-4 (Confined Space Entry)

Standard Operating Procedure Installation and Extraction of the Vapor Pin™

Updated February 27, 2015

Scope:

This standard operating procedure describes the installation and extraction of the Vapor Pin™ for use in sub-slab soil-gas sampling.

Purpose:

The purpose of this procedure is to assure good quality control in field operations and uniformity between field personnel in the use of the Vapor Pin™ for the collection of sub- slab soil-gas samples or pressure readings.

Equipment Needed:

- Assembled Vapor Pin™ [Vapor Pin™ and silicone sleeve(Figure 1)]; Because of sharp edges, gloves are recommended for sleeve installation;
- Hammer drill;
- 5/8-inch (16mm) diameter hammer bit (Hilti™ TE-YX 5/8" x 22" (400 mm) #00206514 or equivalent);
- 1½-inch (38mm) diameter hammer bit (Hilti™ TE-YX 1½" x 23" #00293032 or equivalent) for flush mount applications;
- ¾-inch (19mm) diameter bottle brush;
- Wet/Dry vacuum with HEPA filter (optional);
- Vapor Pin™ installation/extraction tool;
- Dead blow hammer;
- Vapor Pin™ flush mount cover, if desired;
- Vapor Pin™ drilling guide, if desired;
- Vapor Pin™ protective cap; and
- VOC-free hole patching material (hydraulic cement) and putty knife or trowel for repairing the hole following the extraction of the Vapor Pin™.

Figure 1. Assembled Vapor Pin^{TM}

Installation Procedure:

1) Check for buried obstacles (pipes, electrical lines, etc.) prior to proceeding.

2) Set up wet/dry vacuum to collect drill cuttings.

3) If a flush mount installation is required, drill a 1½-inch (38mm) diameter hole at least 1¾-inches (45mm) into the slab. Use of a Vapor Pin™ drilling guide is recommended.

4) Drill a 5/8-inch (16mm) diameter hole through the slab and approximately 1-inch (25mm) into the underlying soil to form a void.

5) Remove the drill bit, brush the hole with the bottle brush, and remove the loose cuttings with the vacuum.

6) Place the lower end of Vapor Pin™ assembly into the drilled hole. Place the small hole located in the handle of the installation/extraction tool over the Vapor Pin™ to protect the barb fitting, and tap the Vapor Pin™ into place using a dead blow hammer (Figure 2). Make sure the installation/extraction tool is aligned parallel to the Vapor Pin™ to avoid damaging the barb fitting.

Figure 2. Installing the Vapor Pin™.

During installation, the silicone sleeve will form a slight bulge between the slab and the Vapor Pin™ shoulder. Place the protective cap on Vapor Pin™ to prevent vapor loss prior to sampling (Figure 3).

Figure 3. Installed Vapor Pin™

7) For flush mount installations, cover the Vapor Pin™ with a flush mount cover, using either the plastic cover or the optional stainless-steel Secure Cover (Figure 4).

Figure 4. Secure Cover Installed

8) Allow 20 minutes or more (consult applicable guidance for your situation) for the sub-slab soil-gas conditions to re-equilibrate prior to sampling.

9) Remove protective cap and connect sample tubing to the barb fitting of the Vapor Pin™. This connection can be made using a short piece of Tygon™ tubing to join the Vapor Pin™ with the Nylaflow tubing (Figure 5). Put the Nylaflow tubing as close to the Vapor Pin as possible to minimize contact between soil gas and Tygon™ tubing.

Figure 5. Vapor Pin™ sample connection.

10) Conduct leak tests in accordance with applicable guidance. If the method of leak testing is not specified, an alternative can be the use of a water dam and vacuum pump, as described in SOP Leak Testing the Vapor Pin™ via Mechanical Means (Figure 6). For flush-mount installations, distilled water can be poured directly into the 1 1/2 inch (38mm) hole.

Figure 6. Water dam used for leak detection

11) Collect sub-slab soil gas sample or pressure reading. When finished, replace the protective cap and flush mount cover until the next event. If the sampling is complete, extract the Vapor Pin™.

Extraction Procedure:

1) Remove the protective cap, and thread the installation/extraction tool onto the barrel of the Vapor Pin™ (Figure 7). Continue turning the tool clockwise to pull the Vapor Pin™ from the hole into the installation/extraction tool.

2) Fill the void with hydraulic cement and smooth with a trowel or putty knife.

Figure 7. Removing the Vapor Pin™.

3) Prior to reuse, remove the silicone sleeve and protective cap and discard. Decontaminate the Vapor Pin™ in a hot water and Alconox® wash, then heat in an oven to a temperature of 265° F (130° C) for 15 to 30 minutes.

The Vapor Pin™ to designed be used repeatedly, however, replacement parts and supplies will be required periodically. These parts are available on-line at VaporPin.CoxColvin.com.

VAPOR SAMPLING DATA SHEET: SUB-SLAB AND INDOOR AIR

General Information

Site Name / Address: ____________________

Sampling Location / Address: ____________________
(if other than site address)

Contact Name:____________________**Phone:** ____________________

Laboratory & Analytical Method:____________________ **Method of Delivery:** __________
(Courier, UPS, delivered by sampler, etc.)

Sampling Team Members: ____________________

Met with resident/business on (date)____________**to provide information on VOC inventory and sampling cross-contamination concerns. If not, explain why:**____________________

____

Indoor Air Samples

Sample ID #:____________ **Canister ID #:**____________**Regulator ID #**____________

Start: Date:____________**Time:**__________ **Initial canister vacuum:**________**mm Hg**

End: Date:____________**Time:**_ **Final canister vacuum:**________**mm Hg**

Regulator Calibrated for: 8 hr______ **24 hr**______ **grab (no regulator)**______

Canister/ Regulator Leak Checked: Yes______**No**_______

Sub-Slab Samples

Sample ID #:____________ **Canister ID #:**____________**Regulator ID #**____________ **Size of canister:**____________ **Thickness of sub-slab (inches)**________**Port install time:** __________

Sampling Start: Date:____________**Time:**__________ **Initial canister vacuum:**________**mm Hg**

Sampling End: Date:____________**Time:**__________ **Final canister vacuum:**________**mm Hg**

Regulator Calibrated for: 8 hr______ **24 hr**______ **grab (no regulator)** ______

Canister/ Regulator Leak Checked: Yes No **Sub-Slab Port Leak Checked: Yes No**

Type of sub-slab port: Swagelok__________ **Vapor Pin®:** ________

Sub-Slab Port Installed by: ____________________**Sub-Slab Port Sealed: Yes No**

PID Reading: VOC ppb **% 02**______________**PID ID#:**

NOTES: (sampler/canister problems, other significant sampling details, or FSOP deviations)

Note: If a diagram of the sample location(s) is sketched on the back of this data sheet, check here ☐

Procedures for Collection of Indoor Air FSOP 2.4.3
(March 9, 2017)
Ohio EPA Division of Environmental Response and Revitalization

1.0 Scope and Applicability

Indoor air samples investigate air quality within buildings for possible vapor intrusion of volatile organic compounds (VOCs) and other volatile chemicals. Samples are collected from locations within buildings and structures that are occupied on a regular and on- going basis to evaluate potential exposure to VOCs. Analysis of the air samples are typically performed using U.S. EPA Method TO-15.

2.0 Definitions

"Summa® Canister", a genericized trademark that refers to electropolished, passivated stainless steel vacuum sampling devices (*i.e.*, evacuated canister). Sizes of canisters will vary with the most commonly used sizes being 6L and 1L. Canister size will depend on the predetermined time-frame for sampling (*e.g.*, 24-hour v. "grab" sampling). A "Silco" canister is another name for a Summa canister.

3.0 Health and Safety Considerations

3.1 This activity involves accessing private residences and spaces in commercial buildings. Follow Ohio EPA Standard Safety Operating Procedure Number SP11-19 (Working Alone) to determine if working alone is appropriate given the site conditions and circumstances.

3.2 Never enter an OSHA-defined confined space for any reason. Only Ohio EPA Office of Special Investigation (OSI) staff or other appropriately trained staff are qualified to enter confined spaces for reconnaissance or sampling activities, and will perform such work as necessary in accordance with Ohio EPA Standard Safety Operating Procedure Number SP14-4 (Confined Space Entry).

3.3 Follow the site-specific health and safety plan (HASP), which should identify the potential presence of asbestos-containing materials and other building-specific health and safety concerns. If a site-specific HASP is not available, follow the health and safety procedures in FSOP 1.1, Initial Site Entry.

3.4 Be aware of potential vermin (fleas, rats, etc.)

3.5 Review available plans or documents before selecting sampling locations.

4.0 Procedure Cautions

4.1 Review the site-specific work plan (SSWP), which should include a description of the building's size and use. In certain emergency circumstances a SSWP may not be available, and all necessary information for indoor air sampling will need to be obtained during the pre-sampling visit as described below.

4.2 A pre-sampling site visit should be conducted to meet with the building's owner and/or tenant and inspect the proposed indoor air sampling locations. During the pre-sampling visit, address arrangements for sampling location access and associated logistical concerns. Also, determine if the sampling areas are occupied or unoccupied spaces. Obtain property access agreements prior to sampling.

4.3 Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens, wear/apply fragrances, or smoke before and/or during the sampling event.

4.4 Care should be taken to ensure that the flow regulator is pre-calibrated to the appropriate sample collection time (8 hours, 24 hours, etc.). Eight (8) hour sample collection is utilized for commercial/industrial settings. Twenty-four (24) hour sample collection is used for residential and/or sensitive receptor settings (*e.g.*, day care facilities).

4.5 The flow regulator must be correctly connected to the sample canister to eliminate the potential for leaks.

4.6 The regulator should be closed shortly before the actual sampling time is completed so that a small amount of vacuum remains. If it isn't closed and no vacuum remains in the canister, extracting a sample for analysis may be very difficult. In addition, sample integrity may be compromised if the canister reaches atmospheric pressure.

4.7 An interview of the building occupants should be conducted before sampling to determine if there are any potential chemicals present that could cause false positives during sample collection. For example, paints, woodworking products, household solvents and various chemicals used in hobbies may all contain VOCs that could be detected. If possible, the building occupants should remove such products several days before sampling takes place. A copy of Instructions for Building Occupants Prior to Indoor Air Sampling Form (attached) should be provided to the resident during the interview.

4.8 If sub-slab samples are to be collected from the same building that indoor air samples are being collected, it is preferable to complete the indoor air sampling prior to installing a sub-slab vapor port (FSOP 2.4.2, Construction, Installation and Decommissioning of Sub-Slab Vapor Ports). However, if site-specific reasons (*e.g.*, access or emergency conditions, etc.) dictate the need to collect both samples at the same time, care needs to be taken to install the sub-slab vapor port before beginning the indoor air sampling. In addition, the indoor air sample should be taken as far as possible from the location where the sub-slab vapor point is installed.

4.9 Indoor air samples should only be collected from the first floor/ground-level floor of the structure.

5.0 Personnel Qualifications

Ohio EPA personnel working at sites that fall under the scope of OSHA's hazardous waste operations and emergency response standard (29 CFR 1910.120) must meet the training requirements described in that standard. Prior knowledge, training and experience with this sampling technique is strongly recommended before collecting samples.

6.0 Equipment and Supplies

6.1 Stainless steel canister(s) (request at least one additional canister as a backup). A 6L canister will be required for this sampling activity. A 1L "grab sample" canister will not provide enough volume to sample for a timed (8 hr. or 24 hr.) sample period, refer to Section 2.0 (Definitions).

6.2 Flow regulator(s) properly calibrated for the specific sample collection duration – 8 hr. or 24 hr. (request at least one extra regulator as a back-up)

6.3 In-line filters, if needed (*e.g.*, for SVOC volatile compounds)

6.4 Open-end wrenches, typically 9/16" (two wrenches are recommended to tighten the fitting in two directions at the same time)

6.5 PID (refer to FSOP 3.1.1, Photoionization Detector)

6.6 Indoor Air Building Survey and Sampling Form (attached)

6.7 Instructions for Building Occupants Prior to Indoor Air Sampling Form (attached)

6.8 Vapor Sampling Data Sheet (attached)

6.9 Field documentation supplies and equipment, including pens, markers, field log book and additional data sheets, chain-of-custody forms, camera

7.0 Procedures

7.1 Sample Location Determination

7.1.1 Conduct a building/structure survey using the Indoor Air Building Survey and Sampling Form to determine potential target receptors and identify potential interferences to sample collection. PID screening may also help to identify VOC sampling interferences. In addition, provide the Instructions for Building Occupants Prior to Indoor Air Sampling Form to the building residents or worker for completion at this time. Potential sampling interferences need to be recognized and eliminated before sample collection begins. This should be completed at least 48 to 72 hours prior to sample collection.

7.1.2 Select indoor air sampling locations that are in inhabited or frequently used.

7.1.3 Do not place sample canisters in locations near primary-use doors or open windows.

7.1.4 Do not place sample canisters in the pathway of indoor fans.

7.1.5 If ceiling fans are in use, request that they be turned off for the duration of the sample period.

7.1.6 Note any obvious odors from scented candles, mothballs, cleaning products, gas or oils.

7.1.7 If the building has a dirt basement or crawl space, evaluate whether or not an indoor air canister should be placed in this area.

7.2 Sample Set-up

7.2.1 Place the sampling canisters at breathing-zone height.

7.2.2 Remove the brass plug from the canister and connect the flow regulator (with in-line particulate filter and vacuum gauge, if needed) to the canister.

7.2.3 Gently tighten the connection between the flow regulator and the canister using the open-end 9/16" wrenches. Do not over-tighten this connection. Before continuing, record the canister number and the associated flow regulator number on the "Vapor Sampling Data Sheet". The canister number can be used for sample identification on the COC form.

7.2.4 Open the canister/regulator valve. Record the sample start time and the canister pressure.

7.2.5 Photograph the canister and the surrounding area.

Example of a canister with a regulator attached and placed in the breathing zone.

7.3 Termination of Sample Collection

7.3.1 Return to the sample collection site a minimum of 15 minutes before the end of the sample collection interval. Examine the flow regulator to ensure that some vacuum is left on the gauge (preferably 2” to 10” of mercury on the regulator flow dial).

7.3.2 Record the vacuum pressure and stop sample collection by closing the flow regulator.

7.3.3 Remove the flow regulator from the canister using the 9/16” open-end wrenches. Re-install the brass plug on the canister fitting, and tighten it with an open-ended wrench.

7.3.4 Package the canister and the flow regulator into the shipping container provided by the lab. **Note**: the canister does not require preservation.

7.3.5 Complete the appropriate forms and sample labels as directed by the laboratory. Use the sample start time when completing the laboratory chain of custody and double check canister identification numbers for accuracy.

7.3.6 Ship the canisters to the laboratory for analysis.

8.0 Data and Records Management

Refer to FSOP 1.3, Field Documentation.

9.0 Quality Assurance and Quality Control

Usually, an ambient air sample is collected outside of the building where the indoor air is being sampled. The ambient air sample is collected at the same time as the indoor air sample and provides quality assurance/quality control (QA/QC) to help evaluate outdoor air quality. In addition, the work plan may specify co-located indoor air samples. Typically, the co-located QA/QC samples are collected at a frequency of 10 percent of the total samples collected.

10.0 Attachments

Indoor Air Building Survey and Sampling Form

Instructions for Building Occupants Prior to Indoor Air Sampling Vapor

Sampling Data Sheet

11.0 References

FSOP 1.1, Initial Site Entry

FSOP 1.3, Field Documentation

FSOP 2.4.2, Construction, Installation and Decommissioning of Sub-Slab Vapor Ports

FSOP 3.1.1, Photoionization Detector

Ohio EPA Standard Safety Operating Procedure SP11-19 (Working Alone)

Ohio EPA Standard Safety Operating Procedure SP14-4 (Confined Space Entry)

Ohio Environmental
Protection Agency

INDOOR AIR BUILDING SURVEY and SAMPLING FORM

Preparer's name: ______________________________ Date: ______________________

Preparer's affiliation: __________________________ Phone #: __________________

Site Name: ________________________________ Case #: ___________________

Part I - Occupants

Building Address: ____

Property Contact: ____________________ Owner / Renter / other: ___________________

Contact's Phone: home ( ) ________ work ( ) ___________ cell ( ) _________

# of Building occupants: Children under age 13 _____ Children age 13-18 _____ Adults _____

Part II – Building Characteristics

Building type: residential / multi-family residential / office / strip mall / commercial / industrial

Describe building: ___________________________________ Year constructed: ________

Sensitive population: day care / nursing home / hospital / school / other (specify): ____________

Number of floors below grade: _____ (full basement / crawl space / slab on grade)

Number of floors at or above grade: _____

Depth of basement below grade surface: ______ ft. Basement size: ______ ft^2

Basement floor construction: concrete / dirt / floating / stone / other (specify): ________________

Foundation walls: poured concrete / cinder blocks / stone / other (specify) ______________

Basement sump present? *Yes / No* Sump pump? *Yes / No* Water in sump? *Yes / No*

Type of heating system (circle all that apply):

hot air circulation
heat pump
other (specify): ____________________
hot air radiation
hot water radiation
wood
kerosene heater
steam radiation
electric baseboard

Type of ventilation system (circle all that apply):

central air conditioning mechanical fans bathroom ventilation fans individual air
conditioning units kitchen range hood fan outside air intake
other (specify): __________________

Type of fuel utilized (circle all that apply):
Natural gas / electric / fuel oil / wood / coal / solar / kerosene

Are the basement walls or floor sealed with waterproof paint or epoxy coatings? *Yes / No*

Is there a whole house fan? *Yes / No*

Septic system? *Yes / Yes (but not used) / No*

Irrigation/private well? *Yes / Yes (but not used) / No*

Type of ground cover outside of building: grass / concrete / asphalt / other (specify) __________________

Existing subsurface depressurization (radon) system in place? *Yes / No* *active / passive*

Sub-slab vapor/moisture barrier in place? *Yes / No*
Type of barrier: ______________________________

Part III - Outside Contaminant Sources

Potential contaminated site (1000-ft. radius): ____

Other stationary sources nearby (gas stations, emission stacks, etc.): _______________________________

Heavy vehicular traffic nearby (or other mobile sources): ____

Part IV – Indoor Contaminant Sources

Identify all potential indoor sources found in the building (including attached garages), the location of the source (floor and room), and whether the item was removed from the building 48 hours prior to indoor air sampling event. Any ventilation implemented after removal of the items should be completed at least 24 hours prior to the commencement of the indoor air sampling event.

Potential Sources	**Location(s)**	**Removed** **(Yes / No / NA)**
Gasoline storage cans		
Gas-powered equipment		
Kerosene storage cans		
Paints / thinners / strippers		
Cleaning solvents		
Oven cleaners		
Carpet / upholstery cleaners		
Other house cleaning products		
Moth balls		
Polishes / waxes		
Insecticides		
Furniture / floor polish		
Nail polish / polish remover		
Hairspray		
Cologne / perfume		
Air fresheners		
Fuel tank (inside building)		NA

Wood stove or fireplace		NA
New furniture / upholstery		
New carpeting / flooring		NA
Hobbies - glues, paints, etc.		

Part V – Miscellaneous Items

Do any occupants of the building smoke? *Yes / No* How often? _______________

Last time someone smoked in the building? _____________hours */ days ago*

Does the building have an attached garage directly connected to living space? *Yes / No*

If so, is a car usually parked in the garage? *Yes / No*

Are gas-powered equipment or cans of gasoline/fuels stored in the garage? *Yes / No*

Do the occupants of the building have their clothes dry cleaned? *Yes / No*

If yes, how often? weekly / monthly / 3-4 times a year

Do any of the occupants use solvents in work? *Yes / No*

If yes, what types of solvents are used? ____

If yes, are their clothes washed at work? *Yes / No*

Have any pesticides/herbicides been applied around the building or in the yard? *Yes* / No

If so, when and which chemicals? ____

Has there ever been a fire in the building? *Yes / No* If yes, when? ______________

Has painting or staining been done in the building in the last 6 months? *Yes / No*

If yes, when___________________ and where? _____________________________

Has there been any remodeling done (flooring/carpeting) in the building in the last 6 months? *Yes / No*

If yes, when ___________________ and where? _____________________________

Part VI – Sampling Information

Sample Technician:______________________________Phone number: ( )________- ___________

Sample Source: Indoor Air / Sub-Slab / Soil Gas

Sampler Type: Tedlar bag / Sorbent / Stainless Steel Canister / Other (specify): __________________

Analytical Method: TO-15 / TO-17 / other:___________ Cert. Laboratory: __________________

Sample locations (floor, room):

Field ID #______- _________________________ Field ID #______- ___________________________

Field ID #______-__________________________ Field ID #______- ____________________________

Were “Instructions for Occupants” followed? Y*es / No*

If not, describe modifications: ____

Additional Comments:

Provide Drawing of Sample Location(s) in Building

Part VII - Meteorological Conditions

Was there significant precipitation within 12 hours prior to (or during) the sampling event? *Yes / No*

Describe the general weather conditions: ______________________________

____

Part VIII – General Observations

Provide any information that may be pertinent to the sampling event and may assist in the data interpretation process.

(NJDEP 1997; NHDES 1998; VDOH 1993; MassDEP 2002; NYSDOH 2005; CalEPA 2005; Ohio EPA 2015)

Instructions for Building Occupants Prior to Indoor Air Sampling

Representatives from the Ohio EPA – Division of Environmental Response and Revitalization (DERR) - will be collecting one or more indoor air samples from your building on_____- beginning @______and ending @______. Your assistance is requested during the sampling program in order to collect an indoor air sample that is both representative of indoor conditions and avoids the common background indoor air sources associated with occupant activities and consumer products.

Please follow the instructions below starting at least 48 hours (2 days) prior to and during the indoor air sampling event:

- ☐ Do operate your furnace and whole house air conditioner as appropriate for the current weather conditions
- ☐ Do not use wood stoves, fireplaces or auxiliary heating equipment
- ☐ Do not use window air conditioners, fans vents
- ☐ Do not use paints or varnishes (up to a week advance, if possible)
- ☐ Do not use cleaning products (*e.g.*, bathroom cleaners, furniture polish, appliance cleaners, all-purpose cleaners, floor cleaners)
- ☐ Do not use hair spray, nail polish remover, perfume, etc.
- ☐ Do not store containers of gasoline, oil or solvents within an attached garage.
- ☐ Do not operate or store automobiles within an attached garage
- ☐ Do not open windows or keep doors open
- ☐ Do not smoke in the building
- ☐ Do not apply pesticides
- ☐ Do not use air fresheners or odor or eliminators
- ☐ Do not engage in indoor hobbies that in use solvents (*e.g.* gun cleaning)
- ☐ Do not operate gasoline powered equipment within the building, attached garage or around the immediate perimeter of the building
- ☐ Do not bring freshly dry cleaned clothes into the building

You will be asked a series of questions about the structure, consumer products you store in your building, and occupant activities typically occurring in the building. These questions are designed to identify “background” sources of indoor air contamination. While this investigation is looking for a select number of chemicals related to the known or suspected subsurface contamination, the laboratory will be analyzing the indoor air samples for a wide variety of chemicals. As a result, chemicals such as tetrachloroethene that is commonly used in dry cleaning or acetone, which is found in nail polish remover might be detected in your sample results.

Your cooperation is greatly appreciated. If you have any questions about these instructions, please feel free to

contact________________at____________________.

SUB-SLAB VAPOR SAMPLING AND INDOOR AIR DATA SHEET

General Information

Site Name / Address: ______________________________

Sampling Location / Address: ______________________________
(if other than site address)

Contact Name: ____________________ **Phone:** ____________________

Laboratory & Analytical Method: ____________________ **Method of Delivery:** __________
(Courier, UPS, delivered by sampler, etc.)

Sampling Team Members: ______________________________

Met with resident/business on (date) ____________ **to provide information on VOC inventory and sampling cross-contamination concerns. If not, explain why:** _

____

Indoor Air Samples

Sample ID #: ____________ **Canister ID #:** ____________ **Regulator ID #** ____________

Start: Date: ____________ **Time:** ________ **Initial canister vacuum:** ______ **mm Hg**

End: Date: ____________ **Time:** _ **Final canister vacuum:** ______ **mm Hg**

Regulator Calibrated for: 8 hr ______ **24 hr** ______ **grab (no regulator)** ______

Canister/ Regulator Leak Checked: Yes ______ **No** ______

Sub-Slab Samples

Sample ID #: ____________ **Canister ID #:** ____________ **Regulator ID #** ____________ **Size of canister:** ______ **Thickness of sub-slab (inches)** ______ **Port install time:** ________

Sampling Start: Date: ____________ **Time:** ________ **Initial canister vacuum:** ______ **mm Hg**

Sampling End: Date: ____________ **Time:** ________ **Final canister vacuum:** ______ **mm Hg**

Regulator Calibrated for: 8 hr ______ **24 hr** ______ **grab (no regulator)** ______

Canister/ Regulator Leak Checked: Yes No **Sub-Slab Port Leak Checked: Yes No**

Type of sub-slab port: Swagelok ________ **Vapor Pin®:** ________

Sub-Slab Port Installed by: ____________________ **Sub-Slab Port Sealed: Yes No**

PID Reading: VOC ppb ________ **% 02** ________ **PID ID#:** ____________

NOTES: (sampler/canister problems, other significant sampling details, or FSOP deviations)

Note: If a diagram of the sample location(s) is sketched on the back of this data sheet, check here ☐

APPENDIX D. Soil Gas Probe Field Data Report Form

Ohio Environmental Protection Agency
Division of Emergency and Remedial Response
Soil Gas Probe Field Data Report Form

Soil Gas Probe Field Data Report								
Site:								
Date:								
Instrument(s) used:								
Tracer used:								
Weather:								
Technician:								
Soil Gas Probe Number	Probe Depth (ft.)	Probe Volume (l)	Purge Rate (lpm)	Volume Purged (l)	Tracer Field Analysis (ppmv or ppbv)	%CO_2	%O_2	Other indicators

ND=Non-Detect
NM=Not Measured

APPENDIX E. Indoor Air/Sub-Slab Sampling Form

Ohio Environmental Protection Agency
Division of Emergency and Remedial Response
Indoor Air/Sub-slab Sampling Form

OHIO EPA DERR Site #____

Site Name____

Address____

____

Occupant Information

Name____

Address____

____

Telephone No:

(H) (_____)____

(W) (_____)____

Number and Age(s) of Occupant(s)

____

____

Does anyone smoke inside the building?

Building Characteristics

Type of building (circle):

Residential / Industrial / School / Commercial / Multi-use / Other?

If residential, what type (circle):

Single family / Condo / Multi-family / Other?

If commercial, what is the business?

How many floors does the building have?

Does the building have a (circle):

Basement / Crawl space / Slab-on-grade / Other?

Is the basement used as a living / workspace area?

What type of foundation does the building have (circle):

Field stone / Poured concrete / Concrete block / Other?_____________

Describe the heating system and type of fuel used.

Is there an attached garage?

Spill / Contaminant Source Information

Type of petroleum / VOC release?

When did the release occur?

What areas of the building have been impacted by the release?

Are there any odors? ___________ If so, describe the odors:

Where are the release odors found?

Sampling Information

Sampling Date

Sampler Type (circle):

Sorbent Canister Tedlar® Other__________

Analysis Method ____________________

Consulting Firm ____

Contact Person Name____

Contact Person Telephone No (____)______________________________

Laboratory Name ____

Laboratory Telephone No (____)_________________________________

Table 1: Sorbent Tube Sample Information

Sample ID#	Floor	Room	Tube ID #	Pump ID #	Volume (liters)	Duration (minutes)	Comments

Table 2: Canister Sample Information

Sample ID #	Floor	Room	Canister ID #	Initial On-site Pressure*	Pressure* On-site Following Sample Collection	Pressure Received at the Laboratory

* Indicate pressure in units of inches of mercury.

Please provide a sketch of area and location of sampler unit(s), include all pertinent structures.

Pre-Sampling Inspection and Product Inventory

List products or items which may be considered potential sources of VOCs such as paint cans, gasoline cans, gasoline powered equipment, cleaning solvents, furniture polish, moth balls, fuel tank, woodstove, fireplace, etc.

Date and time of pre-sampling inspection

Table 3: Pre-sampling Inspection Product Inventory

Potential VOC Source	Present (Y / N)	Location	Field screening Results (ppm)	Product Condition
Paints or paint thinners				
Gas powered equipment				
Gasoline storage cans				
Furniture polish				
Moth balls				
Fuel tank				
Wood stove				
Fireplace				
Perfumes/colognes				
Other:				
Other:				
Other:				

Table 4: Potential vapor migration entry point information

Potential Vapor entry points	Present (Yes/No)	Field screening results (ppm)	Comments
Foundation penetrations in floor or walls			
Cracks in foundation floor or walls			
Sump			
Floor drain			
Other			
Other			

Was the building aired out prior to sample collection?

How long was the airing out process?

Were vapor control methods in effect while the samples were being collected?

Windows open? Yes / No Ventilation fans? Yes / No
Vapor barriers? Yes / No
Vapor phase carbon treatment system? Yes / No
Other site control measures________________________________

Weather Conditions during Sampling

Outside temperature (^{o}F) __________ Inside temperature (^{o}F)_____________

Prevailing wind speed and direction

Describe the general weather conditions (*e.g.*, sunny, cloudy, rainy)

Significant precipitation (0.1 inches or more) within 12 hours of the sampling event?

General Comments

Is there any information you feel is important related to this site and the samples collected which would facilitate an accurate interpretation of the indoor air quality?

APPENDIX F. Soil Gas and Sub-Slab Vapor Analytical Methods and Reporting Limit Ranges

A list of several analytical methods and reporting limit ranges for soil gas and sub-slab vapor samples.

NOTE: The laboratory should be consulted prior to choosing the analytical method. The laboratory can advise sampler on holding times and any method specific requirements.

Method No.	Examples of Collection Device and Methodology#	Type of Compounds	Reporting Limit Range**
TO-1	Tenax solid sorbent GC/MS or GC/FID	VOC	0.02 – 200 µg/m^3 (0.01-100 ppbv)
TO-2	Molecular sieve sorbent GC/MS	VOC	0.2 – 400 µg/m^3 (0.1-200 ppbv)
TO-3	Tedlar® bag or canister GC/FID	BTEX, MTBE, TPH	1-3 µg/m^3
TO-4A*	Filter media$ GC/ECD	Pesticides PCBs	Pesticides (0.5 - 1 µg/sample) PCBs (1 – 2 µg/sample)
TO9A	Filters designed for PCB collection High resolution GC/MS	Mono/Di-PCBs	Contact lab
TO-10A*	Filter media$ GC/ECD	Pesticides PCBs	Pesticides (0.5 - 1 µg/sample) PCBs (1 – 2 µg/sample)
TO-13A*	Polyurethane foam (PUF)$ GC/MS	SVOCs	5-10 µg/ sample
TO-13A SIM*	PUF or XAD-2 resin media$ GC/MS	Low Level SVOCs	0.5-1 µg/sample
TO-14A	Canister / Tedlar® bag GC/ECD/FID or GC/MS	Non-polar VOCs	1-3 µg/m^3
TO14A	Silica lined canisters/Tedlar® bag/sorbent media	H_2S	Contact lab

A list of several analytical methods and reporting limit ranges for soil gas and sub-slab vapor samples.

NOTE: The laboratory should be consulted prior to choosing the analytical method. The laboratory can advise sampler on holding times and any method specific requirements.

Method No.	Examples of Collection Device and Methodology[#]	Type of Compounds	Reporting Limit Range**
TO-15	Canister / Tedlar® Bags GC/MS	VOC (polar/nonpolar)	0.4 – 20 µg/m^3 (0.2-2.5 ppbv)
TO-15	Silica lined canisters/Tedlar® bag/sorbent media	H_2S	Contact lab
TO-15	Canister / Tedlar® bag GC/FID	TPH – Alkanes (C4-C12)	0.1 ppmv
TO-15 SIM	Canister / Tedlar® bag GC/MS	Low level VOCs	0.011-0.5 µg/m^3
TO-17*	Sorbent tube (chilled) GC/MS	VOCs	1-3 µg/m^3
8021B modified	Syringe / Tedlar® bag / Canister/ glass vial GC/PID	VOC	1 – 60 µg/m^3
8260D modified	Syringe / Tedlar® bag / Canister / glass vial GC/MS	VOC	50 – 100 µg/m^3
8270E	Tedlar® bag / Canister GC/MS	SVOC	1000 µg/m^3 (20,000 ppbv to 100,000 ppbv)
8015 modified	Tedlar bag / canister GC/FID	TPH – alkanes (C4-C24)	10 ppmv
Air Toxics IO-5	Gold trap Dual amalgamation cold vapor atomic fluorescence spectrometry (CVAFS)	Hg	Contact lab
NIOSH 6009	Hopcalite cold vapor / Atomic Absorption (CV/AA)	Hg	Contact lab
9056	Silica lined canisters / Tedlar® Bag / sorbent media	H_2S	Contact lab

A list of several analytical methods and reporting limit ranges for soil gas and sub-slab vapor samples.

NOTE: The laboratory should be consulted prior to choosing the analytical method. The laboratory can advise sampler on holding times and any method specific requirements.

Method No.	Examples of Collection Device and Methodology[#]	Type of Compounds	Reporting Limit Range**
1668A	Filters designed for PCB collection High resolution GC/MS	Mono/Di-PCBs	Contact lab
U.S. EPA 3C	Tedlar® bag / Canister GC / FID	Methane nitrogen, oxygen, carbon dioxide, carbon monoxide	10 ppmv 0.1% (1,000 ppmv)
ASTM D-1946	Tedlar® bag/ canister GC / TCD / FID	Methane, nitrogen, oxygen carbon dioxide, carbon monoxide	1000 – 2000 μg/m^3
ASTM D-1945	Tedlar® bag / canister GC / FID	Natural gases	1000-2000 μg/m^3

NOTE: the laboratory should be consulted prior to choosing the analytical method. The laboratory can advise sampler on holding times and any method specific requirements.

* The indicated methods use a sorbent-based sampling technique. The detection limits will depend on the amount of air passed through the media.

** Reporting limits are compound specific and can depend upon the sample collection and the nature of the sample. Detection limits shown are for the range of compounds. Consult laboratory for specific information.

[#] ECD – electron capture detector; FID – flame ionization detector; GS – gas chromatography; MS – mass spectrometry; PID – Photoionization detector; TCD – thermal conductivity detector

[$] High volume collection (may require large sample volume; *e.g.*, 300 m^3)/ chilled 4°C

APPENDIX G. Comparison of Tubing Type to Vapor Absorption

Researcher / Tubing	Ouellette (2004)	Hayes, et. al. (2006)	Nicholson, et. al. (2007)	Hartman (2008)
LDPE	Sorption of hexane and pentane	Sorption of numerous compounds	N/A*	Sorption of TCE and PCE
Tygon	Sorption of hexane, butane, and pentane	N/A	N/A	Acceptable for TCE
Nylaflow	Acceptable	Sorption of naphthalene and 1,2,4-TCB	Sorption of aromatic hydrocarbons	Acceptable for TCE
Teflon	Acceptable	Acceptable	N/A	Acceptable for TCE
Vinyl	Sorption of hexane and pentane	N/A	N/A	N/A
PEEK	N/A	Acceptable	N/A	Acceptable for TCE
Copper	N/A	N/A	N/A	Sorption of TCE and PCE

*N/A – not analyzed

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

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

Quality Assurance Unit
U.S. Environmental Protection Agency – Region 1
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Revision Page

Date	**Rev #**	**Summary of changes**	**Sections**
7/30/96	1	Finalized	
01/19/10	2	Updated	All sections
3/23/17	3	Updated	All sections
9/20/17	4	Updated	Section 7.0

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1.0 USE OF TERMS

Equipment blank: The equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank needs only to include the pump in subsequent sampling rounds. If the pump and tubing are dedicated to the well, the equipment blank is collected prior to its placement in the well. If the pump and tubing will be used to sample multiple wells, the equipment blank is normally collected after sampling from contaminated wells and not after background wells.

Field duplicates: Field duplicates are collected to determine precision of the sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

Indicator field parameters: This SOP uses field measurements of turbidity, dissolved oxygen, specific conductance, temperature, pH, and oxidation/reduction potential (ORP) as indicators of when purging operations are sufficient and sample collection may begin.

Matrix Spike/Matrix Spike Duplicates: Used by the laboratory in its quality assurance program. Consult the laboratory for the sample volume to be collected.

Potentiometric Surface: The level to which water rises in a tightly cased well constructed in a confined aquifer. In an unconfined aquifer, the potentiometric surface is the water table.

QAPP: Quality Assurance Project Plan

SAP: Sampling and Analysis Plan

SOP: Standard operating procedure

Stabilization: A condition that is achieved when all indicator field parameter measurements are sufficiently stable (as described in the "Monitoring Indicator Field Parameters" section) to allow sample collection to begin.

Temperature blank: A temperature blank is added to each sample cooler. The blank is measured upon receipt at the laboratory to assess whether the samples were properly cooled during transit.

Trip blank (VOCs): Trip blank is a sample of analyte-free water taken to the sampling site and returned to the laboratory. The trip blanks (one pair) are added to each sample cooler that contains VOC samples.

2.0 SCOPE & APPLICATION

The goal of this groundwater sampling procedure is to collect water samples that reflect the total mobile organic and inorganic loads (dissolved and colloidal sized fractions) transported through the subsurface under ambient flow conditions, with minimal physical and chemical alterations from sampling operations. This standard operating procedure (SOP) for collecting groundwater samples will help ensure that the project's data quality objectives (DQOs) are met under certain low-flow conditions.

The SOP emphasizes the need to minimize hydraulic stress at the well-aquifer interface by maintaining low water-level drawdowns, and by using low pumping rates during purging and sampling operations. Indicator field parameters (e.g., dissolved oxygen, pH, etc.) are monitored during purging in order to determine when sample collection may begin. Samples properly collected using this SOP are suitable for analysis of groundwater contaminants (volatile and semi-volatile organic analytes, dissolved gases, pesticides, PCBs, metals and other inorganics), or naturally occurring analytes. This SOP is based on Puls, and Barcelona (1996).

This procedure is designed for monitoring wells with an inside diameter (1.5-inches or greater) that can accommodate a positive lift pump with a screen length or open interval ten feet or less and with a water level above the top of the screen or open interval (Hereafter, the "screen or open interval" will be referred to only as "screen interval"). This SOP is not applicable to other well-sampling conditions.

While the use of dedicated sampling equipment is not mandatory, dedicated pumps and tubing can reduce sampling costs significantly by streamlining sampling activities and thereby reducing the overall field costs.

The goal of this procedure is to emphasize the need for consistency in deploying and operating equipment while purging and sampling monitoring wells during each sampling event. This will help to minimize sampling variability.

This procedure describes a general framework for groundwater sampling. Other site specific information (hydrogeological context, conceptual site model (CSM), DQOs, etc.) coupled with systematic planning must be added to the procedure in order to develop an appropriate site specific SAP/QAPP. In addition, the site specific SAP/QAPP must identify the specific equipment that will be used to collect the groundwater samples.

This procedure does not address the collection of water or free product samples from wells containing free phase LNAPLs and/or DNAPLs (light or dense non-aqueous phase liquids). For this type of situation, the reader may wish to check: Cohen, and Mercer (1993) or other pertinent documents.

This SOP is to be used when collecting groundwater samples from monitoring wells at all Superfund, Federal Facility and RCRA sites in Region 1 under the conditions described herein. Request for modification of this SOP, in order to better address specific situations at individual wells, must include adequate technical justification for proposed changes. All changes and modifications must be approved and included in a revised SAP/QAPP before implementation in field.

3.0 BACKGROUND FOR IMPLEMENTATION

It is expected that the monitoring well screen has been properly located (both laterally and vertically) to intercept existing contaminant plume(s) or along flow paths of potential contaminant migration. Problems with inappropriate monitoring well placement or faulty/improper well installation cannot be overcome by even the best water sampling procedures. This SOP presumes that the analytes of interest are moving (or will potentially move) primarily through the more permeable zones intercepted by the screen interval.

Proper well construction, development, and operation and maintenance cannot be overemphasized. The use of installation techniques that are appropriate to the hydrogeologic setting of the site often prevent "problem well" situations from occurring. During well development, or redevelopment, tests should be conducted to determine the hydraulic characteristics of the monitoring well. The data can then be used to set the purging/sampling rate, and provide a baseline for evaluating changes in well performance and the potential need for well rehabilitation. Note: if this installation data or well history (construction and sampling) is not available or discoverable, for all wells to be sampled, efforts to build a sampling history should commence with the next sampling event.

The pump intake should be located within the screen interval and at a depth that will remain under water at all times. It is recommended that the intake depth and pumping rate remain the same for all sampling events. The mid-point or the lowest historical midpoint of the saturated screen length is often used as the location of the pump intake. For new wells, or for wells without pump intake depth information, the site's SAP/QAPP must provide clear reasons and instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected. If the depths to top and bottom of the well screen are not known, the SAP/QAPP will need to describe how the sampling depth will be determined and how the data can be used.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU, and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection may still take place provided the indicator field parameter criteria in this procedure are met. If after 2 hours of purging indicator field parameters have not stabilized, one of three optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, and record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization), c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may reflect a sampling bias and therefore, the data may not meet the data quality objectives of the sampling event).

It is recommended that low-flow sampling be conducted when the air temperature is above 32°F (0°C). If the procedure is used below 32°F, special precautions will need to be taken to prevent the groundwater from freezing in the equipment. Because sampling during freezing temperatures may adversely impact the data quality objectives, the need for water sample collection during months when these conditions are likely to occur should be evaluated during site planning and special sampling measures may need to be developed. Ice formation in the flow-through-cell will cause the monitoring probes to act erratically. A transparent flow-through-cell needs to be used to observe if ice is forming in the cell. If ice starts to form on the other pieces of the sampling equipment, additional problems may occur.

4.0 HEALTH & SAFETY

When working on-site, comply with all applicable OSHA requirements and the site's health/safety procedures. All proper personal protection clothing and equipment are to be worn. Some samples may contain biological and chemical hazards. These samples should be handled with suitable protection to skin, eyes, etc.

5.0 CAUTIONS

The following cautions need to be considered when planning to collect groundwater samples when the below conditions occur.

If the groundwater degasses during purging of the monitoring well, dissolved gases and VOCs will be lost. When this happens, the groundwater data for dissolved gases (e.g., methane, ethene, ethane, dissolved oxygen, etc.) and VOCs will need to be qualified. Some conditions that can promote degassing are the use of a vacuum pump (e.g., peristaltic pumps), changes in aperture along the sampling tubing, and squeezing/pinching the pump's tubing which results in a pressure change.

When collecting the samples for dissolved gases and VOCs analyses, avoid aerating the groundwater in the pump's tubing. This can cause loss of the dissolved gases and VOCs in the groundwater. Having the pump's tubing completely filled prior to sampling will avoid this problem when using a centrifugal pump or peristaltic pump.

Direct sun light and hot ambient air temperatures may cause the groundwater in the tubing and flow-through-cell to heat up. This may cause the groundwater to degas which will result in loss of VOCs and dissolved gases. When sampling under these conditions, the sampler will need to shade the equipment from the sunlight (e.g., umbrella, tent, etc.). If possible, sampling on hot days, or during the hottest time of the day, should be avoided. The tubing exiting the monitoring well should be kept as short as possible to avoid the sun light or ambient air from heating up the groundwater.

Thermal currents in the monitoring well may cause vertical mixing of water in the well bore. When the air temperature is colder than the groundwater temperature, it can cool the top of the water column. Colder water which is denser than warm water sinks to the bottom of the well and the warmer water at the bottom of the well rises, setting up a convection cell. "During low-flow sampling, the pumped water may be a mixture of convecting water from within the well casing and aquifer water moving inward through the screen. This mixing of water during low-flow sampling can substantially increase equilibration times, can cause false stabilization of indicator parameters, can give false indication of redox state, and can provide biological data that are not representative of the aquifer conditions" (Vroblesky 2007).

Failure to calibrate or perform proper maintenance on the sampling equipment and measurement instruments (e.g., dissolved oxygen meter, etc.) can result in faulty data being collected.

Interferences may result from using contaminated equipment, cleaning materials, sample containers, or uncontrolled ambient/surrounding air conditions (e.g., truck/vehicle exhaust nearby).

Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment and/or proper planning to avoid ambient air interferences. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

Clean and decontaminate all sampling equipment prior to use. All sampling equipment needs to be routinely checked to be free from contaminants and equipment blanks collected to ensure that the equipment is free of contaminants. Check the previous equipment blank data for the site (if they exist) to determine if the previous cleaning procedure removed the contaminants. If contaminants were detected and they are a concern, then a more vigorous cleaning procedure will be needed.

6.0 PERSONNEL QUALIFICATIONS

All field samplers working at sites containing hazardous waste must meet the requirements of the OSHA regulations. OSHA regulations may require the sampler to take the 40 hour OSHA health and safety training course and a refresher course prior to engaging in any field activities, depending upon the site and field conditions.

The field samplers must be trained prior to the use of the sampling equipment, field instruments, and procedures. Training is to be conducted by an experienced sampler before initiating any sampling procedure.

The entire sampling team needs to read, and be familiar with, the site Health and Safety Plan, all relevant SOPs, and SAP/QAPP (and the most recent amendments) before going onsite for the sampling event. It is recommended that the field sampling leader attest to the understanding of these site documents and that it is recorded.

7.0 EQUIPMENT AND SUPPLIES

A. Informational materials for sampling event

A copy of the current Health and Safety Plan, SAP/QAPP, monitoring well construction data, location map(s), field data from last sampling event, manuals for sampling, and the monitoring instruments' operation, maintenance, and calibration manuals should be brought to the site.

B. Well keys.

C. Extraction device

Adjustable rate, submersible pumps (e.g., centrifugal, bladder, etc.) which are constructed of stainless steel or polytetrafluoroethylene (PTFE, i.e. Teflon®) are preferred. PTFE, however, should not be used when sampling for per- and polyfluoroalkyl substances (PFAS) as it is likely to contain these substances.

Note: If extraction devices constructed of other materials are to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

If bladder pumps are selected for the collection of VOCs and dissolved gases, the pump setting should be set so that one pulse will deliver a water volume that is sufficient to fill a 40 mL VOC vial. This is not mandatory, but is considered a "best practice". For the proper operation, the bladder pump will need a minimum amount of water above the pump; consult the manufacturer for the recommended submergence. The pump's recommended submergence value should be determined during the planning stage, since it may influence well construction and placement of dedicated pumps where water-level fluctuations are significant.

Adjustable rate, peristaltic pumps (suction) are to be used with caution when collecting samples for VOCs and dissolved gases (e.g., methane, carbon dioxide, etc.) analyses. Additional information on the use of peristaltic pumps can be found in Appendix A. If peristaltic pumps are used, the inside diameter of the rotor head tubing needs to match the inside diameter of the tubing installed in the monitoring well.

Inertial pumping devices (motor driven or manual) are not recommended. These devices frequently cause greater disturbance during purging and sampling, and are less easily controlled than submersible pumps (potentially increasing turbidity and sampling variability, etc.). This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

D. Tubing

PTFE (Teflon®) or PTFE-lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics. As discussed in the previous section, PTFE tubing should not be used when sampling for PFAS. In this case, a suitable alternative such as high-density polyethylene tubing should be used.

PVC, polypropylene or polyethylene tubing may be used when collecting samples for metal and other inorganics analyses.

Note: If tubing constructed of other materials is to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

The use of 1/4 inch or 3/8 inch (inside diameter) tubing is recommended. This will help ensure that the tubing remains liquid filled when operating at very low pumping rates when using centrifugal and peristaltic pumps.

Silastic tubing should be used for the section around the rotor head of a peristaltic pump. It should be less than a foot in length. The inside diameter of the tubing used at the pump rotor head must be the same as the inside diameter of tubing placed in the well. A tubing connector is used to connect the pump rotor head tubing to the well tubing. Alternatively, the two pieces of tubing can be connected to each other by placing the one end of the tubing inside the end of the other tubing. The tubing must not be reused.

E. The water level measuring device

Electronic ”tape”, pressure transducer, water level sounder/level indicator, etc. should be capable of measuring to 0.01 foot accuracy. Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use must include check measurements with a water level “tape” at the start and end of each sampling event.

F. Flow measurement supplies

Graduated cylinder (size according to flow rate) and stopwatch usually will suffice.

Large graduated bucket used to record total water purged from the well.

G. Interface probe

To be used to check on the presence of free phase liquids (LNAPL, or DNAPL) before purging begins (as needed).

H. Power source (generator, nitrogen tank, battery, etc.)

When a gasoline generator is used, locate it downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate samples.

I. Indicator field parameter monitoring instruments

Use of a multi-parameter instrument capable of measuring pH, oxidation/reduction potential (ORP), dissolved oxygen (DO), specific conductance, temperature, and coupled with a flow-through-cell is required when measuring all indicator field parameters, except turbidity. Turbidity is collected using a separate instrument. Record equipment/instrument identification (manufacturer, and model number).

Transparent, small volume flow-through-cells (e.g., 250 mLs or less) are preferred. This allows observation of air bubbles and sediment buildup in the cell, which can interfere with the operation of the monitoring instrument probes, to be easily detected. A small volume cell facilitates rapid turnover of water in the cell between measurements of the indicator field parameters.

It is recommended to use a flow-through-cell and monitoring probes from the same manufacturer and model to avoid incompatibility between the probes and flow-through-cell.

Turbidity samples are collected before the flow-through-cell. A "T" connector coupled with a valve is connected between the pump's tubing and flow-through-cell. When a turbidity measurement is required, the valve is opened to allow the groundwater to flow into a container. The valve is closed and the container sample is then placed in the turbidimeter.

Standards are necessary to perform field calibration of instruments. A minimum of two standards are needed to bracket the instrument measurement range for all parameters except ORP which use a Zobell solution as a standard. For dissolved oxygen, a wet sponge used for the 100% saturation and a zero dissolved oxygen solution are used for the calibration.

Barometer (used in the calibration of the Dissolved Oxygen probe) and the conversion formula to convert the barometric pressure into the units of measure used by the Dissolved Oxygen meter are needed.

J. Decontamination supplies

Includes (for example) non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.

K. Record keeping supplies

Logbook(s), well purging forms, chain-of-custody forms, field instrument calibration forms, etc.

L. Sample bottles

M. Sample preservation supplies (as required by the analytical methods)

N. Sample tags or labels

O. PID or FID instrument

If appropriate, to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

P. Miscellaneous Equipment

Equipment to keep the sampling apparatus shaded in the summer (e.g., umbrella) and from freezing in the winter. If the pump's tubing is allowed to heat up in the warm weather, the cold groundwater may degas as it is warmed in the tubing.

8.0 EQUIPMENT/INSTRUMENT CALIBRATION

Prior to the sampling event, perform maintenance checks on the equipment and instruments according to the manufacturer's manual and/or applicable SOP. This will ensure that the equipment/instruments are working properly before they are used in the field.

Prior to sampling, the monitoring instruments must be calibrated and the calibration documented. The instruments are calibrated using U.S Environmental Protection Agency Region 1 *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction [ORP], and turbidity),* March 23, 2017, or latest version or from one of the methods listed in 40CFR136, 40CFR141 and SW-846.

The instruments shall be calibrated at the beginning of each day. If the field measurement falls outside the calibration range, the instrument must be re-calibrated so that all measurements fall within the calibration range. At the end of each day, a calibration check is performed to verify that instruments remained in calibration throughout the day. This check is performed while the instrument is in measurement mode, not calibration mode. If the field instruments are being used to monitor the natural attenuation parameters, then a calibration check at mid-day is highly recommended to ensure that the instruments did not drift out of calibration. Note: during the day if the instrument reads zero or a negative number for dissolved oxygen, pH, specific conductance, or turbidity (negative value only), this indicates that the instrument drifted out of calibration or the instrument is malfunctioning. If this situation occurs the data from this instrument will need to be qualified or rejected.

9.0 PRELIMINARY SITE ACTIVITIES (as applicable)

Check the well for security (damage, evidence of tampering, missing lock, etc.) and record pertinent observations (include photograph as warranted).

If needed, lay out a sheet of clean polyethylene for monitoring and sampling equipment, unless equipment is elevated above the ground (e.g., on a table, etc.).

Remove well cap and if appropriate measure VOCs at the rim of the well with a PID or FID instrument and record reading in field logbook or on the well purge form.

If the well casing does not have an established reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook (consider a photographic record as well). All water level measurements must be recorded relative to this reference point (and the altitude of this point should be determined using techniques that are appropriate to site's DQOs.

If water-table or potentiometric surface map(s) are to be constructed for the sampling event, perform synoptic water level measurement round (in the shortest possible time) before any purging and sampling activities begin. If possible, measure water level depth (to 0.01 ft.) and total well depth (to 0.1 ft.) the day before sampling begins, in order to allow for re-settlement of any particulates in the water column. This is especially important for those wells that have not been recently sampled because sediment buildup in the well may require the well to be redeveloped. If measurement of total well depth is not made the day before, it should be measured after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe may not be necessary unless analytical data or field analysis signal a worsening situation. This SOP cannot be used in the presence of LNAPLs or DNAPLs. If NAPLs are present, the project team must decide upon an alternate sampling method. All project modifications must be approved and documented prior to implementation.

If available check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous event(s). If changes are made in the intake depth or extraction rate(s) used during previous sampling event(s), for either portable or dedicated extraction devices, record new values, and explain reasons for the changes in the field logbook.

10.0 PURGING AND SAMPLING PROCEDURE

Purging and sampling wells in order of increasing chemical concentrations (known or anticipated) are preferred.

The use of dedicated pumps is recommended to minimize artificial mobilization and entrainment of particulates each time the well is sampled. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

A. Initial Water Level

Measure the water level in the well before installing the pump if a non-dedicated pump is being used. The initial water level is recorded on the purge form or in the field logbook.

B. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the appropriate depth (may not be the mid-point of the screen/open interval). The Sampling and Analysis Plan/Quality Assurance Project Plan should specify the sampling depth (used previously), or provide criteria for selection of intake depth for each new well. If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well.

Pump tubing lengths, above the top of well casing should be kept as short as possible to minimize heating the groundwater in the tubing by exposure to sun light and ambient air temperatures. Heating may cause the groundwater to degas, which is unacceptable for the collection of samples for VOC and dissolved gases analyses.

C. Measure Water Level

Before starting pump, measure water level. Install recording pressure transducer, if used to track drawdowns, to initialize starting condition.

D. Purge Well

From the time the pump starts purging and until the time the samples are collected, the purged water is discharged into a graduated bucket to determine the total volume of groundwater purged. This information is recorded on the purge form or in the field logbook.

Start the pump at low speed and slowly increase the speed until discharge occurs. Check water level. Check equipment for water leaks and if present fix or replace the affected equipment. Try to match pumping rate used during previous sampling event(s). Otherwise, adjust pump speed until there is little or no water level drawdown. If the minimal drawdown that can be achieved exceeds 0.3 feet, but remains stable, continue purging.

Monitor and record the water level and pumping rate every five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" somewhat as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. If the initial water level is above the top of the screen do not allow the water level to fall into the well screen. The final purge volume must be greater than the stabilized drawdown volume plus the pump's tubing volume. If the drawdown has exceeded 0.3 feet and stabilizes, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are collected.

Avoid the use of constriction devices on the tubing to decrease the flow rate because the constrictor will cause a pressure difference in the water column. This will cause the groundwater to degas and result in a loss of VOCs and dissolved gasses in the groundwater samples.

Note: the flow rate used to achieve a stable pumping level should remain constant while monitoring the indicator parameters for stabilization and while collecting the samples.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (e.g., bladder, peristaltic), and/or the use of dedicated equipment. For new monitoring wells, or wells where the following situation has not occurred before, if the recovery rate to the well is less than 50 mL/min., or the well is being essentially dewatered during purging, the well should be sampled as soon as the water level has recovered sufficiently to collect the volume needed for all anticipated samples. The project manager or field team leader will need to make the decision when samples should be collected, how the sample is to be collected, and the reasons recorded on the purge form or in the field logbook. A water level measurement needs to be performed and recorded before samples are collected. If the project manager decides to collect the samples using the pump, it is best during this recovery period that the pump intake tubing not be removed, since this will aggravate any turbidity problems. Samples in this specific situation may be collected without stabilization of indicator field parameters. Note that field conditions and efforts to overcome problematic situations must be recorded in order to support field decisions to deviate from normal procedures described in this SOP. If this type of problematic situation persists in a well, then water sample collection should be changed to a passive or no-purge method, if consistent with the site's DQOs, or have a new well installed.

E. Monitor Indicator Field Parameters

After the water level has stabilized, connect the "T" connector with a valve and the flow-through-cell to monitor the indicator field parameters. If excessive turbidity is anticipated or encountered with the pump startup, the well may be purged for a while without connecting up the flow-through-cell, in order to minimize particulate buildup in the cell (This is a judgment call made by the sampler). Water level drawdown measurements should be made as usual. If possible, the pump may be installed the day before purging to allow particulates that were disturbed during pump insertion to settle.

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, ORP, DO) at a frequency of five minute intervals or greater. The pump's flow rate must be able to "turn over" at least one flow-through-cell volume between measurements (for a 250 mL flow-through-cell with a flow rate of 50 mLs/min., the monitoring frequency would be every five minutes; for a 500 mL flow-through-cell it would be every ten minutes). If the cell volume cannot be replaced in the five minute interval, then the time between measurements must be increased accordingly. Note: during the early phase of purging, emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments followed by stabilization of indicator parameters. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings are within the following limits:

Turbidity (10% for values greater than 5 NTU; if three Turbidity values are less than 5 NTU, consider the values as stabilized),
Dissolved Oxygen (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
Specific Conductance (3%),
Temperature (3%),
pH (± 0.1 unit),
Oxidation/Reduction Potential (±10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Samples for turbidity measurements are obtained before water enters the flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities. Record start and stop times and give a brief description of cleaning activities.

The flow-through-cell must be designed in a way that prevents gas bubble entrapment in the cell. Placing the flow-through-cell at a 45 degree angle with the port facing upward can help remove bubbles from the flow-through-cell (see Appendix B Low-Flow Setup Diagram). Throughout the measurement process, the flow-through-cell must remain free of any gas bubbles. Otherwise, the monitoring probes may act erratically. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must remain submerged in water at all times.

F. Collect Water Samples

When samples are collected for laboratory analyses, the pump's tubing is disconnected from the "T" connector with a valve and the flow-through-cell. The samples are collected directly from the pump's tubing. Samples must not be collected from the flow-through-cell or from the "T" connector with a valve.

VOC samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

If the pump's flow rate is too high to collect the VOC/dissolved gases samples, collect the other samples first. Lower the pump's flow rate to a reasonable rate and collect the VOC/dissolved gases samples and record the new flow rate.

During purging and sampling, the centrifugal/peristaltic pump tubing must remain filled with water to avoid aeration of the groundwater. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help ensure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use the following procedure to collect samples: collect non-VOC/dissolved gases samples first, then increase flow rate slightly until the water completely fills the tubing, collect the VOC/dissolved gases samples, and record new drawdown depth and flow rate.

For bladder pumps that will be used to collect VOC or dissolved gas samples, it is recommended that the pump be set to deliver long pulses of water so that one pulse will fill a 40 mL VOC vial.

Use pre-preserved sample containers or add preservative, as required by analytical methods, to the samples immediately after they are collected. Check the analytical methods (e.g. EPA SW-846, 40 CFR 136, water supply, etc.) for additional information on preservation.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter (transparent housing preferred) is required, and the filter size (0.45 μm is commonly used) should be based on the sampling objective. Pre-rinse the filter with groundwater prior to sample collection. Make sure the filter is free of air bubbles before samples are collected. Preserve the filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in groundwater for human health or ecological risk calculations.

Label each sample as collected. Samples requiring cooling will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

G. Post Sampling Activities

If a recording pressure transducer is used to track drawdown, re-measure water level with tape.

After collection of samples, the pump tubing may be dedicated to the well for re-sampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth annually is usually sufficient after the initial low stress sampling event. However, a greater frequency may be needed if the well has a “silting” problem or if confirmation of well identity is needed.

Secure the well.

11.0 DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well, and then following sampling of each subsequent well. Pumps should not be removed between purging and sampling operations. The pump, tubing, support cable and electrical wires which were in contact with the well should be decontaminated by one of the procedures listed below.

The use of dedicated pumps and tubing will reduce the amount of time spent on decontamination of the equipment. If dedicated pumps and tubing are used, only the initial sampling event will require decontamination of the pump and tubing.

Note if the previous equipment blank data showed that contaminant(s) were present after using the below procedure or the one described in the SAP/QAPP, a more vigorous procedure may be needed.

Procedure 1

Decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump and tubing. The pump may be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Optional - flush with isopropyl alcohol (pesticide grade; must be free of ketones {e.g., acetone}) or with methanol. This step may be required if the well is highly contaminated or if the equipment blank data from the previous sampling event show that the level of contaminants is significant.

Flush with distilled/deionized water. This step must remove all traces of alcohol (if used) from the equipment. The final water rinse must not be recycled.

Procedure 2

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

12.0 FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the groundwater samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. Quality control samples include field duplicates, equipment blanks, matrix spike/matrix spike duplicates, trip blanks (VOCs), and temperature blanks.

13.0 FIELD LOGBOOK

A field log shall be kept to document all groundwater field monitoring activities (see Appendix C, example table), and record the following for each well:

Site name, municipality, state.

Well identifier, latitude-longitude or state grid coordinates.

Measuring point description (e.g., north side of PVC pipe).

Well depth, and measurement technique.

Well screen length.

Pump depth.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and detection method.

Pumping rate, drawdown, indicator parameters values, calculated or measured total volume pumped, and clock time of each set of measurements.

Type of tubing used and its length.

Type of pump used.

Clock time of start and end of purging and sampling activity.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analyses.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions, including approximate ambient air temperature.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling/monitoring equipment used, including trade names, model number, instrument identification number, diameters, material composition, etc.

14.0 DATA REPORT

Data reports are to include laboratory analytical results, QA/QC information, field indicator parameters measured during purging, field instrument calibration information, and whatever other field logbook information is needed to allow for a full evaluation of data usability.

Note: the use of trade, product, or firm names in this sampling procedure is for descriptive purposes only and does not constitute endorsement by the U.S. EPA.

15.0 REFERENCES

Cohen, R.M. and J.W. Mercer, 1993, *DNAPL Site Evaluation*; C.K. Smoley (CRC Press), Boca Raton, Florida.

Robert W. Puls and Michael J. Barcelona, *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*, April 1996 (EPA/540/S-95/504).

U.S. Environmental Protection Agency, 1992, *RCRA Ground-Water Monitoring: Draft Technical Guidance*; Washington, DC (EPA/530-R-93-001).

U.S. Environmental Protection Agency, 1987, *A Compendium of Superfund Field Operations Methods*; Washington, DC (EPA/540/P-87/001).

U.S Environmental Protection Agency, Region 1, *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction [ORP], and turbidity),* March 23, 2017 or latest version.

U.S Environmental Protection Agency, EPA SW-846.

U.S Environmental Protection Agency, 40 CFR 136.

U.S Environmental Protection Agency, 40 CFR 141.

Vroblesky, Don A., Clifton C. Casey, and Mark A. Lowery, Summer 2007, Influence of Dissolved Oxygen Convection on Well Sampling, *Ground Water Monitoring & Remediation* 27, no. 3: 49-58.

APPENDIX A

PERISTALTIC PUMPS

Before selecting a peristaltic pump to collect groundwater samples for VOCs and/or dissolved gases, (e.g., methane, carbon dioxide, etc.) consideration should be given to the following:

- The decision of whether or not to use a peristaltic pump is dependent on the intended use of the data.
- If the additional sampling error that may be introduced by this device is NOT of concern for the VOC/dissolved gases data's intended use, then this device may be acceptable.
- If minor differences in the groundwater concentrations could affect the decision, such as to continue or terminate groundwater cleanup or whether the cleanup goals have been reached, then this device should NOT be used for VOC/dissolved gases sampling. In these cases, centrifugal or bladder pumps are a better choice for more accurate results.

EPA and USGS have documented their concerns with the use of the peristaltic pumps to collect water sample in the below documents.

- "Suction Pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, December 1987.
- "The agency does not recommend the use of peristaltic pumps to sample ground water particularly for volatile organic analytes" *RCRA Ground-Water Monitoring Draft Technical Guidance*, EPA Office of Solid Waste, November 1992.
- "The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and volatiles loss", *Low-flow (Minimal drawdown) Ground-Water Sampling Procedures*, by Robert Puls & Michael Barcelona, April 1996, EPA/540/S-95/504.
- "Suction-lift pumps, such as peristaltic pumps, can operate at a very low pumping rate; however, using negative pressure to lift the sample can result in the loss of volatile analytes", USGS Book 9 Techniques of Water-Resources Investigation, Chapter A4. (Version 2.0, 9/2006).

APPENDIX B

SUMMARY OF SAMPLING INSTRUCTIONS

These instructions are for using an adjustable rate, submersible pump or a peristaltic pump with the pump's intake placed at the midpoint of a 10 foot or less well screen or an open interval. The water level in the monitoring well is above the top of the well screen or open interval, the ambient temperature is above 32°F, and the equipment is not dedicated. Field instruments are already calibrated. The equipment is setup according to the diagram at the end of these instructions.

1. Review well installation information. Record well depth, length of screen or open interval, and depth to top of the well screen. Determine the pump's intake depth (e.g., mid-point of screen/open interval).

2. On the day of sampling, check security of the well casing, perform any safety checks needed for the site, lay out a sheet of polyethylene around the well (if necessary), and setup the equipment. If necessary a canopy or an equivalent item can be setup to shade the pump's tubing and flow-through-cell from the sun light to prevent the sun light from heating the groundwater.

3. Check well casing for a reference mark. If missing, make a reference mark. Measure the water level (initial) to 0.01 ft. and record this information.

4. Install the pump's intake to the appropriate depth (e.g., midpoint) of the well screen or open interval. Do not turn-on the pump at this time.

5. Measure water level and record this information.

6. Turn-on the pump and discharge the groundwater into a graduated waste bucket. Slowly increase the flow rate until the water level starts to drop. Reduce the flow rate slightly so the water level stabilizes. Record the pump's settings. Calculate the flow rate using a graduated container and a stop watch. Record the flow rate. Do not let the water level drop below the top of the well screen.

If the groundwater is highly turbid or discolored, continue to discharge the water into the bucket until the water clears (visual observation); this usually takes a few minutes. The turbid or discolored water is usually from the well-being disturbed during the pump installation. If the water does not clear, then you need to make a choice whether to continue purging the well (hoping that it will clear after a reasonable time) or continue to the next step. Note, it is sometimes helpful to install the pump the day before the sampling event so that the disturbed materials in the well can settle out.

If the water level drops to the top of the well screen during the purging of the well, stop purging the well, and do the following:

> Wait for the well to recharge to a sufficient volume so samples can be collected. This may take a while (pump may be removed from well, if turbidity is not a problem). The project manager will need to make the decision when samples should be collected and the reasons recorded in the site's log book. A water level measurement needs to be performed and recorded before samples are collected. When samples are being collected, the water level must not drop below the top of the screen or open interval. Collect the samples from the pump's tubing. Always collect the VOCs and dissolved gases samples first. Normally, the samples requiring a small volume are collected before the large volume samples are collected just in case there is not sufficient water in the well to fill all the sample containers. All samples must be collected, preserved, and stored according to the analytical method. Remove the pump from the well and decontaminate the sampling equipment.

If the water level has dropped 0.3 feet or less from the initial water level (water level measure before the pump was installed); proceed to Step 7. If the water level has dropped more than 0.3 feet, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are be collected.

7. Attach the pump's tubing to the "T" connector with a valve (or a three-way stop cock). The pump's tubing from the well casing to the "T" connector must be as short as possible to prevent the groundwater in the tubing from heating up from the sun light or from the ambient air. Attach a short piece of tubing to the other end of the end of the "T" connector to serve as a sampling port for the turbidity samples. Attach the remaining end of the "T" connector to a short piece of tubing and connect the tubing to the flow-through-cell bottom port. To the top port, attach a small piece of tubing to direct the water into a calibrated waste bucket. Fill the cell with the groundwater and remove all gas bubbles from the cell. Position the flow-through-cell in such a way that if gas bubbles enter the cell they can easily exit the cell. If the ports are on the same side of the cell and the cell is cylindrical shape, the cell can be placed at a 45-degree angle with the ports facing upwards; this position should keep any gas bubbles entering the cell away from the monitoring probes and allow the gas bubbles to exit the cell easily (see Low-Flow Setup Diagram). Note:

make sure there are no gas bubbles caught in the probes' protective guard; you may need to shake the cell to remove these bubbles.

8. Turn-on the monitoring probes and turbidity meter.

9. Record the temperature, pH, dissolved oxygen, specific conductance, and oxidation/reduction potential measurements. Open the valve on the "T" connector to collect a sample for the turbidity measurement, close the valve, do the measurement, and record this measurement. Calculate the pump's flow rate from the water exiting the flow-through-cell using a graduated container and a stop watch, and record the measurement. Measure and record the water level. Check flow-through-cell for gas bubbles and sediment; if present, remove them.

10. Repeat Step 9 every 5 minutes or as appropriate until monitoring parameters stabilized. Note: at least one flow-through-cell volume must be exchanged between readings. If not, the time interval between readings will need to be increased. Stabilization is achieved when three consecutive measurements are within the following limits:

> **Turbidity** (10% for values greater than 5 NTUs; if three Turbidity values are less than 5 NTUs, consider the values as stabilized),
> **Dissolved Oxygen** (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
> **Specific Conductance** (3%),
> **Temperature** (3%),
> **pH** (± 0.1 unit),
> **Oxidation/Reduction Potential** (±10 millivolts).

If these stabilization requirements do not stabilize in a reasonable time, the probes may have been coated from the materials in the groundwater, from a buildup of sediment in the flow-through-cell, or a gas bubble is lodged in the probe. The cell and the probes will need to be cleaned. Turn-off the probes (not the pump), disconnect the cell from the "T" connector and continue to purge the well. Disassemble the cell, remove the sediment, and clean the probes according to the manufacturer's instructions. Reassemble the cell and connect the cell to the "T" connector. Remove all gas bubbles from the cell, turn-on the probes, and continue the measurements. Record the time the cell was cleaned.

11. When it is time to collect the groundwater samples, turn-off the monitoring probes, and disconnect the pump's tubing from the "T" connector. If you are using a centrifugal or peristaltic pump check the pump's tubing to determine if the tubing is completely filled with water (no air space).

All samples must be collected and preserved according to the analytical method. VOCs and dissolved gases samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

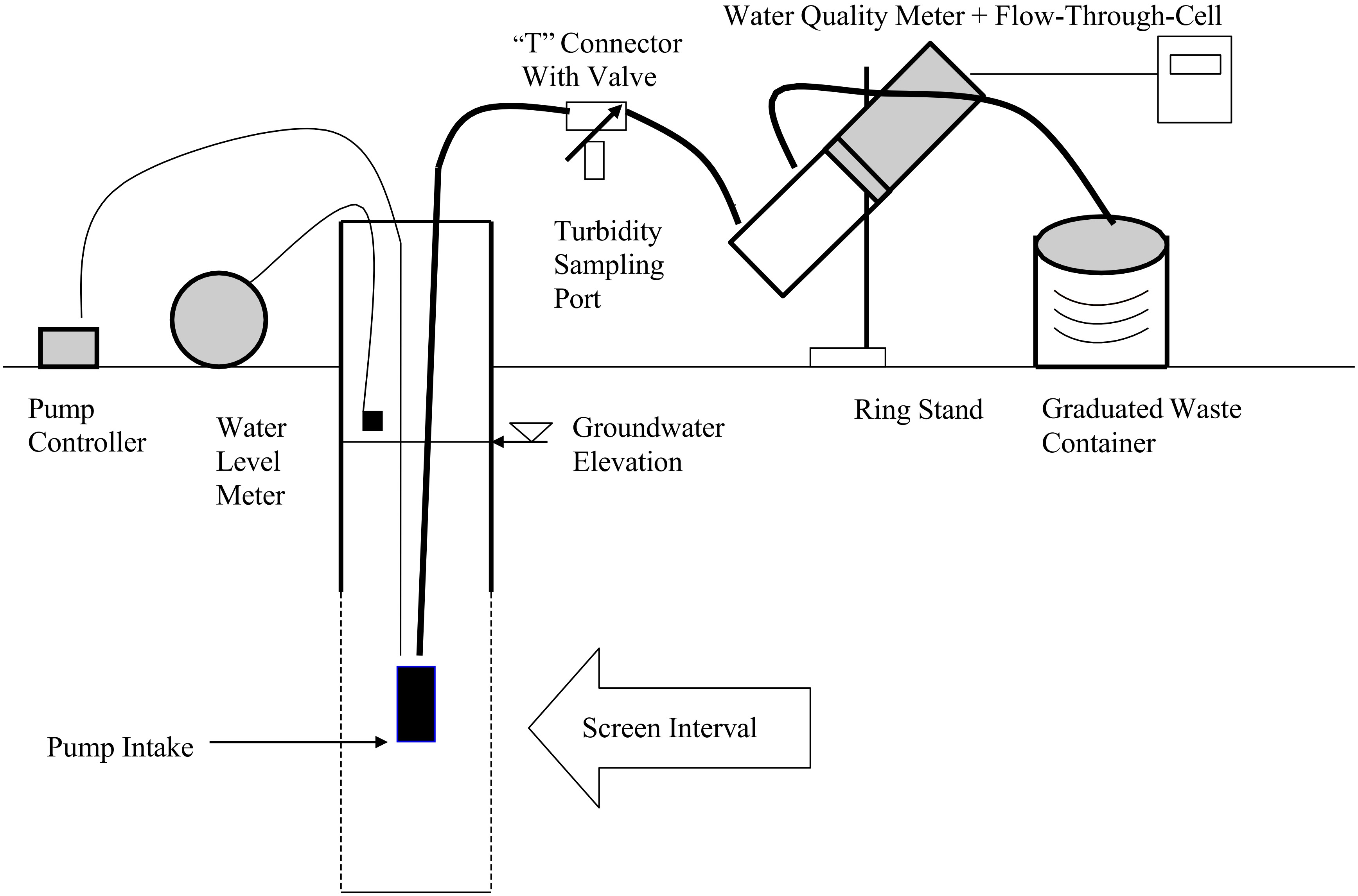
If the pump's tubing is not completely filled with water and the samples are being collected for VOCs and/or dissolved gases analyses using a centrifugal or peristaltic pump, do the following:

> All samples must be collected and preserved according to the analytical method. The VOCs and the dissolved gases (e.g., methane, ethane, ethene, and carbon dioxide) samples are collected last. When it becomes time to collect these samples increase the pump's flow rate until the tubing is completely filled. Collect the samples and record the new flow rate.

12. Store the samples according to the analytical method.

13. Record the total purged volume (graduated waste bucket). Remove the pump from the well and decontaminate the sampling equipment.

Low-Flow Setup Diagram



APPENDIX C

EXAMPLE (Minimum Requirements)

WELL PURGING-FIELD WATER QUALITY MEASUREMENTS FORM

Location (Site/Facility Name)________________________________
Well Number_________________ Date_________________________
Field Personnel____
Sampling Organization_______________________________________
Identify MP____

Depth to _________/________ of screen
(below MP) top bottom
Pump Intake at (ft. below MP)_________
Purging Device; (pump type)__________
Total Volume Purged _______________

Clock Time 24 HR	Water Depth below MP ft	Pump Dial[1]	Purge Rate ml/min	Cum. Volume Purged liters	Temp. "C	Spec. Cond.[2] µS/cm	pH	ORP[3] mv	DO mg/L	Tur-bidity NTU	Comments

Stabilization Criteria 3% 3% ±0.1 ±10 mv 10% 10%

1. Pump dial setting (for example: hertz, cycles/min, etc).
2. µSiemens per cm(same as µmhos/cm)at 25°C.
3. Oxidation reduction potential (ORP)

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A.3 – Laboratory Standard Operating Procedures

eurofins	Always check on-line for validity. **VOCs and GRO by GC/MS in Waters and Wastewaters by EPA 8260C/D**	Level: **Work Instruction**
Document number: **T-VOA-WI8194**		
Old Reference: **1-P-QM-WI- 9013078**		
Version: **11**		Organisation level: **5-Sub-BU**
Approved by: **XL3S** Effective Date: **11-MAY-2022**	Document users: **6_EUUSLA_GC/MS Volatiles_GC/MS Auditors/Verifiers, 6_EUUSLA_GC/MS Volatiles_Level II Peer Review, 6_EUUSLA_GC/MS Volatiles_Management, 6_EUUSLA_GC/MS Volatiles_SW846 8260B/C Water**	Responsible: **5_EUUSLA_GC/MS Volatiles_Manager**

Revision Log

	Revision: 11	**Effective Date:** This version
Section	**Justification**	**Changes**
Revision Log	Formatting requirement per G-DC-SOP16244	Removed revision logs up to the previous version
Header	Update	Added UST LIMs IDs

	Revision: 10	**Effective Date:** 08.APR.2021
Section	**Justification**	**Changes**
Revision Log	Formatting requirement per G-DC-SOP16244	Removed revision logs up to the previous version
Cross Reference	Update	Added reference to QA SOP for information regarding LLOQ
Reagents and Standards 2.d	Correction	Updated TSC Figure references
Calibration D	Enhancement	Added reference to Figure 3 for preparation
Quality Assurance/ Quality Control	Enhancement	Added reference to QA SOP for LLOQ procedure

	Revision: 10	**Effective Date:** 08.APR.2021
Section	**Justification**	**Changes**
Table 2	Clarification	Added note concerning alternative ion selection for quantitation
Figure 1-7	Update	Added Figure # and updated method to include 8260D, removed 8260A

Reference

1. Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), SW-846 Method 8260C, August 2006.

1. Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), SW-846 Method 8260D, June 2018.

2. Determinative Chromatographic Separations, SW-846 Method 8000D, Revision 4, July 2014.

3. Purge and Trap for Aqueous Samples, SW-846 Method 5030B, December 1996.

4. Purge and Trap for Aqueous Samples, SW-846 Method 5030C, Rev 3, May 2003.

5. *Total Petroleum Hydrocarbons Analysis-Gasoline Method*, California Department of Health Services, LUFT Task Force.

6. *Chemical Hygiene Plan*, current version.

Cross Reference

Document	Document Title
T-VOA-WI7691	Glassware Washing
T-VOA-WI7619	GC and GC/MS Instrumentation Maintenance
T-VOA-WI7629	GC/MS Volatile Standards Traceability
T-VOA-WI7692	Preparation and Analysis of Cleaning Blanks for GC and GC/MS Volatiles
T-VOA-WI8373	GC/MS Volatiles Audit Process
T-VOA-WI8400	Level II Review of GS/MS Volatiles
QA-SOP11892	Determining Method Detection Limits and Limits of Quantitation

Scope

This method is suitable for the determination of the target compounds listed and maintained in the LIMS (Laboratory Information Management System) for aqueous matrices. Associated MDLs/LOQs are also listed in the LIMS under the analysis number and/or Project Information lists. Non-target volatile compounds in the sample can be tentatively identified (TIC) using a mass spectral reference library comparison. This analysis must be performed by or under the direct supervision of an operator experienced in the analysis of volatile organics by purge and trap GC/MS methodologies and skilled in mass spectral interpretation. Using this method, the TICs are quantitated with an estimated concentration. Compounds other than those listed in the LIMS for this group of master scans are analyzed using USEPA SW-846 Method 8260C. Theoretical Standard Calibration (TSC) Sheets are included in the Appendix (Figures 1-7). These TSC sheets are to serve as examples only and may not reflect most current version in use. Due to poor purging efficiency or poor gas chromatographic performance, some analytes require calibration at higher levels and higher practical quantitation limits (PQLs). Any additional compounds must be added to the theoretical standard concentrations (TSC) sheet. Standards containing additional analytes must be prepared as described in the Standards section of this document. Both secondary stock solutions and matrix spike solutions must be prepared for use in analyzing additional compounds.

Basic Principles

A 5-mL or 25-mL sample or a dilution of a sample is placed in a specially designed purge vessel. The sample is purged with an inert gas and the effluent gas passed through a sorbent tube where the volatile organics are trapped. After purging, the sorbent trap is rapidly heated and backflushed on to the head of a gas chromatographic (GC) capillary column. The GC column is temperature programmed to separate the volatile compounds, which are subsequently detected and identified using mass spectrometric techniques.

When a compound reaches the Mass Spectrometer, it is bombarded by high-energy electrons (70 eV). This causes the compound to fragment and form ions. The positive ions are focused into a quadrupole mass analyzer, where the ions are separated according to their mass/charge ratios during rapid repetitive scans. These ions are then amplified and detected with an electron multiplier.

The resulting time/intensity/mass spectra data are stored and processed by a computer. Target compounds are identified on the basis of relative retention times and mass spectral matches to standards, which are injected every 12 hours on the same system. The internal standard method is used for quantitation.

The GRO analysis is typically performed in conjunction with the analysis of other volatile target compounds by SW-846 Method 8260C. The GRO quantitation range is 0.1 minutes before the peak apex of C6 (hexane) to 0.2 minutes after the peak apex of C12 (dodecane); however, other ranges can be established. By establishing a (C12) GRO window to 0.2 minutes following the elution of dodecane, the areas from a trio of unresolved peaks eluting near to the upper limit of the range must consistently be included in the total GRO area. In addition, the range remains tight enough to ensure that no C13 or greater compounds can be included in the total GRO area. The C4 range retention time is determined by selecting the first peak after the air and/or artifact peak minus 0.1 minutes in the first standard analyzed in the ICAL. The C5 range retention time is 0.1 minutes before the peak apex of pentane. This analysis must be performed by or under the direct supervision of an operator experienced in the analysis of volatile organics by GC/MS purge and trap methodologies. The area of the total ion chromatogram for the GRO range is determined. The area of the internal standards and surrogate standards are found and subtracted from the total area of the chromatogram within the desired time range. The resulting area is then quantitated versus the internal standard, fluorobenzene.

Interferences

Contaminant sources are volatile compounds in the laboratory environment, impurities in the inert purging gas, carryover from samples containing high concentrations of volatile organic compounds and dirty glassware. The analyst must demonstrate that the system is free from interferences (by producing acceptable method blank data) before analyzing a batch of samples. Matrix effects from heavily contaminated waters can interfere with the internal standard responses, target analytes and surrogate recoveries, thereby hindering accurate quantitation. See Section 4.0 of SW-846 Method 8260C for further discussion.

Safety Precautions and Waste Handling

All laboratory waste is accumulated, managed, and disposed of in accordance with all federal, state, and local laws and regulations.

See *Chemical Hygiene Plan* for general information regarding employee safety, waste management, and pollution prevention.

The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; therefore, each chemical compound must be treated as a potential health hazard. Exposure to these chemicals must be reduced to the lowest possible level by whatever means available, such as the use of fume hoods, safety glasses, lab coats, and gloves. Neat compound sources and stock solutions must be collected into a lab pack upon expiration. The lab pack is delivered to Safety personnel for appropriate disposal. Expired secondary standard solutions in methanol must be disposed of as solvent waste. Pour expired secondary standard solutions into the appropriate solvent waste collection container. Aqueous calibration standard mixes are disposed of as nonhazardous aqueous waste due to the low concentration. Samples with a pH ≤2 are taken to storage until disposal in an acid waste container.

Personnel Training and Qualifications

Education Requirement: A 4-year Baccalaureate Degree from an accredited College or University in one of the physical sciences and/or one to three years of relevant gas chromatography experience.

Analysts must be trained in the proper method of volatile organic sample preparation and analysis as determined by the supervisor(s). All training and education relating to volatile organic sample preparation and analysis must be documented by each analyst in his/her training record. Specifically, each new chemist trains with an experienced chemist for the first 12 weeks depending on the individual and his/her previous experience. The first 12 weeks are spent working one-on-one with the trainer. This time is less if the new chemist has prior relevant experience in GC/MS and/or analytical chemistry background.

During the training period, the new chemist learns daily maintenance, calibration techniques, data and library search review, and forms generation. He/she is also required to read all relevant SOPs and EPA methods. All personnel performing this procedure must have documentation of reading, understanding, and agreeing to follow the current version of this SOP. Each analyst must perform an Initial Demonstration of Capability to measure proficiency. Thereafter, an annual Demonstration of Capability is performed and maintained in the analyst’s training records.

NOTE: A separate Demonstration of Capability for GRO is required.

Sample Collection, Preservation, and Handling

The samples to be analyzed with this method must be stored in a refrigerator at 0°C to 6°C, not frozen. Samples are collected in 40-mL vials with no headspace. Preserve samples to a pH of <2 in order to prevent degradation of aromatic compounds that are present in the sample. 1:1 HCL is the recommended preservative. Preserved samples must be analyzed within 14 days of collection; those that are not preserved must be analyzed within 7 days of collection. Samples to be tested for Acrolein and Acrylonitrile must be collected without headspace in vials that are preserved to a pH range of 4.0 to 5.0 and must be analyzed within 7 days of collection. Samples may also be submitted in unpreserved vials for Acrolein and Acrylonitrile, but must be analyzed within 3 days of collection. Unpreserved samples from South Carolina for Acrolein and Acrylonitrile do not meet RCRA requirements and must be qualified. Samples submitted outside of the pH range or analyzed outside of the specified holding time windows will be reported with a comment on the final analytical report.

Apparatus and Equipment

1. Gastight micro-syringes – 1 to 1000 µL (various sizes)

2. 5-mL gastight syringes

3. Analytical balance, capable of accurately weighing ±0.0001 g

4. Glassware

    a. Class-A Volumetric flasks with ground-glass stopper

    b. Vials, 1.5-mL, 15-mL, and 40-mL screw cap, with Teflon™/silicone septa

    c. Mininert vials, 1 mL, 2 mL, and 5 mL

5. Purge and trap device – Consisting of the sample purger, the trap, and desorber; the OI Analytical 4560, OI Analytical 4660, or equivalent meets the requirements of this method. The purging chamber must have the purge gas passing through the sample as finely divided bubbles and minimize the headspace between the sample and the trap to <15 mL.

6. Autosampler – OI Analytical 4551, OI Analytical 4552, Archon, or equivalent meets the requirements of this method.

7. Spiker unit – OI analytical Model 4551/4552 SAM/Spiker or equivalent. One or two automated syringe spikers can be added to the OI Analytical Model 4551/4552 autosampler to automatically introduce 1 µL of internal standard (ISTD), surrogate standard, and/or matrix spiking solutions to the sample as it is being transferred to the sparge vessel. The Archon has a groove that can deliver 1 µL of appropriate standards.

8. GC/MS system – The Agilent 5890GC/5972 MSD, Agilent 6890GC/5973MSD, Agilent 6890GC/5975MSD and Shimadzu GC/MS QP5000 meet the requirements for this method.

9. Data System/Computer/Software – this is interfaced to the GC/MS system that continuously acquires and stores data during the analysis, and can process/reduce data to generate the appropriate forms and supporting data. The software used for acquisition is HP Chemstation®, and data reduction is accomplished using Target® software.

10. GC Columns

    a. Column 1 – 30M × 0.25 mm ID DB624 capillary column with a 1.4-µm film thickness from Agilent, or equivalent (to be used with the Shimadzu QP5000 or the Agilent 5972, 5973 and 5975 MSDs)

    b. Column 2 – 20M × 0.18 mm ID DB624 capillary column with a 1.0-µm film thickness from Agilent, or equivalent (to be used with the Shimadzu QP5000 or the Agilent 5972, 5973 and 5975 MSDs)

    c. Column 3 – 20M × 0.18 mm ID DB-VRX capillary column with a 1.0-µm film thickness from Agilent, or equivalent (to be used with the Shimadzu QP5000 or the Agilent 5972, 5973 and 5975 MSDs)

    NOTE: Refer to *T-VOA-WI7619* for instrumentation maintenance and troubleshooting.

Reagents and Standards

A. Reagents

1. Reagent water is defined as water in which an interferent is not observed at or above the reporting limit for parameters of interest. In general, the deionized water supplied at the taps in the laboratory meets these criteria. If the reagent water does not meet the requirements, see your supervisor for further instructions.

2. Methanol, Purge and Trap Grade or equivalent.

B. Standards

See *T-VOA-WI7629* for standards traceability.

1. Stock standard solutions – Stock solutions must be prepared in methanol. Standards are prepared from ampulated and neat compounds obtained from suppliers that indicate the purity of the compound. No correction for purity is made if the purity is listed as ≥96%. Pre-made solutions can be used if the supplier documents the concentrations of the solutions. All ampulated standards are stored at ≤-10°C until the expiration date indicated by the vendor or for 1 year if no expiration date is provided.

a. For most of the target compounds, the stock standard solutions are purchased from a vendor as custom mixes (V for calibration and Q for separate source quality control). The internal and surrogate standards are purchased from a vendor, as well as the target compounds that are gases at room temperature. These gaseous standards have a 1-week expiration date, starting from the date they are opened.

b. 8260A Surrogate standard spiking solution (8260SS) – a 2500 µg/mL stock standard solution of dibromofluoromethane, toluene-d8, 4-bromofluorobenzene, and 1,2-dichloroethane-d4 is prepared in methanol by a commercial supplier.

c. 8260A Internal standard spiking solution (8260IS) – a 2500 µg/mL stock standard solution of fluorobenzene, chlorobenzene-d5, 1,4-dichlorobenzene-d4, and 12500 µg/mL deuterated tertiary butyl alcohol (tBA-d10) is prepared in methanol by a commercial supplier. Deuterated tertiary butyl alcohol (tBA-d10) is used sometimes as an auxiliary ISTD.

d. GRO calibration standard – a 5500-µg/mL stock unleaded gasoline composite prepared in methanol by a commercial supplier.

e. GRO QC standard – a 20,000-µg/mL stock unleaded gasoline composite prepared in methanol by a commercial supplier

To prepare stock standards from neat compounds:

(1) Place about 9.8 mL methanol or an equivalent solvent into a tared 10.0-mL glass-stoppered volumetric flask. Weigh the flask to the nearest 0.1 mg.

(2) Add the liquids using a syringe or pipette by adding 2 or more drops of the assayed material to the flask, being careful that no drop hits the side of the flask. Reweigh the flask, record/note the amount, dilute to volume, stopper, and mix by inverting the flask at least 3 times. Calculate the concentration of the standard.

(3) The stock standard solutions are stored in Teflon™-sealed screw-capped vials at ≤-10°C. The compound name, concentration, date prepared, expiration date, preparer name and storage method must appear on the bottle.

(4) Replace in-house prepared stock standard solutions every 6 months.

2. Secondary dilution standards - Using the stock standard solutions, prepare secondary stock solutions in methanol containing the desired compounds. These standards are prepared by calculating the volume of each stock standard required to produce a given volume of a mixed working standard with a known concentration of each analyte. When custom mixes are used, these are diluted down individually or combined together with other mixes. The working standard is tested according to *T-VOA-WI7629*. The verified working standard is poured into Teflon-lined screw-capped GC vials or mininert vials and stored at ≤-10°C. A designator indicating the standard name, month, and day of preparation and expiration date must be on the standard vials. The designator and all data pertaining to the working standard preparation are to be recorded in the standards logbook. Replace secondary dilution standards every 2-4 weeks (1 week for standards containing gases) unless otherwise indicated.

a. 1,4-Bromofluorobenzene (BFB) standard – Prepare a 50-µg/mL solution of BFB in methanol by diluting the stock standard (prepared from neat material) with methanol to a final volume of 100 mL. The volume of stock standard used varies depending on the actual stock concentration.

b. IS/SS spiking solution – Dilute 1 mL of 8260IS and 1 mL of 8260SS with methanol to 10-mL final volume (resulting in a concentration of 250 µg/mL, 1250 µg/mL for tBA-d10). This is assuming a 1-µL groove in the autosampler. If the groove is determined to be other than 1 µL, the standard preparation must be adjusted so that appropriate final concentration is obtained.(50& µg/L for 5-mL purge, 10 µg/L for 25-mL purge).

c. Calibration spiking solution – Prepare solutions in methanol that contain the compounds of interest at known concentrations. Suggested calibration levels are 1, 4, 10, 20, 50, 100, and 300 ppb for 5-mL purge analysis. Suggested calibration levels are 0.2, 0.5, 1, 2, 5, 10, and 25 ppb for 25-mL purge analysis. A Theoretical Standard Concentration (TSC) sheet is filled out for all initial calibrations (see Figures 1, 2, and 5). Replace calibration spiking solution every 2-4 weeks (1 week for standards containing gases).

d. Matrix spiking solution – Prepare second source solutions in methanol that contain the compounds of interest at known concentrations. A TSC sheet is filled out for all quality control samples (see Figures 3, 4 and 6). These solutions serve as both the matrix spiking solution and the laboratory control sample solutions. Matrix spikes also serve as duplicates. Therefore, two aliquots of the same sample need to be spiked for analysis with these solutions. Replace matrix spiking solution every 2-4 weeks (1 week for standards containing gases).

Store all standard solutions at ≤-10°C and protected from light.

Preparation of Glassware

All glassware is cleaned according to *T-VOA-WI7691*.

Calibration

A. Instrument conditions

1. The purge and trap device must have the trap conditioned for at least 10 minutes at 180° to 220°C at a flow rate of 20 to 60 mL/min prior to initial use.

2. An example of purge and trap conditions are listed below:

Purge Gas	Helium
Purge Flow	35 - 45 mL/min
Purge Temperature	40°C for 8260C waters
Purge Time	11 minutes
Desorb Temperature	190°- 220°C
Desorb Time	0.5 to 4 minutes **
Bake Temperature	180°-220°C
Bake Time	5 – 16 min

**Range as suggested by the purge and trap instrument manufacturer

NOTE: Purge and trap conditions are changed to optimize instrument operations. A record of actual purge and trap conditions for each instrument is found in the appropriate instrument maintenance log.

3. The suggested gas chromatographic operating conditions are listed in the table below, depending on the column used:

	Column 1	**Column 2**	**Column 3**
Column liquid phase	DB-624	DB-624	DB-VRX
Carrier gas	Helium	Helium	Helium
Carrier gas flow	0.8 mL/min	0.6 mL/min	0.6 mL/min
Make-up gas flow	None	None	None
Initial temperature	45°C	45°C	45°C
Initial hold time	4.5 min	2.5 min	4 min
Temperature ramp	12°/min until 100°C then 25°/min until 240°C	12°/min until 100°C then 25°/min until 235°C	25°/min until 60°C then 36°/min until 240°C
Final temperature	240°C	235°C	240°C
Final hold time	None	.02 min	1 min

4. The recommended mass spectrometer operating conditions are listed below:

Mass range:	35 – 300 amu
Scan time:	One scan cycle per second or less and resulting in at least five scans per chromatographic peak

NOTE: It is not necessary to use the exact parameters listed above. Equivalent columns and conditions that give the performance required by the method are acceptable.

B. Tuning

Tune the GC/MS system to meet the criteria in Table 1 following a 50-ng injection of BFB. The chromatographic conditions must be the same as those under which the samples are analyzed except that the temperature ramp is increased and the initial temperature and flow rate is different. The BFB tune must be verified every 12 hours.

The tune must be evaluated by taking the average of the three scans across the BFB peak apex with a background subtraction of a scan within 20 scans prior to the start of the BFB peak.

NOTE: All standards, samples, and associated quality control samples must be analyzed with the same MS parameters as those used to obtain a successful tune.

C. Initial calibration

1. The initial internal standard calibration consists of analyzing seven distinct levels of analyte concentrations and producing response factors for each compound (six levels are required if second order regression fits are used). Calibration for GRO consists of analyzing six distinct levels of GRO area in order to produce a response factor for the GRO quantitation range of interest using the internal standard, fluorobenzene. The relative standard deviation of the response factor determines the suitability of the average relative response factor for calculation of the GRO concentration. Refer to Figure 1, 2 or 5 for the preparation of the calibration standards and Figure 7 for preparation of GRO standards. The relative standard deviation of the response factors determines the suitability of the average relative response factor for calculation of the analyte concentration. Prior to the analysis of any calibration level, retention time markers must be run for the GRO range of interest. The retention time markers are hexane (C6) and Dodecane (C12). Other markers can be used if different ranges are required by a project.

NOTE: 5 levels of standard are required by the method.

a. When using an OI 4552 or OI 4551 autosampler, the standards (including target and surrogate compounds) are prepared and poured into 40-mL vials with Teflon™-lined septa. A 5-mL or 25-mL aliquot is withdrawn from the vial by the autosampler. The aliquot is transferred through the spiker unit to add the IS/SS spiking solution and then transferred to the sparge vessel.

b. Purge and desorb according to instrument conditions listed in Calibration A.

c. Collect GC/MS data until the end of the GC run.

d. Empty and rinse the purging chamber at least twice with reagent water prior to loading another sample into the vessel, to minimize the possibility of carryover contamination.

e. Each level is analyzed as described above. Next, tabulate the area response of the characteristic ions (Table 2) against concentration for each analyte, surrogate standard, and internal standard and calculate relative response factors (RRF) for each compound (see Calculation section). The calibration is valid for 12 hours from the injection of the BFB tune standard, at which time a new tune check and a continuing calibration check standard are evaluated prior to the analysis of additional samples. The following table describes the guidelines for an acceptable initial calibration:

Frequency	Acceptance Criteria	Corrective Action
Initially and then when analytes in the daily calibration standard fail criteria.	1. % RSD of≤20% is required for all analytes. 10% of the analytes may fail this criteria. 2. The relative retention times of the target compounds must agree within 0.06 relative retention time (RRT) units. The exception would be in the case of system maintenance. 3. Minimum response factors must be met for select compounds. See Table 3.	1. Any target analyte with a %RSD of ≤20% must use the average RRF for quantitation. For any analyte in which the %RSD >20%, a first-degree linear regression can be used (providing that the correlation coefficient [CC] is ≥0.995). A quadratic fit ** (using 6 stds) can also be used (provided the coefficient of determination [CD] is >0.99). If the linear fit and quadratic fit pass the criteria for any given analyte, then use the line/curve with the smallest positive y-intercept. If the y-intercept quantifies to be greater than the LOQ, consult your supervisor immediately or recalibrate. If CC or CD is <0.995 for linear or <0.99 for quadratic, recalibrate. Supervisory approval is required for exceptions to these guidelines. If >10% target analytes fail, recalibration is required. If a linear or quadratic curve fit is used for a target analyte, the calibration data must be refit back into the calibration model for all calibration levels. Percent error between the calculated and expected amounts of an analyte should be ≤30% for all standards. For some data uses, ≤50% may be acceptable for the lowest calibration point. NOTE: Quadratic regression cannot be used for South Carolina compliance samples. 2.-3. Perform system maintenance and recalibrate.

**Consult USEPA method 8000D for non-linear curve fitting techniques/guidelines

f. Each level is analyzed as described above. Next, tabulate the area response for the GRO quantitation range minus the peak areas for the internal and surrogate standards that elute within the GRO range. Calculate the relative response factor (RRF) for GRO (see Calculation section) using the internal standard peak area for fluorobenzene. Although four internal standard compounds are spiked for the 8260C analysis, only one, fluorobenzene, is used for the quantitation of the GRO result.

Calculate the average relative response factors for the GRO quantitation range of interest. The calibration levels are evaluated on the basis of the relative standard deviation of the RRF values (%RSD). The %RSD for the GRO range of interest must be ≤20%. If the calibration meets this requirement then the average RRF is used to calculate sample concentrations. If the %RSD is >20% then re-analysis of one or more levels can be necessary before the calibration is valid.

D. Following the calibration, an Initial Calibration Verification (ICV) standard must be run. The ICV acts as a second source standard to check against the initial calibration. All analytes must meet ICV acceptance windows of 70%-130% and is prepared according to the TSC sheet in Figure 3. If the ICV does not meet the aforementioned criteria, a second ICV is analyzed before invalidating the initial calibration. Upon failure of the second ICV, the system must be recalibrated after proper corrective action is taken. For the GRO analysis, the ICV is prepared according to the TSC sheet in Figure 7 (QC prep). The ICV acts as a second source standard to check against the initial calibration. Results must quantitate within the 70-130% window. If the ICV does not meet the aforementioned criteria, a second ICV can be run before invalidating the initial calibration. Upon failure of the second ICV, the system must be recalibrated after proper corrective action is taken.

E. Continuing calibration verification (CCV) – The CCV is performed by analyzing a CCV standard in subsequent tune periods after an initial calibration. The CCV (prepared daily due to aqueous nature) is analyzed at 50 ppb for 5-mL purge waters and 10 ppb for 25-mL purge waters. The CCV is considered valid when the criteria listed below are met:

Frequency	Acceptance Criteria	Corrective Action
Every 12 hours.	1. % Drift of ≤20% is required for all analytes. No more than 20% of analytes may fail this criteria if not detected in proceeding samples. 2. The relative retention times (RRT) of the target compounds must agree within 0.06 RRT units. The exception would be in the case of system maintenance. 3. The extracted ion current profile (EICP) area for each internal standard must fall within the window of −50 % to +100 % from the mid-level standard area produced during the last initial calibration. 4. Minimum response factors must be met for select compounds. See Table 3.	1.-4. In the event that the continuing calibration verification (CCV) standard fails any of these criteria, sample analysis must be suspended and the CCV must be re-analyzed. If the re-analysis fails any of the criteria then adjustments are to be made to the analytical system to return it to its original condition, followed by the analyses of 2 consecutive CCVs at the same level that failed. If both CCVs pass the criteria, then sample analysis can continue. Otherwise, the system must be recalibrated and the samples reanalyzed, or the data can be qualified.

A 1100-ppb standard (prepared daily due to aqueous nature) is analyzed for the GRO analysis. The calibration is considered valid if the percent drift is ≤20%. Also, the internal standard peak area of fluorobenzene for the CCV is monitored against the mid-point standard of the initial calibration and must be −50% to +100% of the area counts. If any criteria listed above fails, the CCV is considered invalid. In the case where two consecutive CCVs fail, corrective action must be taken which can include re-analysis of the calibration check, instrument maintenance, and/or recalibration. If the criteria are met, the selected quantitation method from the initial calibration is used for blank and sample calculations until the end of the 12-hour period.

F. MDL Sensitivity Check- A MDL Sensitivity Check must be analyzed in cases where compounds fail to meet the % drift criteria in the CCV and have decreased sensitivity (-20% drift or greater). Affected compounds can be reported as non-detects if it is demonstrated that there is adequate sensitivity to detect the compound at the MDL. If the failed compound is detected, the concentration must be reported as an estimated value.

Procedure

A. Method Blank

Analyze the method blank as described above for the initial calibration standards using reagent water. Refer to table in QA/QC section for specific requirements. The method blank is examined for interfering peaks. Any target compound peaks are calculated as described under the Calculations section of this procedure. All compounds must be less than the reporting limit for the associated samples. If the blank values exceed these values, corrective action must be taken and the method blank reanalyzed until the criteria are met. The method blank must be analyzed before processing any samples.

B. Laboratory Control Sample/ Duplicate and Matrix Spike/Duplicate: Refer to table in QA/QC section for specific requirements.

C. Qualitative analysis

A compound is identified by comparison of the following parameters with those of a standard of this suspected compound (standard reference spectra). In order to verify identification, the following criteria must be met:

1. The intensities of the characteristic ions of the compound must maximize in the same scan or within one scan of each other.

2. The compound relative retention time must compare within ±0.06 RRT units of the RRT of the standard.

3. The characteristic ions from the reference mass spectrum are defined to be the three ions of greatest relative intensity, or any ions over 30% relative intensity if less than three such ions occur in the reference spectrum.

4. The relative intensities of the characteristic ions must agree within 30% of the relative intensities of these ions in the reference spectrum. Analyst discretion is used to determine compound identification. Example: for an ion with an abundance of 50% in the reference spectrum, the corresponding abundance in a sample spectrum can range between 20% and 80%).

5. The above criteria apply to hits greater than or equal to the LOQ. For hits between the MDL and the LOQ, both the criteria listed above and the analyst’s discretion is used to determine compound identification.

6. The analyst must account for peaks that are greater than 10% relative intensity in the sample mass spectrum, but not present in the standard mass spectrum. Also, if a compound fails any of the criteria listed above but in the judgment of the mass spectral interpretation specialist is a correct identification, the identification is used and the quantitation of the peak is performed.

The primary and secondary ions for the target compounds can be found in Table 2.

7. For GRO, the Total Ion Chromatogram (TIC) is reviewed to insure proper integration around the 8260 surrogates and internal standards. Also the TIC is checked to make sure all major peaks are integrated.

D. Quantitative analysis

Once a compound has been identified, quantitation is based on the internal standard technique and the integrated area from the extracted ion current profile (EICP) of the primary characteristic ion. The list of primary characteristic ions is listed in Table 2.

The quantitation of the GRO range is performed using the equations listed in the Calculations section of this procedure. All calculations must report concentrations in values of µg/L. In the case where the total GRO concentration exceeds the calibration range, the sample is re-analyzed at a dilution that brings the GRO concentration within the calibration range of the GC/MS system.

E. Sample Analysis

A 5-mL or 25-mL aliquot of the sample is analyzed using the same instrumental conditions as the standard (whether ICAL or CCV), tune and method blank. If the QA criteria are satisfied and no target compounds are detected at concentrations above the calibration range, the results can be reported. To avoid possible matrix effects, sample carryover and re-analyses, an initial dilution is performed if:

1. Prescreening indicates a high volatile organic content in the sample

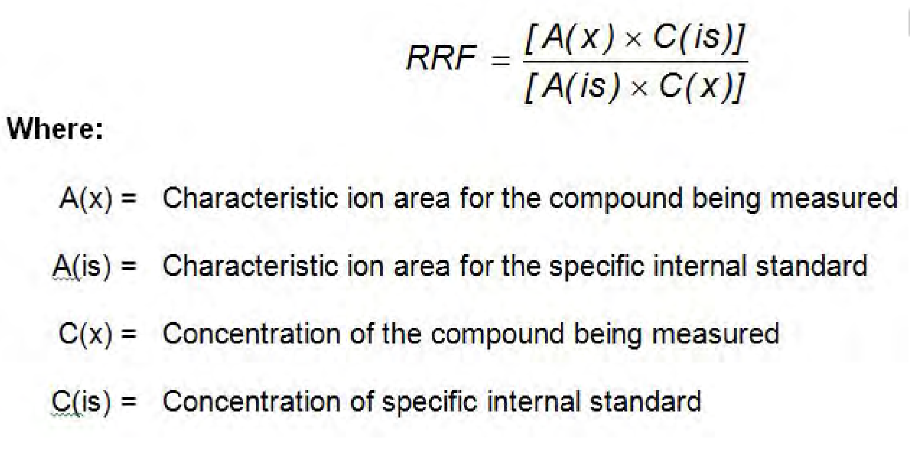
2. Historical data (or lack thereof) and/or sample appearance indicate a need for dilution

If target compounds are detected in the sample at concentrations above the calibration range, a dilution must be performed (See *T-VOA-WI7692* for information on when cleaning blanks must be run). See Section 11.5.6 in method SW-846 8260C for recommended dilution procedures.

Calculations

A. Calibration calculations

1. Calculation of the relative response factor (RRF):



$$RRF = \frac{[A(x) \times C(is)]}{[A(is) \times C(x)]}$$

Where:

A(x) = Characteristic ion area for the compound being measured

A(is) = Characteristic ion area for the specific internal standard

C(x) = Concentration of the compound being measured

C(is) = Concentration of specific internal standard

2. Regression Equations:

1st Order (linear) regression: Y = MX + B

2nd order (quadratic) regression: Y = CX2 + MX + B

Where:
x = Area(Std) /Area(Istd)
Y = Conc.(Std)/Conc.(Istd)
M = 1st degree slope
C = 2nd degree slope
B = Y-intercept

3. Percent relative standard deviation (%RSD):

$$\% \ RSD = \frac{Standard\ Deviation}{Mean} \times 100$$

4. Calculation of the percent drift:

$$\% \ Drift = \frac{C(i) - C(c)}{C(i)} \times 100$$

Where:
C(i) = Calibration check compound standard concentration
C(c) = Measured concentration using selected quantification method

B. QA Calculations

1. Calculation of percent recovery

$$\% \ Recovery = \frac{SSR - SR}{SA} \times 100$$

Where:
SSR = Spiked sample result
SR = Sample result
SA = Spike added

2. Relative percent difference (RPD):

$$RPD = \frac{MSR - MSDR}{(1/2)\ (MSR + MSDR)} \times 100$$

Where:
MSR = Matrix spike measured concentration
MSDR = Matrix spike duplicate measured concentration

3. Analyte Concentration

$$Concentration\ (\mu g/L) = \frac{(Ax)(Is)}{(Ais)(RRF)}$$

Where:

Ax = Area of the quantitation ion peak for the compound to be measured
Ais = Area of the quantitation ion peak for the appropriate internal standard
Is = Concentration of internal standard added in µg/L
RRF = Relative response factor from the initial calibration

Statistical Information/method Performance

The LCS must contain 80% to100% of the compounds in the calibration mix. LCS, MS, and surrogate recoveries and RPD are compared to the limits stored on the LIMS. These limits are statistically derived but must fall within 70% to 130% recovery for South Carolina compliance samples. Historical data for MS/Ds, LCS/Ds, measurement of uncertainty, is reviewed at least annually. Reporting limits including method detection limits (MDLs) and limits of quantitation (LOQs) are set according to EPA method requirements and are evaluated on an annual basis in accordance with 40 CFR Part 136. The MDLs are maintained in the LIMS. Updates to the LIMS are made as needed by the QA Department and only as directed by the supervisor. The department database is updated via a download from the LIMS.

Quality Assurance/Quality Control

Each analysis batch (consisting of no more that 20 samples) must contain a method blank, a laboratory control sample (LCS), and either an unspiked background sample (US), a matrix spike (MS), a matrix spike duplicate (MSD), a laboratory control sample/laboratory control sample duplicate (LCS/LCSD) or a duplicate (DUP). The LCS serves as a 2nd source standard verification of the initial calibration (ICAL). Additional QC samples are required to meet project or state certification requirements. Every sample or QC analysis must contain internal standards and surrogate compounds at a concentration of 50 µg/L for a 5-mL purge or 10 µg/L for a 25-mL purge. For South Carolina samples, an LCS duplicate (LCSD) is only necessary per client request, or when adequate sample volume is not provided to prepare a matrix spike and matrix spike duplicate (MS/MSD). It is not appropriate to prepare and analyze an LCSD with each batch of samples if adequate sample volume has been provided for a MS/DUP or MS/MSD.
The laboratory will establish the Lower Limit of Quantitation (LLOQ) at concentrations where both quantitative and qualitative requirements can consistently be met for 8000D. The LLOQ is the lowest concentration at which the laboratory has demonstrated target analytes can be reliably measured and reported with a certain degree of confidence, which must be ≤ the lowest point in the calibration curve. The LLOQ/LLOQVs (Limit of Quantitation Verifications) are analyzed once per instrument per quarter. See SOP *QA-SOP11892*.

The GC/MS system must be tuned to meet the criteria in Table 1 following BFB injection. The chromatographic conditions must be the same as those under which the samples are analyzed except that the rate of temperature ramping may be increased and the initial temperature and column flow may be different. The BFB tune must be verified every 12 hours.

Quality Control Item	Acceptance Criteria	Corrective Action
1. Internal Standards Added to every sample, standard, method blank and QC sample	1. Peak areas within -50% to +100% of the area in the associated reference standard. 2. Retention time (RT) within 30 seconds of RT for associated reference standard.	1. Check instrument for possible problems and then reanalyze samples. 2. If re-injecting meets the criteria, report this analysis. 3. If this reanalysis still shows the same problem, report results from first analysis and qualify data with a comment.
2 Surrogates Added to every sample, standard, method blank and QC sample	All % recoveries must fall within statistically derived QC limits, which are evaluated on a semi-annual basis.	If non-compliant, check for calculation or preparation errors. If no errors are found, check system for problems and reanalyze. If this reanalysis still shows the same problem, report first analysis and qualify data with a comment. If recoveries are outside of specification high and no target compounds are detected, then a reanalysis or comment is not required.

Quality Control Item	Acceptance Criteria	Corrective Action
3 Method Blank (MB) Performed during each tune period after the initial calibration or CCV (minimum of 1 MB per 20 samples)	1. Must meet internal standard criteria. 2. Must meet surrogate criteria. 3. Quantitative results for all target compounds must be less than the reporting limit for the associated samples.	1.-2.Inspect system for possible problems and reanalyze. 3. If the MB contains target analytes and the associated samples do not, then no corrective action is required. If the target compounds in the MB are also in the associated samples, then they must be reanalyzed after a clean MB is obtained (certain projects may allow some exceptions for common laboratory contaminants like methylene chloride and acetone up to 5X the LOQ)
Laboratory Control Sample/Laboratory Control Sample Duplicate (LCS/LCSD) LCS analyzed with each batch of ≤ 20 samples LCSD analyzed if MS/MSD unavailable See Figure	1. Must meet internal standard criteria. 2. Must meet surrogate criteria. 3. All % recoveries must fall within statistically derived QC limits, which are evaluated on a semi-annual basis.	1.-2. If non-compliant, check for calculation or preparation errors. If no errors found, check system for problems and reanalyze. 3. If LCS/LCSD re-analysis still fails, perform appropriate system maintenance and restart the tune period. Only with a LCS % recovery failing high (for the requested target compounds) with targets non-detected in the sample, can the results be reported. Otherwise, the sample must be analyzed with a compliant LCS.
Matrix Spike/Matrix Spike Duplicate (MS/MSD) MS/MSD analyzed with each batch of ≤ 20 samples (if sufficient sample volume available) See Figures 4 and 5 for preparation info.	1. % Recoveries must fall within statistically derived QC limits, which are evaluated on a semi-annual basis 2. RPDs within QC limits.	1. If LCS within QC limits, proceed with sample analysis. 2. If most recoveries and/or RPDs outside of QC limits, consult the supervisor.

NOTE: Prior to release from the analytical laboratory, all data is reviewed in accordance with *T-VOA-WI8373* or *T-VOA-WI8400* (dual purge and trap).

Table 1

BFB Key Ion Abundance Criteria

Mass	Ion Abundance Criteria
50	15% to 40% of mass 95
75	30% to 60% of mass 95
95	base peak, 100% relative abundance
96	5% to 9% of mass 95
173	less than 2% of mass 174
174	greater than 50% of mass 95
175	5% to 9% of mass 174
176	greater than 95% but less than 101% of mass 174
177	5% to 9% of mass 176

Table 2

Primary and Secondary Ions

Compound Name	Primary Ion	Secondary Ion
Chloromethane	50	52
Vinyl Chloride	62	64
Bromomethane	94	96

Compound Name	Primary Ion	Secondary Ion
Chloroethane	64	66
1,1-Dichloroethene	96	61, 63
Acetone	43	58
Carbon Disulfide	76	78
Methylene Chloride	84	49, 86
1,1-Dichloroethane	63	65, 83
trans-1,2-Dichloroethene	96	61, 63
cis-1,2-Dichloroethene	96	61, 63
2-Butanone	43	72
Chloroform	83	85
1,2-Dichloroethane	62	98
1,1,1-Trichloroethane	97	61, 99
Carbon Tetrachloride	117	119
Benzene	78	
Trichloroethene	95	130, 132
1,2-Dichloropropane	63	76
Bromodichloromethane	83	85
cis-1,3-Dichloropropene	75	77, 110
trans-1,3-Dichloropropene	75	77, 110
1,1,2-Trichloroethane	97	83, 85
Dibromochloromethane	129	127
Bromoform	173	175
4-Methyl-2-pentanone	43	58
Toluene	92	91
Tetrachloroethene	166	131, 164
2-Hexanone	43	58
Chlorobenzene	112	77
Ethylbenzene	91	106
Xylene (total)	106	91
Styrene	104	78
1,1,2,2-Tetrachloroethane	83	85, 131
Dibromofluoromethane	113	111
1,2-Dichloroethane-d4	102	104
Fluorobenzene	96	70
Toluene-d8	98	100
Chlorobenzene-d5	117	82
4-Bromofluorobenzene	95	174
1,4-Dichlorobenzen-d4	152	115

NOTE: Alternative ions may be used for quantitation due to response factor, ion interference or other analytical needs.

Table 3
Minimum Relative Response Factors For ICAL and CCV

Volatile Compounds	Minimum Response Factor
Dichlorodifluoromethane	0.100
Chloromethane	0.100
Vinyl Chloride	0.100
Bromomethane	0.100
Chloroethane	0.100
Trichlorofluoromethane	0.100
1,1-Dichloroethene	0.100
1,1,2-Trichloro-1,2,2-trifluoroethane	0.100
Acetone	0.100
Carbon Disulfide	0.100
Methyl Acetate	0.100
Methylene Chloride	0.100
trans-1,2-Dichloroethene	0.100
cis-1,2-Dichloroethene	0.100
Methyl tert-Butyl Ether	0.100
1,1-Dichloroethane	0.200
2-Butanone	0.100
Chloroform	0.200
1,1,1-Trichloroethane	0.100
Cyclohexane	0.100
Carbon Tetrachloride	0.100
Benzene	0.500
1,2-Dichloroethane	0.100
Trichloroethene	0.200
Methylcyclohexane	0.100
1,2-Dichloropropane	0.100
Bromodichloromethane	0.200

cis-1,3-Dichloropropene	0.200
trans-1,3-Dichloropropene	0.100
4-Methyl-2-pentanone	0.100
Toluene	0.400
1,1,2-Trichloroethane	0.100
Tetrachloroethene	0.200
2-Hexanone	0.100
Dibromochloromethane	0.100
1,2-Dibromoethane	0.100
Chlorobenzene	0.500
Ethylbenzene	0.100

Table 3 - Continued

Volatile Compounds	Minimum Response Factor
m&p-Xylene	0.100
o-Xylene	0.300
Styrene	0.300
Bromoform	0.100
Isopropylbenzene	0.100
1,1,2,2-Tetrachloroethane	0.300
1,3-Dichlorobenzene	0.600
1,4-Dichlorobenzene	0.500
1,2-Dichlorobenzene	0.400
1,2-Dibromo-3-chloropropane	0.050
1,2,4-Trichlorobenzene	0.200

Attachment:
Figure 1 (.doc)
Figure 2 (.doc)
Figure 3 (.doc)
Figure 4 (.doc)
Figure 5 (.doc)
Figure 6 (.doc)
Figure 7 (.xls)

11892 Determining Method Detection Limits and Limits of Quantitation
7619 GC and GC/MS Instrumentation Maintenance
7629 GC/MS Volatile Standards Traceability
7691 Glassware Washing
7692 Preparation and Analysis of Cleaning Blanks for GC and GC/MS Volatiles
8373 GC/MS Volatiles Audit Process
8400 Level II Review of GC/MS Volatiles

End of document

Version history

Version	Approval	Revision information	
9	25.MAR.2020		
10	08.APR.2021		
11	27.APR.2022		

FIGURE 1
Theoretical Standard Concentrations
Initial Calibration for Large Curve
Purchased Standards
EPA SW846 Method 8260B/C/D

Date:_________

Instrument:_________

VOA1= 1:5 dilution of VCS#1B, VCS#2B, and VCS#4C

VOA2= 1:5 dilution of VCS#2B

VOA6= 1:5 dilution of VCS#6

VOA3= 1:5 dilution of VCS#3B and Vacrolein

2CEVE= 1:5 dilution of VCS#1B-2CEVE

VOA8= 1:5 dilution of Hexachloroethane and 2,2'-oxybis(1-Chloropropane)

Stock mix name	VOA1 ______ 2CEVE ______ 1,3-BUT ______	VOA3 ______	VOA2 ______	VOA6 ______ EE ______ Custom V LG Freons ______	n-PEN ______ VOA8 ______	CYC ______	EOH ______	Restek Gases (2000 ppm) Lt#________ TAEE _____		Flask mL	
300 ppb std	15 µL	6 µL		15µL	15 µL	30 µL	30 µL	7.5 µL		50	
100 ppb std	5 µL	2 µL		5 µL	5 µL	10 µL	10 µL	2.5 µL		50	
50 ppb std	5 µL	2 µL		5 µL	5 µL	10 µL	10 µL	2.5 µL		100	
20 ppb std	4 µL	1.6 µL	4 µL	4 µL	4 µL	16 µL	16 µL	2.0 µL		200	
10 ppb std	2 µL	0.8 µL	2 µL	2 µL	2 µL	8 µL	8 µL	1.0 µL		200	
4 ppb std	4 µL	1.6 µL	12 µL	4 µL	4 µL	32 µL	20 µL	2.0 µL		1000 *	
1 ppb std	* Aliquot 12.5 mL of 1000 mL flask into 50 mL flask										
0.5 ppb MDL std	+ Aliquot 12.5 mL of 1000 mL flask into 100 mL flask										

Compound name	std mix	Stock ppm	300 ppb	100 ppb	50 ppb	20 ppb	10 ppb	4 ppb	1 ppb	0.5 ppb
Benzene	CS#1B	5000	300	100	50	20	10	4	1	0.5
Bromobenzene		5000	300	100	50	20	10	4	1	0.5
Bromodichloromethane		5000	300	100	50	20	10	4	1	0.5
Bromoform		5000	300	100	50	20	10	4	1	0.5
n-Butylbenzene		5000	300	100	50	20	10	4	1	0.5
sec-Butylbenzene		5000	300	100	50	20	10	4	1	0.5
tert-Butylbenzene		5000	300	100	50	20	10	4	1	0.5
Carbon Tetrachloride		5000	300	100	50	20	10	4	1	0.5
Chlorobenzene		5000	300	100	50	20	10	4	1	0.5
Chloroform		5000	300	100	50	20	10	4	1	0.5
2-Chlorotoluene		5000	300	100	50	20	10	4	1	0.5
4-Chlorotoluene		5000	300	100	50	20	10	4	1	0.5
Dibromochloromethane		5000	300	100	50	20	10	4	1	0.5
1,2-Dibromo-3-chloropropane		5000	300	100	50	20	10	4	1	0.5
1,2-Dibromoethane (EDB)		5000	300	100	50	20	10	4	1	0.5
Dibromomethane		5000	300	100	50	20	10	4	1	0.5
1,2-Dichlorobenzene		5000	300	100	50	20	10	4	1	0.5
1,3-Dichlorobenzene		5000	300	100	50	20	10	4	1	0.5
1,4-Dichlorobenzene		5000	300	100	50	20	10	4	1	0.5

FIGURE 1

Theoretical Standard Concentrations
Initial Calibration for Large Curve
Purchased Standards
EPA SW846 Method 8260B/C/D

Compound name	std mix	Stock ppm	300 ppb	100 ppb	50 ppb	20 ppb	10 ppb	4 ppb	1 ppb	0.5 ppb
1,1-Dichloroethane	CS#1B	5000	300	100	50	20	10	4	1	0.5
1,2-Dichloroethane		5000	300	100	50	20	10	4	1	0.5
1,1-Dichloroethene		5000	300	100	50	20	10	4	1	0.5
cis-1,2-Dichloroethene		5000	300	100	50	20	10	4	1	0.5
trans-1,2-Dichloroethene		5000	300	100	50	20	10	4	1	0.5
1,2-Dichloropropane		5000	300	100	50	20	10	4	1	0.5
1,3-Dichloropropane		5000	300	100	50	20	10	4	1	0.5
2,2-Dichloropropane		5000	300	100	50	20	10	4	1	0.5
1,1-Dichloropropene		5000	300	100	50	20	10	4	1	0.5
cis-1,3-Dichloropropene		5000	300	100	50	20	10	4	1	0.5
trans-1,3-Dichloropropene		5000	300	100	50	20	10	4	1	0.5
Ethylbenzene		5000	300	100	50	20	10	4	1	0.5
Hexachlorobutadiene		5000	300	100	50	20	10	4	1	0.5
Isopropylbenzene		5000	300	100	50	20	10	4	1	0.5
p-Isopropyltoluene		5000	300	100	50	20	10	4	1	0.5
Methylene Chloride		5000	300	100	50	20	10	4	1	0.5
Naphthalene		5000	300	100	50	20	10	4	1	0.5
n-Propylbenzene		5000	300	100	50	20	10	4	1	0.5
Styrene		5000	300	100	50	20	10	4	1	0.5
1,1,1,2-Tetrachloroethane		5000	300	100	50	20	10	4	1	0.5
1,1,2,2-Tetrachloroethane		5000	300	100	50	20	10	4	1	0.5
Tetrachloroethene		5000	300	100	50	20	10	4	1	0.5
Toluene		5000	300	100	50	20	10	4	1	0.5
1,2,3-Trichlorobenzene		5000	300	100	50	20	10	4	1	0.5
1,2,4-Trichlorobenzene		5000	300	100	50	20	10	4	1	0.5
1,3,5-Trichlorobenzene		5000	300	100	50	20	10	4	1	0.5
1,1,1-Trichloroethane		5000	300	100	50	20	10	4	1	0.5
1,1,2-Trichloroethane		5000	300	100	50	20	10	4	1	0.5
Trichloroethene		5000	300	100	50	20	10	4	1	0.5
1,2,3-Trichloropropane		5000	300	100	50	20	10	4	1	0.5
1,2,4-Trimethylbenzene		5000	300	100	50	20	10	4	1	0.5
1,3,5-Trimethylbenzene		5000	300	100	50	20	10	4	1	0.5
m-Xylene		5000	300	100	50	20	10	4	1	0.5
o-Xylene		5000	300	100	50	20	10	4	1	0.5
p-Xylene		5000	300	100	50	20	10	4	1	0.5
1-Chlorohexane		5000	300	100	50	20	10	4	1	0.5
Pentachloroethane	CS#6	5000	300	100	50	20	10	4	1	0.5
Allyl Chloride		5000	300	100	50	20	10	4	1	0.5
Bromochloromethane		5000	300	100	50	20	10	4	1	0.5
Methyl Acetate		5000	300	100	50	20	10	4	1	0.5
Methylcyclohexane		5000	300	100	50	20	10	4	1	0.5
2-Methylnaphthalene		5000	300	100	50	20	10	4	1	0.5
1,2,3-Trimethylbenzene		5000	300	100	50	20	10	4	1	0.5
1,2-Diethylbenzene		5000	300	100	50	20	10	4	1	0.5
1,3-Diethylbenzene		5000	300	100	50	20	10	4	1	0.5
1,4-Diethylbenzene		5000	300	100	50	20	10	4	1	0.5

FIGURE 1
Theoretical Standard Concentrations
Initial Calibration for Large Curve
Purchased Standards
EPA SW846 Method 8260B/C/D

Compound name	Std mix	Stock ppm	300 ppb	100 ppb	50 ppb	20 ppb	10 ppb	4 ppb	1 ppb	0.5 ppb
Methacrylonitrile	CS#2B	12500	750	250	125	100	50	40	10	5
Propionitrile		25000	1500	500	250	200	100	80	20	10
trans-1,4-Dichloro-2-Butene		12500	750	250	125	100	50	40	10	5
t-Butyl Alcohol		25000	1500	500	250	200	100	80	20	10
2-Propanol		25000	1500	500	250	200	100	80	20	10
Isobutyl Alcohol		62500	3750	1250	625	500	250	200	50	25
n-Butanol		125000	7500	2500	1250	1000	500	400	100	50
1,4-Dioxane		62500	3750	1250	625	500	250	200	50	25
2-Butanone	CS#3B	25000	600	200	100	40	20	8	2	1
2-Hexanone		25000	600	200	100	40	20	8	2	1
4-Methyl-2-Pentanone		25000	600	200	100	40	20	8	2	1
Acetone		25000	600	200	100	40	20	8	2	1
Acrylonitrile		12500	300	100	50	20	10	4	1	0.5
2-Nitropropane		25000	600	200	100	40	20	8	2	1
Tetrahydrofuran		25000	600	200	100	40	20	8	2	1
Methyl-t-butyl Ether	CS#4C	5000	300	100	50	20	10	4	1	0.5
Ethyl Methacrylate		5000	300	100	50	20	10	4	1	0.5
Methyl Methacrylate		5000	300	100	50	20	10	4	1	0.5
Freon 113		5000	300	100	50	20	10	4	1	0.5
Hexane		5000	300	100	50	20	10	4	1	0.5
Heptane		5000	300	100	50	20	10	4	1	0.5
Cyclohexane		5000	300	100	50	20	10	4	1	0.5
Benzyl Chloride		5000	300	100	50	20	10	4	1	0.5
Methyl Iodide		5000	300	100	50	20	10	4	1	0.5
Carbon Disulfide		5000	300	100	50	20	10	4	1	0.5
2-Chloro-1,3-Butadiene		5000	300	100	50	20	10	4	1	0.5
di-Isopropyl Ether		5000	300	100	50	20	10	4	1	0.5
tert-Amyl Methyl Ether		5000	300	100	50	20	10	4	1	0.5
Ethyl-t-butyl Ether		5000	300	100	50	20	10	4	1	0.5
Bromomethane	Gas mix	2000	300	100	50	20	10	4	1	0.5
Chloroethane		2000	300	100	50	20	10	4	1	0.5
Chloromethane		2000	300	100	50	20	10	4	1	0.5
Dichlorodifluoromethane		2000	300	100	50	20	10	4	1	0.5
Trichlorofluoromethane		2000	300	100	50	20	10	4	1	0.5
Vinyl Chloride		2000	300	100	50	20	10	4	1	0.5
Cyclohexanone	CYC	6250	3750	1250	625	500	250	200	50	25
2-Chloroethyl Vinyl Ether	2CEVE	5000	300	100	50	20	10	4	1	0.5
1,3-Butadiene	1,3-BUT	1000	300	100	50	20	10	4	1	0.5

FIGURE 1

Theoretical Standard Concentrations
Initial Calibration for Large Curve
Purchased Standards
EPA SW846 Method 8260B/C/D

Compound name	std mix	Stock ppm	300 ppb	100 ppb	50 ppb	20 ppb	10 ppb	4 ppb	1 ppb	0.5 ppb
Acrolein	VACR	125000	3000	1000	500	200	100	40	10	5
tert-Amyl ethyl ether	TAEE	2000	300	100	50	20	10	4	1	0.5
Ethyl Ether	EE	1000	300	100	50	20	10	4	1	0.5
n-Pentane	n-PEN	1000	300	100	50	20	10	4	1	0.5
Freon 123a	Custom V	1000	300	100	50	20	10	4	1	0.5
Dichlorofluoromethane	LG Freon	1000	300	100	50	20	10	4	1	0.5
Hexachloroethane	VOA8	5000	300	100	50	20	10	4	1	0.5
2,2'-oxybis(1-Chloropropane)		5000	300	100	50	20	10	4	1	0.5
Ethanol	EOH	12500	7500	2500	1250	1000	500	250	62.5	31.25

ppb of analytical standard = (stock ppm)(µL stock) / flask mL

Analyst:______________
Date:______________

FIGURE 2

Theoretical Standard Concentrations
Initial Calibration for Large Curve
Purchased Standards
HP Capillary Column
EPA SW846 Method 8260 B/C/D
25 mL Purge

Date:_________
Instrument:_________

Stock mix name	RV4MIX1 ______ RV4GAS ______	RV4 826 ______					Flask ml
25 ppb std	25 µl	25 µl					50
10 ppb std	10 µl	10 µl					50
5 ppb std	5 µl	5 µl					50
2 ppb std	2 µl	2 µl					50
1 ppb std	2 µl	2 µl					100
.5 ppb std	2 µl	2 µl					200
.2 ppb std	2 µl	2 µl					500
.1 ppb std	1 µl	1 µl					500

	Std mix	Stock ppm	25 ppb	10 ppb	5 ppb	2 ppb	1 ppb	.5 ppb	.2 ppb	.1 ppb
Benzene	CS#1B	5000	25	10	5	2	1	.5	.2	.1
Bromobenzene		5000	25	10	5	2	1	.5	.2	.1
Bromodichloromethane		5000	25	10	5	2	1	.5	.2	.1
Bromoform		5000	25	10	5	2	1	.5	.2	.1
n-Butylbenzene		5000	25	10	5	2	1	.5	.2	.1
sec-Butylbenzene		5000	25	10	5	2	1	.5	.2	.1
tert-Butylbenzene		5000	25	10	5	2	1	.5	.2	.1
Carbon Tetrachloride		5000	25	10	5	2	1	.5	.2	.1
Chlorobenzene		5000	25	10	5	2	1	.5	.2	.1
Chloroform		5000	25	10	5	2	1	.5	.2	.1
2-Chlorotoluene		5000	25	10	5	2	1	.5	.2	.1
4-Chlorotoluene		5000	25	10	5	2	1	.5	.2	.1
Dibromochloromethane		5000	25	10	5	2	1	.5	.2	.1
1,2-Dibromo-3-chloropropane		5000	25	10	5	2	1	.5	.2	.1
1,2-Dibromoethane (EDB)		5000	25	10	5	2	1	.5	.2	.1
Dibromomethane		5000	25	10	5	2	1	.5	.2	.1
1,2-Dichlorobenzene		5000	25	10	5	2	1	.5	.2	.1
1,3-Dichlorobenzene		5000	25	10	5	2	1	.5	.2	.1
1,4-Dichlorobenzene		5000	25	10	5	2	1	.5	.2	.1
1,1-Dichloroethane		5000	25	10	5	2	1	.5	.2	.1

FIGURE 2

Theoretical Standard Concentrations
Initial Calibration for Large Curve
Purchased Standards
HP Capillary Column
EPA SW846 Method 8260 B/C/D

Compound name	std mix	Stock ppm	25 ppb	10 ppb	5 ppb	2 ppb	1 ppb	.5 ppb	.2 ppb	.1 ppb
1,2-Dichloroethane	CS#1B	5000	25	10	5	2	1	.5	.2	.1
1,1-Dichloroethene		5000	25	10	5	2	1	.5	.2	.1
cis-1,2-Dichloroethene		5000	25	10	5	2	1	.5	.2	.1
trans-1,2-Dichloroethene		5000	25	10	5	2	1	.5	.2	.1
1,2-Dichloropropane		5000	25	10	5	2	1	.5	.2	.1
1,3-Dichloropropane		5000	25	10	5	2	1	.5	.2	.1
2,2-Dichloropropane		5000	25	10	5	2	1	.5	.2	.1
1,1-Dichloropropene		5000	25	10	5	2	1	.5	.2	.1
cis-1,3-Dichloropropene		5000	25	10	5	2	1	.5	.2	.1
trans-1,3-Dichloropropene		5000	25	10	5	2	1	.5	.2	.1
Ethylbenzene		5000	25	10	5	2	1	.5	.2	.1
Hexachlorobutadiene		5000	25	10	5	2	1	.5	.2	.1
Isopropylbenzene (Cumene)		5000	25	10	5	2	1	.5	.2	.1
p-Isopropyltoluene		5000	25	10	5	2	1	.5	.2	.1
Methylene Chloride		5000	25	10	5	2	1	.5	.2	.1
Naphthalene		5000	25	10	5	2	1	.5	.2	.1
n-Propylbenzene		5000	25	10	5	2	1	.5	.2	.1
Styrene		5000	25	10	5	2	1	.5	.2	.1
1,1,1,2-Tetrachloroethane		5000	25	10	5	2	1	.5	.2	.1
1,1,2,2-Tetrachloroethane		5000	25	10	5	2	1	.5	.2	.1
Tetrachloroethene		5000	25	10	5	2	1	.5	.2	.1
Toluene		5000	25	10	5	2	1	.5	.2	.1
1,2,3-Trichlorobenzene		5000	25	10	5	2	1	.5	.2	.1
1,2,4-Trichlorobenzene		5000	25	10	5	2	1	.5	.2	.1
1,3,5-Trichlorobenzene		5000	25	10	5	2	1	.5	.2	.1
1,1,1-Trichloroethane		5000	25	10	5	2	1	.5	.2	.1
1,1,2-Trichloroethane		5000	25	10	5	2	1	.5	.2	.1
Trichloroethene		5000	25	10	5	2	1	.5	.2	.1
1,2,3-Trichloropropane		5000	25	10	5	2	1	.5	.2	.1
1,2,4-Trimethylbenzene		5000	25	10	5	2	1	.5	.2	.1
1,3,5-Trimethylbenzene		5000	25	10	5	2	1	.5	.2	.1
m-Xylene		5000	25	10	5	2	1	.5	.2	.1
o-Xylene		5000	25	10	5	2	1	.5	.2	.1
p-Xylene		5000	25	10	5	2	1	.5	.2	.1
1-Chlorohexane		5000	25	10	5	2	1	.5	.2	.1
2-Chloroethyl Vinyl Ether	2-CEVE	5000	25	10	5	2	1	.5	.2	.1
Bromomethane	Gas mix	2000	25	10	5	2	1	.5	.2	.1
Chloroethane		2000	25	10	5	2	1	.5	.2	.1
Chloromethane		2000	25	10	5	2	1	.5	.2	.1
Dichlorodifluoromethane		2000	25	10	5	2	1	.5	.2	.1
Trichlorofluoromethane		2000	25	10	5	2	1	.5	.2	.1
Vinyl Chloride		2000	25	10	5	2	1	.5	.2	.1

FIGURE 2
Theoretical Standard Concentrations
Initial Calibration for Large Curve
Purchased Standards
HP Capillary Column
EPA SW846 Method 8260 B/C/D

Compound name	std mix	Stock ppm	25 ppb	10 ppb	5 ppb	2 ppb	1 ppb	.5 ppb	.2 ppb	.1 ppb
Methacrylonitrile	CS#2B	12500	250	100	50	20	10	5	2	1
Propionitrile		25000	500	200	100	40	20	10	4	2
trans-1,4-Dichloro-2-Butene		12500	250	100	50	20	10	5	2	1
t-Butyl Alcohol		25000	500	200	100	40	20	10	4	2
2-Propanol		25000	500	200	100	40	20	10	4	2
Isobutyl Alcohol		62500	1250	500	250	100	50	25	10	5
n-Butanol		125000	2500	1000	500	200	100	50	20	10
1,4-Dioxane		62500	1250	500	250	100	50	25	10	5
2-Butanone	CS#3B	25000	250	100	50	20	10	5	2	1
2-Hexanone		25000	250	100	50	20	10	5	2	1
4-Methyl-2-Pentanone		25000	250	100	50	20	10	5	2	1
Acetone		25000	250	100	50	20	10	5	2	1
2-Nitropropane		25000	250	100	50	20	10	5	2	1
Tetrahydrofuran		25000	250	100	50	20	10	5	2	1
Acrylonitrile		12500	125	50	25	10	5	2.5	1	.5
Methyl-t-butyl Ether	CS#4C	5000	25	10	5	2	1	.5	.2	.1
Ethyl Methacrylate		5000	25	10	5	2	1	.5	.2	.1
Methyl Methacrylate		5000	25	10	5	2	1	.5	.2	.1
Freon 113		5000	25	10	5	2	1	.5	.2	.1
Hexane		5000	25	10	5	2	1	.5	.2	.1
Heptane		5000	25	10	5	2	1	.5	.2	.1
Cyclohexane		5000	25	10	5	2	1	.5	.2	.1
Benzyl Chloride		5000	25	10	5	2	1	.5	.2	.1
Methyl Iodide		5000	25	10	5	2	1	.5	.2	.1
Carbon Disulfide		5000	25	10	5	2	1	.5	.2	.1
2-Chloro-1,3-Butadiene		5000	25	10	5	2	1	.5	.2	.1
di-Isopropyl Ether		5000	25	10	5	2	1	.5	.2	.1
tert-Amyl Methyl Ether		5000	25	10	5	2	1	.5	.2	.1
Ethyl-t-butyl Ether		5000	25	10	5	2	1	.5	.2	.1
1,3-Butadiene		5000	25	10	5	2	1	.5	.2	.1
Freon 123a		5000	25	10	5	2	1	.5	.2	.1
n-Pentane		5000	25	10	5	2	1	.5	.2	.1
tert-Amyl ethyl ether		5000	25	10	5	2	1	.5	.2	.1
Acrolein	VACR	125000	1250	500	250	100	50	25	10	5
Ethyl Ether	EE	1000	25	10	5	2	1	.5	.2	.1

FIGURE 2
Theoretical Standard Concentrations
Initial Calibration for Large Curve
Purchased Standards
HP Capillary Column
EPA SW846 Method 8260 B/C/D

Compound name	std mix	Stock ppm	25 ppb	10 ppb	5 ppb	2 ppb	1 ppb	.5 ppb	.2 ppb	.1 ppb
Bromochloromethane	CS#6	5000	25	10	5	2	1	.5	.2	.1
Allyl Chloride		5000	25	10	5	2	1	.5	.2	.1
Methyl Acetate		5000	25	10	5	2	1	.5	.2	.1
Methylcyclohexane		5000	25	10	5	2	1	.5	.2	.1
Pentachloroethane		5000	25	10	5	2	1	.5	.2	.1
1,2,3-Trimethylbenzene		5000	25	10	5	2	1	.5	.2	.1
2-Methylnaphthalene		5000	25	10	5	2	1	.5	.2	.1
1,2-Diethylbenzene		5000	25	10	5	2	1	.5	.2	.1
1,3-Diethylbenzene		5000	25	10	5	2	1	.5	.2	.1
1,4-Diethylbenzene		5000	25	10	5	2	1	.5	.2	.1
1-Bromo-2-chloroethane	BCE	2000	25	10	5	2	1	.5	.2	.1
Dichlorofluoromethane	DCFM	2000	25	10	5	2	1	.5	.2	.1
Bromoethane	EtBr	1000	25	10	5	2	1	.5	.2	.1

ppb of analytical standard = (stock ppm)(µL stock) / flask mL

Analyst:______________
Date:______________

page 4 of 4

(saved as 8260C Lg Ical 25 mL purge)

FIGURE 3

Theoretical Standard Concentrations
Quality Control
Purchased Standards
HP Capillary Column
EPA SW846 Method 8260 B/C/D
Water Prep

Date:______________
Instrument:______________

QARC = 1: 25 QCS#1B2CEVE, QACR stock
QVOA6= 1:25 QCS#6
QVOA1= 1:25 QCS#1B, QCS#2B, QCS3B, QCS#4C
QVOA8= 1:25 VOA8
QGASES= 1:50 Restek 502.2 "Q" Gas mix
QDCFM = 20µL Dichlorofluoromethane Lt#__________ + 980µL MeOH Lt#_________

Stock mix Name	QVOA1 ______ QARC ______	QVOA6 ______ QEE ______ QDEM ______	QEOH _______ QCYC ______	8260 SS 2500 ppm Lot#_____	QGASES ________ QVOA8 _______ QDCFM __________	Final Volume	MeOH Lot# _______	Used
20 ppb	2.5 µL	2.5 µL	2.5 µL	0.1 ul	2.5 µL	5 mL Syringe	.1 mL	
20 ppb	21.5 µL	21.5 µL	21.5 µL	-	21.5 µL	43 mL Vial	-	
20 ppb	25.0 µL	25.0 µL	25.0 µL	1.0 ul	25.0 µL	50 mL Flask	1 mL	

Compound name	std mix	Stock ppm	20 ppb
Benzene	QCS#1B	1000	20
Bromobenzene		1000	20
Bromodichloromethane		1000	20
Bromoform		1000	20
n-Butylbenzene		1000	20
sec-Butylbenzene		1000	20
tert-Butylbenzene		1000	20
Carbon Tetrachloride		1000	20
Chlorobenzene		1000	20
Chloroform		1000	20
2-Chlorotoluene		1000	20
4-Chlorotoluene		1000	20
Dibromochloromethane		1000	20
1,2-Dibromo-3-chloropropane		1000	20
1,2-Dibromoethane (EDB)		1000	20
Dibromomethane		1000	20
1,2-Dichlorobenzene		1000	20
1,3-Dichlorobenzene		1000	20
1,4-Dichlorobenzene		1000	20
1,1-Dichloroethane		1000	20
1,2-Dichloroethane		1000	20
1,1-Dichloroethene		1000	20
cis-1,2-Dichloroethene		1000	20

FIGURE 3

Theoretical Standard Concentrations
Quality Control
Purchased Standards
HP Capillary Column
EPA SW846 Method 8260 B/C/D
Water Prep

trans-1,2-Dichloroethene		1000	20
1,2-Dichloropropane	QCS#1B	1000	20
1,3-Dichloropropane		1000	20
2,2-Dichloropropane		1000	20
1,1-Dichloropropene		1000	20
cis-1,3-Dichloropropene		1000	20
trans-1,3-Dichloropropene		1000	20
Ethylbenzene		1000	20
Hexachlorobutadiene		1000	20
p-Isopropyltoluene		1000	20
Methylene Chloride		1000	20
Isopropylbenzene (Cumene)		1000	20
Naphthalene		1000	20
n-Propylbenzene		1000	20
Styrene		1000	20
1,1,1,2-Tetrachloroethane		1000	20
1,1,2,2-Tetrachloroethane		1000	20
Tetrachloroethene		1000	20
Toluene		1000	20
1,2,3-Trichlorobenzene		1000	20
1,2,4-Trichlorobenzene		1000	20
1,3,5-Trichlorobenzene		1000	20
1,1,1-Trichloroethane		1000	20
1,1,2-Trichloroethane		1000	20
Trichloroethene		1000	20
1,2,3-Trichloropropane		1000	20
1,2,4-Trimethylbenzene		1000	20
1,3,5-Trimethylbenzene		1000	20
m-Xylene		1000	20
o-Xylene		1000	20
p-Xylene		1000	20
1-Chlorohexane		1000	20
Bromomethane	QGas mix	2000	20
Chloroethane		2000	20
Chloromethane		2000	20
Dichlorodifluoromethane		2000	20
Trichlorofluoromethane		2000	20
Vinyl Chloride		2000	20
Methacrylonitrile	QCS#2B	7500	150
Propionitrile		7500	150
trans-1,4-Dichloro-2-Butene		5000	100
t-Butyl Alcohol		10000	200
2-Propanol		7500	150
Isobutyl Alcohol		25000	500

FIGURE 3

Theoretical Standard Concentrations
Quality Control
Purchased Standards
HP Capillary Column
EPA SW846 Method 8260 B/C/D
Water Prep

n-Butanol	QCS#2B	50000	1000
1,4-Dioxane		25000	500
2-Butanone	QCS#3B	7500	150
2-Hexanone		5000	100
4-Methyl-2-Pentanone		5000	100
Acetone		7500	150
Acrylonitrile		5000	100
2-Nitropropane		1000	20
Tetrahydrofuran		5000	100
Methyl-t-butyl Ether	QCS#4C	1000	20
Ethyl Methacrylate		1000	20
Methyl Methacrylate		1000	20
Freon 113		1000	20
Hexane		1000	20
Heptane		1000	20
Cyclohexane		1000	20
Benzyl Chloride		1000	20
Methyl Iodide		1000	20
Carbon Disulfide		1000	20
2-Chloro-1,3-Butadiene		1000	20
di-Isopropyl Ether		1000	20
tert-Amyl Methyl Ether		1000	20
Ethyl-t-butyl Ether		1000	20
1,3-Butadiene		1000	20
Freon 123a		1000	20
n-Pentane		1000	20
tert-Amyl ethyl ether		1000	20
Pentachloroethane	QCS#6	1000	20
Allyl Chloride		1000	20
Bromochloromethane		1000	20
Methyl Acetate		1000	20
Methylcyclohexane		1000	20
2-Methylnaphthalene		1000	20
1,2,3-Trimethylbenzene		1000	20
1,2-Diethylbenzene		1000	20
1,3-Diethylbenzene		1000	20
1,4-Diethylbenzene		1000	20
Acrolein	QACR	7500	150
2- Chloroethyl Vinyl Ether	QCS#1B 2CEVE	1000	20
Cyclohexanone	QCYC	1000	500

FIGURE 3

Theoretical Standard Concentrations
Quality Control
Purchased Standards
HP Capillary Column
EPA SW846 Method 8260 B/C/D
Water Prep

Ethyl Ether	QEE	40	20
Diethoxymethane	QDEM	40	20
Hexachloroethane	QVOA8	1000	20
2,2’-oxybis(1-Chloropropane)		1000	20
Ethanol	QEOH	1000	500
Dichlorofluoromethane	DCFM	2000	20

ppb of analytical standard = (stock ppm)(µl stock) / final volume

Analyst/Date:__________________

Reviewer/Date:__________________

FIGURE 4

Theoretical Standard Concentrations
Quality Control
Purchased Standards
HP Capillary Column
EPA SW846 Method 8260 B/C/D
25 ml Purge Waters

Date:______________
Instrument:______________

QARC= 1:25 QCS#1B2CEVE, QACR stock
QVOA1= 1:25 QCS#1B, QCS#2B, QCS3B, QCS#4C QVOA6= 1:25 QCS#6
QGAS=1:50 Restek 502.2 “Q” Gas Mix + 1:50 1-Bromo-2-chloroethane + 1:50 Dichlorofluoromethane

Stock mix Name	QVOA1 ______ QARC ______	QVOA6 ______	QEE ______ QEtBr ______	QGAS ______	Final Volume	Prep Used
5 ppb	6.25 µL	6.25 µL	6.25 uL	6.25 ul	50 mL	
5 ppb	12.5 µL	12.5 µL	12.5 uL	12.5 ul	100 mL	
5 ppb	5.38 µL	5.38 µL	5.38 uL	5.38 ul	43 mL vial	

Compound name	std mix	Stock ppm	5 ppb
Benzene	QCS#1B	1000	5
Bromobenzene		1000	5
Bromodichloromethane		1000	5
Bromoform		1000	5
n-Butylbenzene		1000	5
sec-Butylbenzene		1000	5
tert-Butylbenzene		1000	5
Carbon Tetrachloride		1000	5
Chlorobenzene		1000	5
Chloroform		1000	5
2-Chlorotoluene		1000	5
4-Chlorotoluene		1000	5
Dibromochloromethane		1000	5
1,2-Dibromo-3-chloropropane		1000	5
1,2-Dibromoethane (EDB)		1000	5
Dibromomethane		1000	5
1,2-Dichlorobenzene		1000	5
1,3-Dichlorobenzene		1000	5
1,4-Dichlorobenzene		1000	5
1,1-Dichloroethane		1000	5
1,2-Dichloroethane		1000	5
1,1-Dichloroethene		1000	5
cis-1,2-Dichloroethene		1000	5
trans-1,2-Dichloroethene		1000	5
1,2-Dichloropropane		1000	5
1,3-Dichloropropane		1000	5
2,2-Dichloropropane		1000	5
1,1-Dichloropropene		1000	5
cis-1,3-Dichloropropene		1000	5

FIGURE 4

Theoretical Standard Concentrations
Quality Control
Purchased Standards
HP Capillary Column
EPA SW846 Method 8260 B/C/D
25 ml Purge Waters

Compound name	std mix	Stock ppm	5 ppb
trans-1,3-Dichloropropene		1000	5
Ethylbenzene		1000	5
Hexachlorobutadiene	QCS#1B	1000	5
Isopropylbenzene (Cumene)		1000	5
p-Isopropyltoluene		1000	5
Methylene Chloride		1000	5
Naphthalene		1000	5
n-Propylbenzene		1000	5
Styrene		1000	5
1,1,1,2-Tetrachloroethane		1000	5
1,1,2,2-Tetrachloroethane		1000	5
Tetrachloroethene		1000	5
Toluene		1000	5
1,2,3-Trichlorobenzene		1000	5
1,2,4-Trichlorobenzene		1000	5
1,3,5-Trichlorobenzene		1000	5
1,1,1-Trichloroethane		1000	5
1,1,2-Trichloroethane		1000	5
Trichloroethene		1000	5
1,2,3-Trichloropropane		1000	5
1,2,4-Trimethylbenzene		1000	5
1,3,5-Trimethylbenzene		1000	5
m-Xylene		1000	5
o-Xylene		1000	5
p-Xylene		1000	5
1-Chlorohexane		1000	5
2-Chloroethyl Vinyl Ether	QCS#1B 2CLEVE	1000	5
Bromomethane	QGas mix	2000	5
Chloroethane		2000	5
Chloromethane		2000	5
Dichlorodifluoromethane		2000	5
Trichlorofluoromethane		2000	5
Vinyl Chloride		2000	5
Methacrylonitrile	QCS#2B	7500	37.5
Propionitrile		7500	37.5
trans-1,4-Dichloro-2-Butene		5000	25

FIGURE 4
Theoretical Standard Concentrations
Quality Control
Purchased Standards
HP Capillary Column
EPA SW846 Method 8260 B/C/D
25 ml Purge Waters

Compound name	std mix	Stock ppm	5 ppb
t-Butyl Alcohol	QCS#2B	10000	50
2-Propanol		7500	37.5
Isobutyl Alcohol		25000	125
n-Butanol		50000	250
1,4-Dioxane		25000	125
2-Hexanone	QCS#3B	5000	25
4-Methyl-2-Pentanone		5000	25
Acetone		7500	37.5
Acrylonitrile		5000	25
2-Nitropropane		1000	5
Tetrahydrofuran		5000	25
2-Butanone		7500	37.5
Methyl-t-butyl Ether	QCS#4C	1000	5
Ethyl Methacrylate		1000	5
Methyl Methacrylate		1000	5
Freon 113		1000	5
Hexane		1000	5
Heptane		1000	5
Cyclohexane		1000	5
Benzyl Chloride		1000	5
Methyl Iodide		1000	5
Carbon Disulfide		1000	5
2-Chloro-1,3-Butadiene		1000	5
di-Isopropyl Ether		1000	5
tert-Amyl Methyl Ether		1000	5
Ethyl-t-butyl Ether		1000	5
1,3-Butadiene		1000	5
Freon 123a		1000	5
n-Pentane		1000	5
tert-Amyl ethyl ether		1000	5
Pentachloroethane	QVOA6	1000	5
Allyl Chloride		1000	5
Bromochloromethane		1000	5
Methyl Acetate		1000	5
Methylcyclohexane		1000	5
2-Methylnaphthalene		1000	5
1,2,3-Trimethylbenzene		1000	5
1,2-Diethylbenzene		1000	5

FIGURE 4

Theoretical Standard Concentrations
Quality Control
Purchased Standards
HP Capillary Column
EPA SW846 Method 8260 B/C/D
25 ml Purge Waters

Compound name	std mix	Stock ppm	5 ppb
1,3-Diethylbenzene	QVOA6	1000	5
1,4-Diethylbenzene		1000	5
Bromoethane	QEtBr	40	5
Ethyl Ether	QEE	40	5
Acrolein	QACR	7500	37.5
Dichlorofluoromethane	DCFM	2000	5
1-Bromo-2-chloroethane	BCE	2000	5

ppb of analytical standard = (stock ppm)(µl stock) / final volume

Analyst/Date:__________________
Reviewer/Date:____________________

FIGURE 5

Theoretical Standard Concentrations
Initial Calibration for Dual PT
Purchased Standards
HP Capillary Column
EPA SW846 Method 8260B/C/D

Date:__________
Instrument:__________

Stock mix name	EOH ______	dMBOH ______	Custom UST V MIX Lt#_________	MTBE ______	tAmOH ______	tBF ______		Flask mL
200 ppb std	40 µL	20 µL	10.0 ul	40.0 ul	25 µL	20 µL		100
100 ppb std	20 µL	10 µL	5.0µL	20.0 µL	20 µL	10 µL		100
50 ppb std	10 µL	8 µL	2.5 µL	7.5 µL	10 µL	5 µL		100
20 ppb std	8 µL	4 µL	1.0 µL	1.5 µL	5 µL	2 µL		100
20 ppb std for .4 ppb MDL	20uL	5 µL	1.0 µL		10 µL	2 µL		100*
0.4 ppb MDL	*Dilute 2 mL of 20 ppb standard prepped for .4 MDL run in 100 mL flask.							

Dilute stock mix As noted w/ MeOH Lt#_________	EOH ______	1:10# dMBOH ________	1:20 Custom UST V Mix Lt#_________		1:20^ tAmOH ________	1:20 tBF ______		
10 ppb std	4 µL	2 µL	10 µL		2 µL	20 µL		100
2 ppb std	2 uL	8 µL#	2 µL		20 µL^	4 µL		100
1 ppb std	1 uL	4 µL#	1 µL		N/A	N/A		100

Compound name	std mix	Stock ppm	200 ppb	100 ppb	50 ppb	20 ppb	10 ppb	2 ppb	1 ppb	0.4 ppb
Benzene	UST V Mix	2000	200	100	50	20	10	2	1	.4
Bromoform		2000	200	100	50	20	10	2	1	.4
Chlorobenzene		2000	200	100	50	20	10	2	1	.4
Chloroform		2000	200	100	50	20	10	2	1	.4
Chloromethane		2000	200	100	50	20	10	2	1	.4
1,2-Dibromoethane		2000	200	100	50	20	10	2	1	.4
1,1-Dichloroethane		2000	200	100	50	20	10	2	1	.4
1,2-Dichloroethane		2000	200	100	50	20	10	2	1	.4
1,1-Dichloroethene		2000	200	100	50	20	10	2	1	.4
1,2-Dichloropropane		2000	200	100	50	20	10	2	1	.4
Ethylbenzene		2000	200	100	50	20	10	2	1	.4
Isopropylbenzene		2000	200	100	50	20	10	2	1	.4
Methyl-t-butyl Ether @		2000	200	100	50	20	10	2	1	.4
Naphthalene		2000	200	100	50	20	10	2	1	.4
1,1,2,2,-Tetrachloroethane		2000	200	100	50	20	10	2	1	.4
Toluene		2000	200	100	50	20	10	2	1	.4
Vinyl Chloride		2000	200	100	50	20	10	2	1	.4
m+p-Xylene		4000	400	200	100	40	20	4	2	.8
o-Xylene		2000	200	100	50	20	10	2	1	.4
Isopropyl ether (dIPE)		2000	200	100	50	20	10	2	1	.4
tert-Amyl methyl ether		2000	200	100	50	20	10	2	1	.4
Ethyl-tert-butyl ether		2000	200	100	50	20	10	2	1	.4
Tert-Butanol (tBA)		10000	1000	500	250	100	50	10	5	2

FIGURE 5

Theoretical Standard Concentrations
Initial Calibration
Purchased Standards
HP Capillary Column
EPA SW846 Method 8260B/C/D

Compound name	std mix	Stock ppm	200 ppb	100 ppb	50 ppb	20 ppb	10 ppb	2 ppb	1 ppb	0.4 ppb
1,2,4-Trimethylbenzene	UST	2000	200	100	50	20	10	2	1	.4
1,3,5-Trimethylbenzene	V Mix	2000	200	100	50	20	10	2	1	.4
tert-Amyl ethyl ether		2000	200	100	50	20	10	2	1	0.4
t-Amyl Alcohol	tAmOH	5000	1250	1000	500	250	100	50	N/A	10
Methyl-t-butyl Ether @	MTBE	2000	800	400	150	30				
Ethanol	EOH	12500	5000	2500	1250	1000	500	250	125	50
3,3-Dimethyl-1,1-butanol	dMBOH	12500	2500	1250	1000	500	250	100	50	10
t-Butyl Formate	tBF	2500	500	250	125	50	25	5	N/A	1

ppb of analytical standard = (stock ppm)(µL stock) / flask mL

@ Methyl-t-butyl Ether is present in both MTBE and UST V mix standards

Analyst ______________
Date______________

page 2 of 2

saved as 8260B USToxy (DUALPT)

Figure 6

Theoretical Standard Concentrations
Quality Control for Dual PT
Purchased Standards
HP Capillary Column
EPA SW846 Method 8260B/C/D

Date:______________
Instrument:______________

Stock mix name	QUST Lot#_________	QEOH _________	Qt-AmOH _________	QdmBOH _________	QtBF _________	Final Volume	Prep Used
20 ppb	21.5 µL	21.5 µL	21.5 µL	21.5 µL	21.5 µL	43 mL Vial	
20 ppb	25.0 µL	25.0 µL	25.0 µL	25.0 µL	25.0 µL	50 mL Flask	

Compound name	std mix	Stock ppm	20 ppb
Benzene	QUST	40	20
Bromoform		40	20
Chlorobenzene		40	20
Chloroform		40	20
1,2-Dibromoethane (EDB)		40	20
1,1-Dichloroethane		40	20
1,2-Dichloroethane		40	20
1,1-Dichloroethene		40	20
1,2-Dichloropropane		40	20
Ethylbenzene		40	20
Isopropylbenzene (Cumene)		40	20
Chloromethane		40	20
Naphthalene		40	20
Vinyl Chloride		40	20
1,1,2,2-Tetrachloroethane		40	20
m-Xylene		40	20
o-Xylene		40	20
p-Xylene		40	20
Toluene		40	20
t-Butyl Alcohol		400	200
Methyl t-butyl Ether		40	20
Diisopropyl ether		40	20
Tert-amyl methyl ether		40	20
Ethyl-tert-butyl ether		40	20
1,2,4-Trimethylbenzene		40	20
1,3,5-Trimethylbenzene		40	20
tert-Amyl ethyl ether		40	20
t-Amyl Alcohol	Qt-AmOH	400	200
3,3-Dimethyl-1-1-butanol	QdmBOH	1000	500
t-Butyl Formate	QtBF	200	100
Ethanol	QEOH	1000	500

Analyst/Date:_________________
Reviewer/Date:_________________

Theoretical Standard Concentrations
Gasoline Range Organics
Water Prep

FIGURE 7

Instrument:_____________

Restek V Unleaded Gasoline Composite Standard

Date:_____________

Lot: ________________ Exp: _________

INITIAL CALIBRATION TSC

			level 6	level 5	level 4	level 3	level 2	level 1	MDL
		ul stock	40	20	10	10	2	4	2
		FV H20 Ml	50	50	50	100	100	500	500
Compound Name	**CAS #**	**Stock ppm**	**Conc. ug/L**	**Conc. ug/L**	**Conc. ug/L**	**Conc. ug/L**	**Conc. ug/L**	**Conc. ug/L**	**Conc. ug/L**
Unleaded Gasoline Composite std.	8006-61-9	5500	4400	2200	1100	550	110	44	22

Analyst:_________________________

Date:____________________________

QUALITY CONTROL TSC

Restek Q Unleaded Gasoline Composite std. Lot____________ 20000ug/mL

QGRO=1:10 Restek Q Unleaded Gasoline Composite std.

Stock mix	QGRO _______	Final Volume	Prep Used
1000 ppb GRO	21.5 ul	43 ml Vial	
1000 ppb GRO	25.0 ul	50 mL Flask	

Analyst:_________________________

Date:____________________________

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APPENDIX B

INVESTIGATION-DERIVED WASTE MANAGEMENT PLAN

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B. Investigation-Derived Waste Management

This Investigation-Derived Waste (IDW) Management Plan addresses generic waste collection, characterization, storage, and disposal procedures to be used when implementing a vapor intrusion study and additional groundwater sampling at CC RVAAP-69 Building 1048 Fire Station within Camp James A. Garfield (CJAG). Activities are limited to air, sub-slab soil vapor, and groundwater sampling.

IDW includes all materials generated during an investigation that cannot be effectively reused, recycled, or decontaminated in the field. Two types of IDW will be generated during the implementation of field activities: indigenous and non-indigenous. Indigenous IDW potentially generated during field activities includes purge water from low-flow sampling. Non-indigenous IDW potentially generated includes concrete/dust slurry, decontamination rinse fluids, and compactable and miscellaneous trash (e.g., disposable personal protective equipment [PPE] or investigation-related equipment). Procedures used to manage IDW are described below.

All wastes generated during environmental investigations at CJAG will be managed in accordance with Federal and State of Ohio requirements. All waste activities must comply with the CJAG Waste Management Guidelines. All waste disposal, other than municipal refuse, will be coordinated with the Ohio Army National Guard (OHARNG) Environmental Specialist.

B.1 INVESTIGATION-DERIVED WASTE COLLECTION AND CONTAINERIZATION

It is not anticipated that indigenous solid IDW will be generated during the field activities for these investigations. All solid non-indigenous (e.g., concrete/dust slurry, expendable sampling equipment, PPE, trash) IDW will be segregated and disposed of as municipal waste. Leidos will remove all of the municipal trash it produces from the facility and will not use onsite trash receptacles.

All liquid indigenous IDW (e.g., purge water) and non-indigenous IDW (e.g., decontamination rinse water, soap, water/water rinses from alcohol rinses [e.g., isopropanol], acid rinses [e.g., nitric acid]) will be contained in labeled, U.S. Department of Defense (DOT)-approved, 55-gallon closed-top drums. The volume of alcohol and acid rinses used for decontamination purposes is anticipated to be minimal.

B.2 WASTE CONTAINER LABELING

All containers, including those that are empty, must be properly labeled. All waste storage containers (drums) will be labeled immediately before and continuously during their use to ensure proper management of the contained wastes. All labels will be weather-resistant, commercially available labels. One label will be affixed and located on the upper one-third of each storage container. Labels will be legibly completed using indelible ink. The drum number will be legibly recorded directly on a clean dry drum surface on the top and upper one-third of each storage container using an indelible paint marker. Additional label information may be recorded directly on a clean, dry drum surface.

An example of the waste storage container label is shown in Figure B-1. The following procedure will be used for waste container labeling:

- Place label on a smooth part of the container and do not affix it across drum bungs, seams, ridges, or dents.
- Upon use of a container, replace the empty label with a drum label filled out with the information listed below.
- When sampling each container per the procedures outlined in Section B.4, affix an appropriate pending analysis label to the container.
- When classifying the IDW based on analytical results, affix the appropriate non-hazardous label to the drum.
- Record the following information on each label:
  - Contractor-assigned container number
  - Contents
  - Source of waste
  - Source location (if applicable)
  - Project name and area of concern (AOC) identification
  - Physical characteristic of the waste
  - Generation date(s)
  - Address of waste generation
  - Contact information for a contractor contact and the OHARNG Environmental Specialist.
- Record all information on container labels with indelible ink (permanent marker or paint pen) and record necessary information in a field logbook or on an appropriate field form.
- Protect all container labels so that damage or degradation of the recorded information is prevented.
- Drum labels will be photographed when affixed to the container. Photographs will be provided to the OHARNG Environmental Specialist. New photographs will be collected whenever drum status is updated (i.e., pending analysis, final classification).

B.3 INVESTIGATION-DERIVED WASTE STAGING

Subject to the approval of the Army National Guard (ARNG) Program Manager and OHARNG Environmental Specialist, all IDW drums will be stored at Building 1036. The volume of waste expected to be generated during field activities is minimal, and the need for designated field staging areas is not anticipated. IDW drums will be brought back to Building 1036 for staging at the end of each day. Building 1036 will be used as the centralized decontamination area to support the investigation and to store liquid and solid IDW resulting from decontamination activities. After IDW characterization, the wastes will be disposed of according to Section B.5 or stored at Building 1036 pending disposal.

All IDW (purge water, decontamination rinse water, and expendable material) will be stored at Building 1036 until it is characterized for disposal in accordance with Section B.4. After characterization of the non-IDW, the wastes will be disposed of according to Section B.5 or stored at Building 1036 pending disposal. All non-contaminated, non-indigenous solid IDW will be disposed of as municipal trash offsite. Onsite trash receptacles will not be used for non-contaminated, non-indigenous solid waste.

The waste generated during this investigation is expected to be non-hazardous. Generator knowledge and historical sampling data suggest the IDW is unlikely to be characterized as hazardous waste. In the event waste characterization samples determine any waste to be hazardous, it will be coordinated with the U.S. Army Corps of Engineers (USACE) and OHARNG to determine a path forward. IDW staged and stored at Building 1036 is subject to the requirements of CJAG Waste Management Guidelines and must comply with the following:

- An IDW container log will be completed for each 55-gallon drum of IDW (solid or liquid) generated during the investigation. The IDW container log will document the following:
  - Container specific drum number (example provided in Figure B-1)
  - Location of drum staging area
  - Type of material (soil/liquid)
  - Quantity added to drum and date
  - Cumulative quantity of drum and date.
- All contractor waste, including environmental waste pending sampling and pending analysis waste, will be inspected and inventoried weekly. Documentation of the inspection will be recorded on the CJAG weekly waste inventory sheet. This inventory sheet will be submitted weekly to the OHARNG Environmental Specialist. Waste can be inspected and inventoried monthly once characterization results have confirmed it as non-hazardous. CJAG Waste Management Guidelines, the weekly inspection/inventory sheet, and the waste disposal tracking form are presented in Attachment B-1. Inventory and inspection must include, at a minimum:
  - Inventory of number of containers
  - Inspection of container(s) conditions (no bulging, or rusting)
  - Inspection of labels (all present, correctly labeled, not faded)
  - Date and time of inspection
  - Inspector's name and signature.
- Waste characterization samples will be collected upon completion of field sampling activities at the end of the mobilization. Waste characterization results will be submitted to USACE, ARNG, and OHARNG within 30 days of sample collection. A waste characterization summary report and waste profile will be submitted to USACE, ARNG, and OHARNG after sample results from the laboratory are available.
- Waste profiles will be signed by the OHARNG Environmental Specialist.
- All waste (except for municipal waste) must be manifested.
- All liquid waste must have secondary containment.
- All contractors must confirm that the disposal facility has received the waste shipments within the required time frames. This will be accomplished by contacting the OHARNG Environmental Specialist to verify that the disposal facility signed and returned a copy of the manifest to CJAG. If the copy has not been returned within 30 days of the pickup date, the contractor must contact the treatment, storage, and disposal facility to inquire and request a copy of the return manifest. If unsuccessful, the contractor must notify the OHARNG Environmental Specialist and begin corrective actions. A copy of the return manifest must be given to the OHARNG Environmental Specialist for the waste file.

B.4 INVESTIGATION-DERIVED WASTE CHARACTERIZATION AND CLASSIFICATION FOR DISPOSAL

All indigenous liquid IDW (e.g., purge water) and non-indigenous liquid IDW (e.g., water generated from decontamination of groundwater sampling equipment) will be characterized for disposal based on analytical results from environmental samples and from direct analysis of composite IDW samples. All IDW must be analyzed for toxicity characteristic leaching procedure (TCLP) volatile organic compounds, TCLP semivolatile organic compounds, TCLP metals, TCLP herbicides, TCLP pesticides, polychlorinated biphenyls (PCBs), total sulfide, total cyanide, corrosivity (pH), and flashpoint for proper disposal. Other analyses may be added at the request of the disposal facility.

Non-indigenous IDW, except for PPE and expendable sampling equipment, will be characterized for disposal based on composite samples collected from segregated waste stream storage containers. Composite waste samples will be submitted for laboratory analysis to characterize each waste stream for disposal. PPE and expendable sampling equipment will be disposed of as municipal waste.

Analytical results from the subcontracted laboratory (approximately 30 days after submission of sample delivery groups) will be reviewed to determine the classification of the waste. This review includes a comparison of the analytical results against levels and limits presented in Tables B-1 through B-3. Table B-1 presents the maximum concentration of contaminants for toxicity characterization of hazardous wastes as specified in 40 Code of Federal Regulations (CFR) 261.24. (Note that all tables and figures are presented at the end of Section B.5.) Table B-2 presents the maximum concentrations for non-TCLP analytes for hazardous waste determination. Table B-3 presents the regulatory level for PCB waste classification. Based on the results of analytical data, IDW will be categorized and labeled as either hazardous or non-hazardous. After all analytical results have been received for each investigation and prior to the disposal of any waste, an IDW Characterization and Disposal Plan will be prepared and submitted to the OHARNG Environmental Specialist, ARNG Program Manager, and USACE. The IDW Characterization and Disposal Plan will present an inventory of all stored IDW, document the analytical results and IDW characterization, and make recommendations for the disposal of all IDW based on the determined waste classification.

B.4.1 Liquid Investigation-Derived Waste Composite Sampling Procedure

Sampling of liquid IDW (purge/decontamination water) for disposal characterization will be performed using a composite grab sampling technique. The equipment used in liquid IDW sampling will consist of sample containers and disposable or decontaminated sampling equipment (e.g., bailers, pump tubing, and drum thief). Composite grab sample collection will be performed as follows:

1. Correlate the number of grab samples and sample volume required by the laboratory to determine the volume needed to provide equal amounts of aliquot from each grab sample (drum container) at the recommended sample volume (e.g., five 20-mL aliquots from five discrete grab samples to generate a 100-mL composite sample representing five IDW containers).
2. Using decontaminated or clean disposable equipment, collect discrete grab samples from each drum.

3. Using a clean pipette or equivalent clean measuring device, deliver equal aliquots of the grab samples directly into sample container(s) to be sent to the laboratory.
4. Repeat this process until equal amounts of each aliquot from each grab sample have been collected. Each discrete grab sample should be collected in identical fashion.
5. Seal the sample container and shake well to mix. Prepare the container for shipment to the laboratory.

B.5 INVESTIGATION-DERIVED WASTE DISPOSAL

Table B-4 identifies the disposal options for all expected waste streams from environmental investigations at CJAG based on past efforts. Waste disposal options recommended in the IDW Characterization and Disposal Plan are subject to the approval of the OHARNG Environmental Specialist, ARNG Program Manager, and USACE. The OHARNG Environmental Specialist, or designee, will sign all waste manifests and other shipping documents and oversee the disposition of all IDW at CJAG. Transportation of all IDW for storage and/or disposal will be in accordance with applicable Federal and State of Ohio regulations. When IDW will be disposed of offsite, using public roads as a means of transportation, the shipment or transportation of IDW may be subject to DOT requirements for containerizing, labeling, and shipping documentation (49 CFR 172).

There is no means for disposal of contaminated IDW at CJAG. All IDW will be disposed of offsite according to applicable Federal and state regulations.

Any liquid IDW or saturated soil IDW that is stored at Building 1036 during the winter will require special management to prevent accidental releases due to freezing. The contractor's foremost responsibility is to manage IDW so that, if possible, disposal can be completed before freezing conditions arise. If disposal cannot be executed before the onset of such conditions, or if long-term storage of liquids is anticipated, secondary containment is required. Secondary containment is the responsibility of the contractor and is subject to the requirements of the Resource Conservation and Recovery Act.

All non-indigenous solid (concrete/dust slurry, expendable sampling equipment, and trash) IDW will be disposed of as municipal trash. All expendable sampling equipment determined to be potentially contaminated will be decontaminated according to Worksheet 18, Section 18.8 and then disposed of as municipal trash.

All treatment, storage, and disposal facilities must be in good standing with environmental regulatory agencies. The OHARNG Environmental Specialist must be notified in advance of waste disposal as to which disposal facility is to be used. The OHARNG Environmental Specialist has the authority to refuse the use of a particular disposal facility based on his/her review of their ability to protect the interests of the Army.

All IDW is disposed of offsite at appropriate licensed facilities, using public roads as a means of transportation, making the shipment or transportation of IDW subject to DOT requirements for containerizing, labeling, and shipping documentation (49 CFR 172). Therefore, the contractor will comply with all DOT requirements.

Table B-1. Maximum Concentration of Contaminants for Toxicity Characteristic (40 CFR 261.24)

USEPA Hazardous Waste Number	Contaminant	CAS Number	Regulatory Level (mg/L)
D004	Arsenic	7440-38-2	5.0
D005	Barium	7440-39-3	100.0
D018	Benzene	71-43-9	0.5
D006	Cadmium	7440-43-2	1.0
D019	Carbon Tetrachloride	56-23-5	0.5
D020	Chlordane	57-74-9	0.03
D021	Chlorobenzene	108-90-7	100.0
D022	Chloroform	67-66-3	6.0
D007	Chromium	7440-47-3	5.0
D023	o-Cresol	95-48-7	200.0[a]
D024	m-Cresol 65794-96-9	108-39-4	200.0[a]
D025	p-Cresol	106-44-5	200.0[a]
D026	Cresol	--	200.0[a]
D016	2,4-D	94-75-7	10.0
D027	1,4-Dichlorobenzene	106-46-7	7.5
D028	1,2-Dichloroethane	107-06-2	0.5
D029	1,1-Dichloroethene	75-35-4	0.7
D030	2,4-Dinitrotoluene	121-14-2	0.13[b]
D012	Endrin	72-20-8	0.02
D031	Heptachlor (and its epoxide)	76-44-8/1024-57-3	0.008
D032	Hexachlorobenzene	118-74-1	0.13[b]
D033	Hexachlorobutadiene	87-68-3	0.5
D034	Hexachloroethane	67-72-1	3.0
D008	Lead	7439-92-1	5.0
D013	Lindane	58-89-9	0.4
D009	Mercury	7439-97-6	0.2
D014	Methoxychlor	72-43-5	10.0
D035	Methyl Ethyl Ketone (2-Butanone)	78-93-3	200.0
D036	Nitrobenzene	98-95-3	2.0
D037	Pentachlorophenol	87-86-5	100.0
D038	Pyridine	110-86-1	5.0[b]
D010	Selenium	7782-49-2	1.0
D011	Silver	7440-22-4	5.0
D039	Tetrachloroethene	127-18-4	0.7
D015	Toxaphene	8001-35-2	0.5
D040	Trichloroethene	79-01-6	0.5
D041	2,4,5-Trichlorophenol	95-95-4	400.0
D042	2,4,6-Trichlorophenol	88-06-2	2.0
D017	2,4,5-TP (Silvex)	93-72-1	1.0
D043	Vinyl Chloride	75-01-4	0.2

[a] If o-, m-, and p-Cresol concentrations cannot be differentiated, the total cresol (D026) concentration is used. The regulatory level of total cresol is 200 mg/L.

[b] Quantitation limit is greater than the calculated regulatory level. The quantitation limit, therefore, becomes the regulatory level.

-- No standard exists
CAS = Chemical Abstracts Service
CFR = Code of Federal Regulations
USEPA = U.S. Environmental Protection Agency

Table B-2. Maximum Concentration of Hazardous Waste Characterization Analytes (40 CFR 261.21-23)

USEPA Hazardous Waste Number	Analyte	CAS Number	Aqueous Reporting Limit	Solid Reporting Limit
D002	pH/Corrosivity	Q183	$2 \leq pH \leq 12.5$	--
D003	Cyanide, total[a]	57-12-5	See Note.	
D001	Flashpoint	Q376	<140°F	<180°F
D003	Sulfide, total[a]	Q1314	See Note.	

Note: USEPA requires generators to use their knowledge to make a D003 determination per CFR 261.23(a)(5) for cyanide or sulfide-bearing wastes.
-- No standard exists
CAS = Chemical Abstracts Service
CFR = Code of Federal Regulations
USEPA = U.S. Environmental Protection Agency

Table B-3. Regulatory Level for PCB Waste Classification (40 CFR 761.60)

Contaminant	CAS Number	Regulatory Level
PCB-1016	12674-11-2	Combined concentration of 50 ppm
PCB-1221	11104-28-2	
PCB-1232	11141-16-5	
PCB-1242	53469-21-9	
PCB-1248	12672-29-6	
PCB-1254	11097-69-1	
PCB-1260	11096-82-5	
PCB-1262	37324-23-5	
PCB-1268	11100-14-4	

CAS = Chemical Abstracts Service
PCB = Polychlorinated Biphenyl
ppm = Parts per Million

Table B-4. IDW Disposal Options for Potential Waste Streams

Waste Stream	Municipal Waste	Non-Hazardous Waste	Hazardous Waste
Solid (soil)	N/A	Dispose of offsite at permitted waste facility	Dispose of offsite at permitted hazardous waste facility
Liquid (decontamination fluids – water, Liquinox®, Alconox®, isopropanol, nitric acid)	N/A	Dispose of offsite at permitted waste facility	Dispose of offsite at permitted hazardous waste facility
Expendable sampling equipment and trash	Dispose of as municipal trash offiste	N/A	N/A

IDW = Investigation-Derived Waste
N/A = Not Applicable

Figure B-1. Example of Waste Storage Container Label Information

Drum Number: Leidos-B1048FS-L-001
(for purge/decontamination water)

Contents: (Purge/Decontamination Water)

Source of Waste: Vapor Intrusion Sampling

Source Location: Building 1048 Fire Station

Generation Dates: Day/Month/Year

Address: 8451 State Route 5, Ravenna Ohio 44266

Contact: Katie Tait (614) 366-6136, Charles Spurr (216) 317-5726

Notes:

The second suffix in the drum number is the abbreviation of the AOC associated with the waste.

Figure C-1 is an example of what information should be used on a Pending Analysis or Non-Hazardous Waste label. Pending Analysis labels are required prior to knowledge of waste characterization sampling results. Non-Hazardous Waste labels can be used once the waste is characterized as non-hazardous.

AOC = Area of Concern
B1048FS = Building 1048 Fire Station
IDW = Investigation-Derived Waste
L = Liquid IDW

ATTACHMENT B-1

CJAG WASTE MANAGEMENT

- CJAG Waste Management Guidelines
- CJAG Weekly IDW Inspection Sheet
- Waste Disposal Tracker

CJAG WASTE MANAGEMENT GUIDELINES

PURPOSE: Guidelines to be followed by contractors working at Camp James A. Garfield Joint Military Training Center who are generating/shipping Hazardous, Non-Hazardous, Special or Universal Waste.

POLICY: The policy at CJAG is to comply with all local, state, federal and installation requirements. Contractor is responsible for waste minimization and is required to recycle materials if possible.

Restoration Program POC: Katie Tait (614) 336-6136 **Military & Non-Restoration POC: Brad Kline (614) 336-4918**

Coordination:

- Coordinate all waste generation and shipments with the appropriate CJAG POC listed above or the Environmental Supervisor in their absence at (614) 336-6568.
- Notify CJAG POC prior to waste sampling for characterization. Details about sampling activities must be included (i.e., number of sample, analyticals, etc.).
- All Hazardous and Non-Hazardous waste management storage locations must be pre-approved prior to generation.
- Ensure all labels include: Date, Contractor, and Waste Type.
- When contractors have waste onsite, a weekly Inspection inventory must be completed and submitted to the appropriate POC in the CJAG environmental office.
- All wastes shall be tracked and logged throughout the duration of the project. Contractor will provide CJAG POC with a monthly rollup report of all waste and recycled streams generated by no later than the 10th day of the following month.

Hazardous Waste Treatment, Storage and Disposal Facilities and Waste Haulers: Contractors are required to utilize hazardous waste haulers and Treatment, Storage, and Disposal Facilities on the latest Defense Reutilization Marketing Office (DRMO) approved list. The current qualified waste hauler and TSDF list can be viewed by following the “Qualified Facilities” and “Qualified Transporters” links found on the DLA Hazardous Waste Disposal Homepage, http://www.dispositionservices.dla.mil/newenv/hwdisposal.shtml.

Hazardous or Non-Hazardous manifest form, the following must be included:

- Military and non-restoration operations waste Site Name = Camp James A. Garfield Joint Military Training Center. Mailing and Site address: CJAG ENV, 1438 State Route 534 SW, Newton Falls, Ohio 44444, (614) 336-4918. Ohio EPA ID # – OHD981192925.
- Restoration Program waste Site Name = Former Ravenna Army Ammunition Plant. Mailing address is same as address above. Site address: 8451 State Route 5, Ravenna, Ohio 44266, (614) 336-6136. Ohio EPA ID # – OH5210020736.
- Contractor’s shipping Hazardous Waste must provide a Land Disposal Restriction (LDR) in accordance with 40 CFR Part 268.
- Profiling:
  - The required shipping documentation (i.e. waste profile and executive summary of lab reports (if available)) need to be submitted to appropriate CJAG POC or designee(s) for approval and signature prior to shipping.
  - Results of characterization must be submitted to appropriate CJAG POC within 30 days after collecting sample.
- Manifests - Hazardous and Non-Hazardous:
  - The waste carrier/transporter provides appropriate manifest to the contractor.
  - The contractor is required to:
    - Ensure that CJAG POC or designee(s) is available to sign the manifest on the scheduled day of shipment;
    - Verify that each manifest is properly completed and signed by CJAG POC or designee(s);
    - Provide the Generator copy of the manifest to CJAG POC or designee(s); and
    - Ensure that the original Generator copy of the manifest signed by the treatment storage disposal facility is returned to CJAG within 30 days of the shipping date for Hazardous and Non-Hazardous Waste.
    - The use of a Bill of Lading, in lieu of a waste manifest, must be approved by the CJAG environmental office.

All satellite accumulation storage sites and containers will comply with 40CFR 262.34(c)(1):

- Any material that is subject to Hazardous Waste Manifest Requirements of the US Environmental Protection Agency must comply with 40 CFR Part 262.
- From the time any waste is placed in a satellite storage container, proper labeling must be on the container (proper labeling includes date, contractors name and product type).
- Pending analysis label is to be used from the time the sample is taken until the results are received.
- In no case will waste labeled pending analysis exceed 45 days.

All CJAG Hazardous and Non-Hazardous records are maintained at the CJAG environmental office, point of contacts are Katie Tait at (614) 336-6136 and Brad Kline at (614) 336-4918.

CJAG WEEKLY NON-HAZARDOUS & HAZARDOUS WASTE INSPECTION/INVENTORY SHEET

Contractor: ____________ **Month:** _________________ **Year:** ____________ **Waste Description:** ____________

Container Nos. ____

	WEEK 1	WEEK 2	WEEK 3	WEEK 4
	Date: **Time:**	**Date:** **Time:**	**Date:** **Time:**	**Date:** **Time:**
Point of Contact (Name / Number)				
Project Name:				
Contracting Agency and POC:				
Waste Determination: Pending Analysis, Hazardous, Non-Hazardous, etc.				
*Location on installation:				
Date Generated:				
Projected date of disposal:				
Non-Haz, Satellite, 90 day storage area				
Waste generation site:				
Number of Containers (size / type):				
Condition of Container:				
Containers closed, no loose lids, no loose bungs?	yes / no	yes / no	yes / no	yes / no
Waste labeled properly and visible (40 CFR 262.34 (c) (1):	yes / no	yes / no	yes / no	yes / no
Secondary containment	yes / no	yes / no	yes / no	yes / no
Incompatibles stored together?	yes / no	yes / no	yes / no	yes / no
Any spills?	yes / no	yes / no	yes / no	yes / no
Spill kit available?	yes / no	yes / no	yes / no	yes / no
Fire extinguisher present and charged?	yes / no	yes / no	yes / no	yes / no
Containers grounded if ignitables?	yes / no / na	yes / no / na	yes / no / na	yes / no / na
Emergency notification form/info present?	yes / no	yes / no	yes / no	yes / no
Container log binder present?	yes / no	yes / no	yes / no	yes / no
Signs posted if required?	yes / no	yes / no	yes / no	yes / no
Photos submitted	yes / no	yes / no	yes / no	yes / no
Printed Name:				
Signature:				

This form is required for Non-Hazardous and Hazardous waste including PCB and special waste.

CONTRACTORS ARE REQUIRED TO SUBMIT THIS FORM <u>WEEKLY</u> TO THE CAMP RAVENNA ENV OFFICE WHEN WASTE IS STORED ON SITE.

CONTRACTORS ARE ENCOURAGED TO INCLUDE PHOTOS WITH EACH WEEKLY INSPECTION SHEET WHEN WASTE IS STORED ON SITE.

*Draw detailed map showing location of waste within the site.

-

Construction/Demolition Diversion and Waste Disposal Form/Tracker

Project Title ______________________________ **Project Number** ______________________

Date	Material Type*	Material Description**	Total Quantity of Material	Tons/lbs/CY/each	Total Number of Manifest/Disposal Tickets Attached

***Material Type:** C&D Debris, Recyclable/Reutilized Material, Universal Waste, TSCA Regulated Waste

****Material Description:**
C&D Debris (wood, glass, asphalt, concrete, soil, plastic etc…)
Recyclable Material (scrap metal and concrete etc….)
Universal Waste (bulbs, mercury containing devices, used batteries)
TSCA Waste (asbestos, PCB's, lead based paints)

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APPENDIX C

OHARNG ENVIRONMENTAL PROCEDURES

- C.1 – OHARNG Environmental Procedures
- C.2 – First Responder Form (Spill Response)

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C.1 – OHARNG Environmental Procedures

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OHARNG Environmental Procedures
Restoration Program Specific Version
15 July 2022

1. General

1.1. These Environmental Procedures identify environmental compliance requirements for Ohio Army National Guard (OHARNG) projects. The Environmental Procedures are intentionally broad in scope to ensure contractors have information needed to price and complete work knowing all the requirements. Contractors conducting work not specified in these procedures are considered to be in compliance with no specific action required.

1.2. The Contractor must comply with all applicable local, state, and federal environmental requirements to include applicable Army and OHARNG regulations. This includes, but is not limited to, the proper characterization, management and disposal of wastes; proper storage, use and transportation of hazardous materials; spill prevention and clean up; obtaining proper permits and submitting proper notifications as applicable to the work being conducted; and protection of surface water and natural resources.

1.3. The Contractor (to include subcontractors) will not correspond with any regulatory agency regarding an OHARNG project without approval of the OHARNG. This includes meetings, phone calls, emails, permit/application submittals, or other written or verbal communications. The OHARNG will review and approve all correspondence, to include permit applications and notifications, before they are sent to a regulatory agency to include but not limited to the federal or Ohio Environmental Protection Agency (EPA), the US Fish and Wildlife Service, the Ohio Historic Preservation Office, the US Army Corps of Engineers, County Engineer offices, and local Soil and Water Conservation offices.

1.4. The Contractor is responsible for paying all fees and acquiring all applicable permits or regulatory approvals associated with the work they are performing. Depending upon the permit/notification, it may need to be issued in the OHARNG's name. Coordination will be done with the OHARNG to determine this and as applicable the Contractor will complete the application/notification for OHARNG signature and submit the application and associated fees. All permit submittals will be coordinated, reviewed and approved by the OHARNG before submittal regardless of who signs the application.

1.5. Executive Order (EO) 13693, *Planning for Federal Sustainability in the Next Decade*, establishes a federal integrated strategy toward sustainability including efforts to "eliminate waste, recycle, and prevent pollution." Additionally, EO 13693 establishes targets to divert at least 50% of non-hazardous solid waste, including construction and demolition debris, from the waste stream. The Contractor will utilize the most current waste prevention, waste diversion (salvage, reuse, recycle), and waste minimization guidelines to ensure this target is met.

2. Emergency Spill Response and Petroleum, Oil, and Lubricant (POL) Management

2.1. The Contractor must comply with the local OHARNG Spill Contingency Plan and implement appropriate measure to prevent spills/releases to the environment and to respond, notify, and report when a release occurs. The Contractor is required to inspect equipment, fuel, and hazardous materials storage areas to ensure there are no leaks or releases. The Contractor is responsible for implementing spill response and cleanup of all spills/leaks within the project area immediately upon discovery. Clean up must be satisfactory to the OHARNG and/or the Ohio EPA or other applicable regulatory agency. Wastes will be managed as described in the waste management section of these Environmental Procedures.

2.2. The OHARNG will be notified of all spills/releases. Incidental releases (petroleum product less than 25 gallons, a release that stays of OHARNG property, not in water, and not a reportable quantity) will be responded to by the contractor and the OHARNG notified by telephone within 2-hours. Any spill of petroleum products over 25 gallons, a spill that goes off of OHARNG property, a spill of any amount into a body of water, or a reportable quantity release must be reported to the OHARNG **immediately**. All spills/releases must be reported in writing on the OHARNG Spill Report Form (Attachment 1) and submitted to the OHARNG within 24 hours. The Contractor will be provided with a copy of the OHARNG Spill Report Form and a point of contact for submitting such reports/notifications.

2.3. The Contractor is required to have a spill kit with appropriate absorbents, plastic bags, drums, shovels, and other supplies and equipment suitable to clean up any releases or spills from their activities.

2.4. Contractor stationary fuel pods must be in/on secondary containment with a storage capacity of 110% of the container. A double walled container is sufficient secondary containment. Releases of rain water from secondary containment can only be initiated after approval from the OHARNG Environmental Office and after inspection and verification/absorption of all petroleum, oil, and lubricants (POL) and/or other contaminants in the water by the Contractor. Discharge of POL or other contaminants/pollutants from secondary containment is not permitted. At minimum, discharging through an oil only boom/filter or an oil absorption filter bag is required. If the contractor cannot show proof of lack of contaminants, the water will need to be sampled and characterize to determine the proper discharge/disposal method. The contractor will document all discharges/disposal from secondary containments to include name and signature of person conducting discharge/disposal, date of discharge/disposal, volume discharged/disposed, method of discharge/disposal, method of determining water was clean to discharge (analytical result if applicable), and a statement that any discharge did not contain POL or other contaminants. Discharges from secondary containment will be addressed in the Waste Management Section of the Work Plan.

2.5. Individual fuel/POL cans (5 gallon or less) and hazardous materials used on job sites must be stored in a manner that prevents release to the environment. This will usually involve a covered storage area with appropriate secondary containment that protects them from rain and accidental damage. Chainsaw fuel and bar oil on logging jobs can be left at the tree felling site in the woods or brought out to the log landing each day.

3. Erosion Control, Storm Water and Other Surface Water Management

3.1. For all projects, regardless of the disturbance acreage, the Contractor will use all methods appropriate and required to prevent soil from leaving the project site either by wind, water, or on vehicles and equipment. Silt fence and other temporary soil run off detention methods will be used as needed. Spoil piles and disturbed areas will be managed in accordance with the stipulations outlined in the Ohio EPA General National Pollutant Discharge Elimination system (NPDES) Storm Water Construction Permit and the most current version of the Ohio Department of Natural Resources' Rainwater and Land Development Manual; Ohio's Standards for Storm Water Management, Land Development, and Urban Stream Protection (available on-line). The site must be seeded with a temporary seed mix if left idle for the designated period of time. The project site will be closed out by preparing the soil as a seed bed and seeding and mulching with the appropriate seed mix. Temporary erosion control measures (silt fence) will be removed by the contractor once vegetation has been established and soil on the project area is stabilized.

3.2. Native seed mixes will be used and compatible with maintenance requirements. An appropriate turf grass mix will be used for high traffic and high maintenance areas. Annual ryegrass can be added to mixes to provide quick cover. For late season seeding, winter wheat/rye can be added to provide a quick cover. Contractors will use the approved grass seed mixes listed below or propose alternative seed mixes. The OHARNG Environmental Office must approve all seed mixes. The seed mixes that will be used will be identified in the Storm Water Management, Sediment, and Erosion Controls section of the Environmental Work Plan.

The following seed is approved for establishment of temporary cover. Species can be mixed if/as necessary for specific application.

- Annual Rye Grass (*Lolium multiflorum*), broadcast @ 40 lbs/acre, drilled at 30 lbs/acre, mulch with a minimum of 3 bales of straw per 1000 square feet. Use mulch netting or fiber mat on slopes greater than 6%. Grows quickly but of short duration. Good growth during hot summer period.

- Winter Rye (*Secale cereal)* broadcast @ 112 lbs/acre, drilled at 80 lbs/acre, mulch with a minimum of 3 bales of straw per 1000 square feet. Use mulch netting or fiber mat on slopes greater than 6%. Good for fall seeding. Select a hardy variety.

- Oats (*Avena sativa*) broadcast @ 80 lbs/acre, drilled at 65 lbs/acre, mulch with a minimum of 3 bales of straw per 1000 square feet. Use mulch netting or fiber mat on slopes greater than 6%. Best for spring seeding. Fall seeding will die when winter sets in.

- 40% Nodding Wild Rye (*Elymus canadensis*), 40% Virginia wild rye (*Elymus virginicus*), 15% Partridge Pea (*Chamaecrista fasciculata*), and 5% Black-eyed Susan (*Rudbeckia hirta*), broadcast @ 35 lbs/acre, drilled at 25 lbs/acre, mulch with a minimum of 3 bales of straw per 1000 square feet. Add 20 lbs/acre of Annual Rye Grass (*Lolium multiflorum*) to the broadcast mix and 15 lbs/acre to the drilled mix. Good for areas that will remain unfinished indefinitely.

- 23.5% Nodding Wild Rye (*Elymus canadensis*), 25% Virginia wild rye (*Elymus virginicus*), 18.75% Partridge Pea (*Chamaecrista fasciculata*), 1.5% Black-eyed Susan (*Rudbeckia hirta*), and 31.25% Little Bluestem (*Schizachyrium scoparium*), broadcast @ 25 lbs/acre, drilled at 18 lbs/acre), mulch with a minimum of 3 bales of straw per 1000 square feet. Add 20 lbs/acre of Annual Rye Grass (*Lolium multiflorum*) to the broadcast mix and 15 lbs/acre to the drilled mix. Good for late season (after 15 September) quick temporary cover.

The following seed is approved for establishment of permanent cover in areas that are not maintained as turf grass or high foot traffic areas such as range impact areas that are not regularly mowed, roadsides outside of cantonment areas, fence lines outside of cantonment areas, etc. Substitution with similar species is permitted but must be approved by the OHARNG Environmental Office.

- 23.5% Nodding Wild Rye (*Elymus canadensis*), 25% Virginia wild rye (*Elymus virginicus*), 22% Little Bluestem (*Schizachyrium scoparium*), 18.75% Partridge Pea (*Chamaecrista fasciculata*), 7.75% Thin-leaved Coneflower (*Rudbeckia triloba*), 1.5% Brown fox sedge (*Carex vulpinoidea*), 1.5% Black-eyed Susan (*Rudbeckia hirta*), broadcast @ 18 lbs/acre, drilled at 12 lbs/acre, mulch with a minimum of 3 bales of straw per 1000 square feet. Add 20 lbs/acre of Annual Rye Grass (*Lolium multiflorum*) to the broadcast mix and 15 lbs/acre to the drilled mix. This mix is for use in open areas that receive good sunlight.

- 31% Deertongue (*Dichanthelium clandestinum*), 25% Virginia wild rye (*Elymus virginicus*), 25% Nodding Wild Rye (*Elymus canadensis*), 10% Big Bluestem (*Andropogon gerardii*), and 9% Side-Oats Grama (*Bouteloua curtipendula*), broadcast @ 30 lbs/acre, drilled at 20 lbs/acre), mulch with a minimum of 3 bales of straw per 1000 square feet. Add 20 lbs/acre of Annual Rye Grass (*Lolium multiflorum*) to the broadcast mix and 15 lbs/acre to the drilled mix. This mix is for use in shaded areas, partial sun, and openings in the forest canopy.

Areas that are maintained with regular mowing during the growing season and receive heavy foot traffic will be seeded with an appropriate turf grass mix. Such areas include lawns in cantonment areas, parade fields, and range operational control areas (ROCAs). Turf grass mixes of Kentucky blue grass, fine fescue, and perennial ryegrass using varieties appropriate for the specific application will be identified by the contractor and reviewed and approved by the OHARNG prior to application.

Contractors will provide draught resistant varieties in seed mixes. A potential mix and varieties are as follows.

- 40% Kentucky Bluegrass (applicable varieties), 30% Perennial Ryegrasses (applicable varieties), 20% Hard Fescue (applicable varieties), and 10% Creeping Red Fescue (applicable varieties)

3.3. For projects that disturb one (1) or more acres of ground (or otherwise meet the Ohio EPA criteria for permit coverage), the contractor is required to have a Storm Water Pollution Prevention Plan (SWP3) and should be included in the Work Plan. The Contractor is responsible for the development of Erosion and Storm Water Control (E&S) Plans and Details and the subsequent development of a Storm Water Pollution Prevention Plan (SWP3) in accordance with the requirements contained in the Ohio EPA General NPDES Permit for Storm Water Discharges Associated with Construction Activity. The Contractor will ensure that E&S controls and permanent post construction / water quality controls comply with Section 438 of the Energy Independence and Security Act of 2007 (EISA) and the latest version of the Ohio Department of Natural Resources publication titled **"Rainwater and Land Development - Ohio's Standards for Storm Water Management and Land Development and Urban Stream Protection" (available on-line)**.Most CERCLA projects do not require coverage under a applicable stormwater permit but all substantive requirements of the Ohio EPA General Permit for Construction Activities must be followed.

3.4. The Contractor will implement the SWP3 and conduct all inspections and maintain storm water/erosion controls in accordance with the SWP3 and Ohio EPA requirements. The Contractor will use the inspection checklist for storm water controls in the SWP3 or the Ohio EPA inspection checklist from the General Permit and will complete and maintain signed inspections on site in the SWP3 binder. Copies of weekly/post storm event inspections will be provided to the OHARNG project manager and Environmental Office monthly. The Contractor will notify the OHARNG project manager and Environmental Office immediately if there is a storm water control failure and off site discharge from the project area. Any proposed changes to the SWP3 must be coordinated with and approved by the OHARNG. The person conducting the stormwater inspections must be competent and well versed and have experience in stormwater management and inspections and proof of experience must be provided in the SWP3. The Contractor must keep a corrective action log during the project and document all deficiencies and corrective actions.

3.5. The Contractor will use best management practices or whatever means necessary to prevent contamination of storm water due to runoff from wastes, debris piles, fuel tanks, materials, equipment, and other storage/materials on the project site.

3.6. The Contractor is not permitted to disturb or fill any wetlands, streams, or other surface waters while performing tasks within the scope of work unless such disturbance or fill is specifically identified as a task in the scope and applicable permits and authorizations have been obtained. The Contractor will maintain a 30 foot undisturbed buffer around wetlands and depressional areas that hold water and will keep all equipment, materials, vehicles, debris, waste, and personnel out of this buffer and prevent discharges of any type (chemical or soil) from entering such areas.

3.7. The OHARNG Environmental Office must approve all dewatering activities. Dewatering will be addressed in the waste management section or dewatering section of the Work Plan if applicable to the project. Standing water must be characterized to determine if it is regulated before dewatering procedures are implemented. Characterization may be possible by generator knowledge or may require sampling and analysis. At minimum, discharges must meet water quality standards identified in Ohio Administrative Code 3745-1 and Ohio EPA requirements. If able to be discharged, at minimum, water must go through an oil absorption and/or an activated charcoal, and/or a sediment filter bag as appropriate, prior to being discharged. Discharge will be done in a vegetated upland area that drains away from the work site unless otherwise specified in the scope of work or authorized by the OHARNG Environmental Office. Discharge will be done so as to allow the discharge to filter through dense groundcover vegetation. The discharge hose will be set on a piece of plywood or rubber mat to disperse the water and prevent a concentrated discharge that can cut and erode soil. Direct discharge to a stream, pond, wetland, ditch or other body of water or conveyance is not permitted. If water does not meet state standards or approval for discharge, then it must be properly transported and disposed.

4. Waste, Recycling and Hazardous Waste

4.1. The OHARNG is the generator of all waste including wastes generated by any Contractor working on OHARNG projects of facilities. The Contractor is responsible for minimizing all waste generation from OHARNG projects and for properly managing all wastes generated from OHARNG projects in accordance with the Ohio Army National Guard Waste Management Guidelines (attached). Waste will be managed in accordance with all applicable Federal, State, U.S. Army, NGB and OHARNG regulations and requirements. OHARNG sites may have specific hazardous waste information / management guidelines that must be followed to ensure compliance with applicable regulations and requirements. The contractor must include all waste management in their Work Plan and coordinate all waste generation and management activities with the OHARNG Environmental Office prior to beginning work.

4.2. The Contractor is responsible for characterizing all waste generated from a project and notifying the OHARNG of all waste streams, management methodology, and disposal methods prior to beginning work. If an alternative practice is available that will eliminate, recycle or minimize waste generation, the contractor is required to implement such practice.

4.3. The Contractor is responsible for properly labeling, storing, and inspecting non-hazardous, special, and hazardous waste stored at the project site pending disposal. All containers on the project site will be labeled as to the contents, whether waste or otherwise. All waste stored on site must be inspected weekly using the Ohio Army National Guard Weekly Non-Hazardous and Hazardous Waste Inspection/Inventory Sheet (attached).

4.4. The Contractor is responsible for properly completing all waste profiles, waste manifests, and shipping documents (hazardous, special and non-hazardous waste). Such documents will be reviewed, approved, and signed by the OHARNG Environmental Office. No waste will leave the site until the shipping documents are reviewed, approved and signed by the OHARNG Environmental Office. The Contractor is responsible for weighing and documenting all waste material (regulated, diverted, landfilled) leaving the site. The Contractor will complete a Construction/Demolition Diversion and Waste Disposal Form (attached) or other waste tracker and provide supporting documentation (weight tickets, manifests etc.) to the OHARNG at the end of the project. Contractors may be asked to provide monthly waste totals for waste total reporting and for monthly Ohio EPA update reports.

4.5. The Contractor is required to recycle materials when possible and practicable. Recycled materials must be tracked using the Construction/Demolition Diversion and Waste Disposal Form (attached). Materials that cannot be recycled or repurposed must be properly disposed at an appropriate waste handling facility.

4.6. The Contractor is required to utilize qualified Defense Logistics Agency (DLA), Defense Marketing and Reutilization Organization (DRMO) waste haulers and Treatment, Storage, and Disposal Facilities (TSDFs) for hazardous waste. The current qualified waste hauler and TSDF list can be viewed by following the "Qualified Facilities" and "Qualified Transporters" links found on the DLA Disposition Services' Hazardous Waste Disposal Homepage, http://www.dla.mil/DispositionServices/Offers/Disposal/HazardousWaste/HazWasteDisposal.aspx.

4.7. Gray water, vehicle wash water, and other liquid wastes (to include extracted groundwater and water from dewatering) generated by the Contractor will be managed in accordance with the waste management guidance in this section and applicable federal, state, and local regulations. Liquid waste will not be discharged to the land surface, surface water, storm drain/ditch, or a sanitary sewer unless properly characterized and done in accordance with applicable laws and applicable permit conditions. Liquid waste will be characterized and proper management and disposal methods identified and implemented. Guidance on construction site dewatering is provided above.

5. Asbestos

5.1. All asbestos activities, including any disturbance or removal, must be conducted in accordance with applicable Federal, State, and local regulations. Asbestos must be properly handled, removed, containerized, and disposed of in accordance with applicable Federal, State, and local regulations. The Contractor will complete a Construction/Demolition Diversion and Waste Disposal Form (attached) and provide supporting documentation (weight tickets, manifests etc.) for all wastes generated to the OHARNG at the end of the project. Asbestos removal methods and disposal operations will be detailed in the Work Plan to be reviewed and approved by the OHARNG Environmental Office prior to the start of work activities. All abatement activities will be conducted by a licensed abatement contractor in accordance with applicable Federal, State, and local regulations and guidance. All asbestos wastes generated as part of demolition activities and/or abatement activities must be disposed of in a licensed asbestos landfill. Disposal manifests and/or Regulated Asbestos Material Waste Shipment Records for all asbestos waste must also be signed and approved by an OHARNG Environmental Office representative or a representative designated by the Environmental Office prior to shipment from the project site or OHARNG facility.

5.2. As required for asbestos projects, the Contractor is required to submit a completed Ohio Environmental Protection Agency (EPA) Notification of Demolition and Renovation Form to the OHARNG for review and approval 30 days prior to commencement of asbestos work. Upon receipt of written approval from the OHARNG Environmental Office, the approved notification and associated notification fee must be submitted to the Ohio EPA at least 10 business days prior to commencement of work. Under no circumstances is the Contractor to submit any correspondence to the Ohio EPA or any other regulatory agency without written approval from the OHARNG. Copies of all correspondence from the Ohio EPA or any other regulatory agency must be submitted to the OHARNG Environmental Office upon receipt. If requested, the Contractor must provide a copy of the asbestos survey to the regulatory agency.

5.3. The Contractor is required to develop and submit a Work Plan that includes asbestos abatement to the OHARNG for review and approval prior to the commencement of work. The work plan will specify the procedures to be utilized by the contractor to ensure compliance with all applicable State and Federal asbestos regulations. The work plan will address the abatement techniques to be used, the safety precautions to be taken, and emergency procedures to be implemented in the event of inadvertent exposure. Proof/copies of proper and current contractor licensure must also be included in the work plan. The work plan will also address how the asbestos waste is to be handled, stored, transported, and disposed of in accordance with all applicable regulations. Site clearance procedures must be addressed in the plan if applicable. The plan must contain a detailed description of the project activities, including the amount of asbestos to be abated, the exact location and type of asbestos, and whether or not a contained work site will be established as required by 29 CFR Part 1926.1101.

5.4. Asbestos contractors must be properly licensed in accordance with applicable local, State, and Federal regulations. Only licensed contractors approved and licensed through the Ohio EPA will be utilized on OHARNG asbestos abatement projects. The contractor will show proof of license and will maintain appropriate paperwork on the work site at all times. Work is to be performed in accordance with 29 CFR 1926.1101 (OSHA Asbestos Construction Standard) and 40 CFR Part 61 (Asbestos NESHAPS) in addition to accepted industry work procedures and other applicable local, State, and

Federal regulations. The onsite Superintendent must be a ‘competent person’ as defined in 29 CFR 1926.1101(b) and must be onsite full time during the project.

5.5. The Contractor is responsible for managing all asbestos waste generated during the project. Any asbestos removed must be properly abated, containerized, managed, labeled and disposed of as an asbestos waste in accordance with applicable local, State, and Federal regulations. Asbestos waste must be properly transported to an approved, licensed asbestos disposal facility. Waste shipment records must be maintained during transport. A final copy of the waste shipment record will be forwarded to the OHARNG within 30 days for recordkeeping. A representative from the OHARNG Environmental Office will review and sign all waste profiles and manifests generated as the result of any asbestos abatement activities prior to the shipment of the waste from an OHARNG facility to a disposal facility.

6. Earth Fill

6.1. Any earth fill brought on site must be free of chemical contaminants and organic material (plant or animal parts). The contractor will identify the source of earth fill in the Work Plan.

6.2. Fill material must be sampled prior to coming onsite. One sample will be collected using incremental sampling methodology (ISM) or composite sampling for every 4,000 cubic yards of earth fill. This quantity of earth fill must come from the same source or an additional sample must be collected. The samples will be analyzed for the following parameters: VOCs (total compound list), SVOCs (total compound list), pesticides (total compound list), PCBs, Explosives, Nitro-glycerine, Nitro-guanadine, Nitrocellulose, TAL Metals, pH. The results will be screened by the contractor against a provided list of facility background levels. The earth fill must be approved by the OHARNG and, at a minimum, be at or below the facility-wide background values.

7. Natural Resources

7.1. Threatened and Endangered Species

The OHARNG has training areas and facilities throughout the State of Ohio. Both federally and state listed rare species have been identified at a few OHARNG locations and all OHARNG locations are within the known ranges of other listed species. The OHARNG is required to protect listed species. In addition, there are migratory birds that nest in vegetation and structures on OHARNG property. The Migratory Bird Treaty Act prohibits harm to nesting migratory birds, their eggs, and their nests (with the exception of a few introduced species). The Contractor is responsible for doing everything possible so as to not intentionally or unintentionally harm any listed or protected species at any OHARNG facility. Immediately prior to the action commencing, the contractor will perform a thorough inspection for nesting birds, inhabiting bats, or other animals within the project area (structure(s), construction site, etc.). This thorough search will be to determine if any bats, birds, or other animals are present within the work area (under roof flashing, under siding, nesting in brush, etc.). The Contractor will also remain alert for the presence of any animals during project implementation. This is particularly important for demolition because animals may be utilizing old/abandoned buildings or structures. If any animals are found, the contractor will stop work in that area and immediately notify the project manager and the OHARNG Environmental Office.

The OHARNG can impose project specific restrictions on activities due to regulatory requirements. Any such project specific restriction will be identified in the project scope of work and/or contract language and discussed with the contractor prior to bidding and commencement of work. The Contractor is required to comply with any such restrictions.

7.2. Mowing

There are no seasonal mowing restrictions on maintained lawns, grassland rights-of- way, and easements that are regularly mowed and maintained at a height of less than 10 inches. Grass and brush that is allowed to grow more than 10 inches tall during bird nesting season becomes suitable habitat for grassland nesting birds and will not be mowed between 15 April and 15 August unless the Contractor has confirmed the absence of nests and nesting birds to the satisfaction of the OHARNG Environmental Office**.**

7.3. Vegetation Clearing and Tree Trimming

The Contractor must inform the OHARNG Environmental Office of their intended schedule a minimum of two weeks in advance of a vegetation clearing, tree cutting/felling, or tree trimming project. The OHARNG will determine if the proposed work dates are within the allowable window for the location and type of work being conducted. If work is proposed within the restricted time period, the Contractor will have to reschedule the work.

Tree and vegetation clearing, brush cutting, tree felling/cutting (height equal to or greater than 24" above ground) and tree trimming of any branches and any other part of the tree that is at least three inches in diameter, can only occur between 1 October and 31 March. Abandoned wood utility poles are treated as trees in the sense that they can only be felled between 1 October and 31 March.

When clearing trees the contract specification will identify if the trees must be removed and hauled off site by the contractor or if they will remain on site to be salvaged by the government. The government will salvage trees when they are determined by the OHARNG Forester to have adequate commercial value as sawtimber or another forest product. When trees remain on site the Contractor will transport them and neatly stack them in a location designated by the OHARNG. If taken offsite, the Contractor will recycle the material as firewood, biomass, mulch, fuel chips, or some other reuse.

When trees are salvaged as sawtimber, all 8' 6" and longer straight portions of the trees up to a 10" diameter outside bark top that are felled will be limbed and neatly stacked in a location designated by the OHARNG. Limbing will consist of cutting limbs flush to the boll of the trees. Branch stubs are not permitted. Trees will be kept and stacked in as long of lengths as possible and under no circumstance less than 8'6" long. Pieces shorter than 8'6" are not suitable for sawtimber salvage. The Contractor will not cut otherwise longer tree sections to a length less than 8' 6" to avoid managing them a as sawtimber.

When trees are salvaged for firewood and/or biomass, all portions of the trees down to a 4" diameter top will be cut into 4.5' to 9' lengths and neatly stacked in an area designated by the OHARNG. Firewood salvage will include sawtimber sized trees that have poor form or are too short to be sawtimber and sawtimber topwood.

Limbs, branches, brush and tree parts not salvaged will be removed from the site and recycled. This material will be chipped prior to removal. If only a small amount of chips are generated and the work is not within a cantonment or other maintained area, the chips will be blown/scattered in adjacent unimproved areas/woodlands. Piles of chips are not permitted and chips will not be placed in wetlands. Brush can be ground or chipped in place as part of the clearing operation.

7.4. Stumps

Stumps will be ground or excavated in accordance with contract specification requirements. Stumps that are two feet tall or taller will not be ground or removed between 1 April and 30 September. Grinding of all stumps (to include major roots) will be to a minimum depth of 6 inches below ground surface. Grindings will be managed as directed by the project specifications. If in an upland area, chips can be spread on site adjacent to the stump. Grindings will not be spread in wetlands. If the area is not being leveled and re-graded, stump holes must be leveled and filled with clean fill dirt and top soil. Piles of grinding and chips will not be left on the project area or anywhere in a mowing zone.

The Contractor will not place chips or any parts of trees, brush, or any type of fill into any wetland including but not limited to ditches, streams, floodplain areas, wet spots or low areas. Stumps in wetlands will not be ground or excavated without a wetland permit and prior approval of the OHARNG Environmental Office.

If stumps are excavated, the contractor is required to remove and properly dispose of the stumps offsite or as otherwise specified within the project specifications. Surface disposal or burial on OHARNG property is not permitted.

7.5. Vegetation Establishment

The Contractor is responsible for ensuring the establishment of vegetative cover and soil stabilization of the project area and must use all means available and necessary to accomplish this. Straw erosion mats, rip rap, geo-cell, or other applicable soil stabilization methods, when needed, will be proposed to the OHARNG and approved before implementation. The contractor will utilize native vegetation. Vegetation to be used on a project will be identified in the Work Plan.

The Contractor is required to prepare an adequate seed bed prior to seeding. The seed bed must consist of clean, weed free top soil and must be broken up and loose and suitable for seed germination. Fertilization will be required if the soil is poor and/or nutrient levels are low. Lime will be applied as necessary to adjust the soil pH to the recommended level for the seed being sown.

An appropriate turf grass mix will be used for high traffic and high maintenance areas. Annual ryegrass can be added to mixes to provide quick cover. For late season seeding, winter wheat/rye can be added to provide a quick cover. Contractors will use approved grass seed mixes provided by the OHARNG. The OHARNG Environmental Office must approve all seed mixes. Seeding must be mulched with at least 2 inches of straw mulch if broadcast seeded, an appropriate fiber matting, or an appropriate cover if hydro-seeded. Seed drilling usually does not require mulch.

8. Cultural Resources

If during a project, the Contractor makes an inadvertent discovery of human remains, funerary items, animal remains, household artifacts or other artifacts, they will immediately stop work. All remains and artifacts will be left in place and measures taken to protect the site and artifacts from pilferage and damage will be implemented. The project manager, contracting office, and OHARNG Cultural Resources Manager will be notified immediately. In the event that human remains are identified, the on-site OHARNG security personnel or Range Control must be immediately contacted to allow them to contact the appropriate law enforcement agency.

9. Unanticipated Munitions Discovery

If unanticipated munitions, MEC, or MD are encountered at a work site, ground disturbing work will stop immediately, personnel will vacate the area, the area will be secured to keep personnel out, and the Contractor will immediately notify the USACE Project Manager and OHARNG Range Control. The OHARNG will investigate the discovery and coordinate with the appropriate UXO or Explosive Ordinance Division (EOD) support personnel. Contractor work in the area of the munitions will be suspended until the area is made/ declared safe by a qualified munitions/EOD technician. If the discovery of munitions results in the need to change the scope of work and/or contract terms, such changes will be determined by the Army team. Should the overall project require munitions investigation or removal or UXO construction support, details will be provided in the project-specific SOW or PWS.

10. Other

Keys shall be obtained and signed out from the OHANRG environmental office or CJAG logistics. Keys shall be returned after each field activity to the appropriate location. Keys shall not be copied or destroyed.

Positive drainage and grading shall be established and conducted by the Contractor in all disturbed project areas. This includes remediation areas, ruts, access/haul routes, laydown areas etc. Areas must be returned to conditions prior to disturbance. OHARNG/ARNG will approve final conditions.

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C.2 – First Responder Form (Spill Response)

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QRG 2.2 FIRST RESPONDER REPORTING FORM

Collect as much of the information on the top half of this form as possible before making initial notification. Complete the top and bottom of the form before turning in to Range Operations.

Name of individual reporting spill: ____

When did the spill occur (Date and Time)? ____

Spill Location (Building or area name / number, indoors or out; if vehicle involved, type and bumper number):
____

What was spilled? ____________________ **How much was spilled?** ____________________

Rate at which material is currently spilling. ____

Extent of spill travel? ____

Did the spill reach water (ditch, creek, stream, pond, well head)? ______________________________

Number of injured personnel and type injuries, if applicable. ______________________________

Do you need the Fire Department to respond to protect life, property, and environment? ____________________

Unit: ____________________ **State:** __________ **Report Date & Time:** ____________________

On Scene Coordinator Name and Grade: ______________________________ **Phone:** ______________

How did the spill occur (be specific)? ____
____

What remedial action was taken? ____
____

Was soil and absorbent material generated? __________ **How much?** ______________________________

What is the location of the soil and absorbents? ____

Was the Environmental Office contacted (yes or No, date and time)? ______________________________

Who did you talk to in the Environmental Office? ____

Was the site cleared by the Env. Office (Yes or No, date and time)? ______________________________

Who cleared the site (name and grade, date and time)? ____

Initial information is critical. Get as much information as you can, but don't hesitate to make the initial notification if a spill is moving or worsening rapidly!

This form must be completed for all releases and turned-in to CJAG Range Operations within 24 hours.

FIRST RESPONDER SPILL/RELEASE RESPONSE ACTIONS

Units or contractors performing training or other operations at Camp James A. Garfield shall be responsible for adhering to the provisions identified in the Integrated Environmental Contingency Plans (IECP). A copy of the IECP may be obtained from the Camp James A. Garfield Environmental Supervisor. Following discovery of a spill (any size), the procedures outlined below shall be executed where applicable:

1. **If necessary, initiate evacuation of the immediate area.**
2. **Notify Camp James A. Garfield Range Operations via two-way radio or by calling (614) 336-6041, and report information contained on the "First Responder Reporting Form" if it is known or can reasonably be determined. This form has been copied on the opposite side of this page. If Range Operations cannot be reached, contact a Camp James A. Garfield OSC (listed below).**
3. **Stop spill flow when possible without undue risk of personal injury.**
4. **If trained, contain the spill using available spill response equipment or techniques.**
5. **Make spill scene OFF LIMITS to unauthorized personnel.**
6. **Restrict all sources of ignition when flammable substances are involved.**
7. **Report to the OSC upon his/her arrival to the scene. Turn in a completed copy of the Camp James A. Garfield First Responder Form to Range Operations for ALL releases, even ones cleaned up by the reporter.**

TELEPHONE NUMBER

When Camp James A. Garfield Range Operations is *not available*, the OSC *must be contacted* by the discoverer/first responder following a release if it is in water, at or above a reportable quantity (25 gallons or more of POL), a hazardous or extremely hazardous substance, a hazardous waste, or involves fire, explosion, or is otherwise a major incident.

NAME	JOB TITLE	OFFICE	24 HOUR
Camp James A Garfield Range Operations	**Operations and Training**	**(614)336-6041**	**(614) 202-5783**
Tim Morgan (Primary OSC)	**Environmental Supervisor**	**(614)336-6568**	**(330)322-7098**
Brad Kline (Alternate OSC)	**Environmental Specialist**	**(614)336-4918**	**Contact Alternate**
Katie Tait (Alternate OSC)	**Environmental Specialist**	**(614)336-6136**	**Contact Alternate**
Joint Forces Command (Alternate POC)	**OHARNG Emergency Center**	**(888)637-9053**	**(888)637-9053**

Off-site (from Camp James A. Garfield area code 614 phones)

Ravenna Dispatch 9-1-330 296-6486

SEE REVERSE FOR FIRST RESPONDER REPORTING FORM

APPENDIX D

PROJECT PLANNING SESSION PRESENTATION AND MEETING MINUTES

Project Planning Session
Former Ravenna Army Ammunition Plant
Meeting Minutes (Revision 1)

Teleconference Information

DATE: July 18, 2023 (Tuesday)
TIME: 12:30-2:00 p.m. EST
CONFERENCE CALL-IN INFORMATION: (855) 534-3677 Conference ID: 822476524
Microsoft Teams: https://gov.teams.microsoft.us/l/meetup-join/19%3agcch%3ameeting_cda85b1ea1d341708ecc6d0bdfcc2f13%40thread.v2/0?context=%7b%22Tid%22%3a%22b64da4ac-e800-4cfc-8931-e607f720a1b8%22%2c%22Oid%22%3a%220ba6af77-6847-4d7d-a264-ea9e7b8ae673%22%7d

Presentation

Leidos Presentation: Project Planning Session For Investigations at the Former Ravenna Army Ammunition Plant, July 18, 2023
Handouts:
1) RVAAP_Project Planning Session_0782023_FINAL (MS PowerPoint presentation)
2) Figures that are in the presentation

Attendees

U.S. Army Corps of Engineers: Steve Kvaal
OHARNG: Katie Tait
Ohio Environmental Protection Agency: Megan Oravec, Kevin Palombo, Nick Roope, Ed D'Amato
Leidos: Jed Thomas, Mike Barta, Ryan Laurich, Sarah Kosbab

Scope of Meeting

Discuss sampling strategy presented in the following UFP-QAPPs:
- RVAAP-34 Sand Creek Disposal Road Landfill – Additional Delineation Sampling
- CC RVAAP-69 Building 1048 Fire Station – Vapor Intrusion Study for Building 1037
- CC RVAAP-78 Quarry Pond Surface Dump – Remedial Investigation of Asbestos
- Multiple Areas of Concern - Additional Remedial Design Sampling
    - RVAAP-38 NACA Test Area,
    - RVAAP-42 Load Line 9,
    - RVAAP-45 Wet Storage Area,
    - CC RVAAP-76 Depot Area

Meeting Minutes

The following minutes supplement the presentation referenced above. If notes are not provided for a slide, no additional dialogue occurred beyond what is presented in the slide.

Slide 1: Title Slide

- Jed Thomas initiates the meeting.
- All attendees are introduced.

Project Planning Session
Former Ravenna Army Ammunition Plant
Meeting Minutes (Revision 1)

Slide 2: Purpose of Project Planning Session

- Jed indicates that the Project Planning Session is done, in part, to define the purpose and expected results of the project and the final products and deliverables for the project. Worksheet 9 of the UFP-QAPP documents the Project Planning Session(s).
- Jed comments that the UFP-QAPPs have been submitted as Preliminary Draft stage and are undergoing Army review.
- Jed clarified that the scope of this contract is to perform sampling and investigation. The contract does not include removal or remedial actions.

Slide 3: Project Team

- Megan Oravec states that currently Ed D'Amato is the Ohio EPA Site Coordinator for CC-RVAAP-69 Building 1048 Fire Station, CC-RVAAP-78 Quarry Pond Surface Dump, and the Multiple Areas of Concern investigation. The Ohio EPA Site Coordinator(s) for the other sites are not yet determined.

Slides 4-8: RVAAP-34 Sand Creek Disposal Road Landfill Additional Delineation Sampling

- Katie Tait notes that there are plans to demolish the nearby buildings.
- Ed asks what sampling was used to determine the extent for the removal action.
    - Jed responded that the removal areas were the extent of the ISM areas sampled during previous investigations. Discrete and ISM samples were collected as confirmation samples during and after the removal action. Discrete samples are planned for the investigations presented in this Project Planning Session.
- Jed summarizes the icons associated with the figure on Slide 7 (and subsequent figures).
    - Red triangles are locations that exceeded CUGs, and green triangles are locations that did not exceed CUGs.
    - If the excavation floor sample results were below the CUG, no more floor samples were taken.
    - If the excavation wall samples were below the CUG, then there was no step-out sampling.
    - The squares represent proposed step-out soil sample locations.
- Kevin asked if the proposed samples will be the basis for removal.
    - Jed responded by saying the removal will go up to locations where samples are below the CUG.
- Nick Roope asked how frequent the bank of Sand Creek floods.
    - Katie responded that it is not monitored, but it does have frequent high water.
    - Ryan Laurich noted that a monitoring well immediately adjacent to Sand Creek is showing signs of erosion.
    - Katie said that water from Sand Creek did not enter into the excavations during removal action activities.
- Katie mentioned that some restoration actions will be necessary during excavation activities.

Slides 9-15: CC RVAAP-69 Building 1048 Fire Station Vapor Intrusion Study of Building 1037

- Kevin asks if it is correct that the focus will be on the vapor intrusion of Building 1037 and the groundwater sampling.
    - Jed confirmed that is correct.
- Kevin asks if Building 1034 at the Motor Pool is occupied and if there is a concern for vapors.
    - Katie responds that there are maintenance activities being done currently, however eventually all those activities will be moved to a different site. Regarding occupation, no one is there for the full 8 hr day and there are also large garage doors.
- Nick Roope made a comment that risk assessors consider showers a preferential pathway for VI.
    - Katie responded that the shower rooms are used for storage but is unsure about the drains and if they have been plugged or not.
- Ryan commented that Charles Spurr (of Leidos) is familiar with the area and has experience doing VI studies.
- Jed commented that the VI study and groundwater study are treated as separate studies. The next step would be to develop the FS.
- Kevin asked if there was a tank where the groundwater data shows the highest COC concentrations.
    - Katie responded that carbon tetrachloride was stored in the tank near the highest COC concentration in groundwater.

Slides 16-19: CC RVAAP-78 Quarry Pond Surface Dump Remedial Investigation of Asbestos

- Jed notes that the results will be incorporated into an RI Report for asbestos.
- Kevin asked if trenches were 14 ft deep and if there were any other contaminants besides ACM.
    - Jed confirmed that the trenches will be 14 ft deep and that ACM is the only contaminant being assessed in this investigation.
- Katie commented that it's hard to see ACM in soil borings and trenching is a better method to determine extent.
- Mike Barta stated the trenches will get near the road to the west but is not expected to impact the road.

Slide 20: Multiple Areas of Concern

- Kevin points out that there is a typo on Slide 20: "RVAAP-38 NACA Test Area: Area 1, Area 2, and Area 2." The last area should be Area 3.

Slides 21-23: RVAAP-38 NACA Test Area Additional Remedial Design Sampling

- Kevin asks if the plane fuel from crash tests is the source of the COCs.
    - Katie confirms that jet fuel was used but is unsure if that is the sole source of contamination.
    - Jed notes that besides the Well Pit (contaminated with lead), all of the COCs at the site are PAHs.

Slides 24-26: Load Line 9 Additional Remedial Design Sampling

- Regarding the figure:
  - Leidos will change the green icon at LL9cs-144M to red, as the location had an exceedance.
  - Leidos will change the red icon at LL9cs-142M to green, as the location did not have any exceedances.

Slides 27-28: Wet Storage Area Additional Remedial Design Sampling

- Kevin asked why the site is called Wet Storage Area.
  - Katie responds that the area used to store sensitive explosives in water/other solutions in drums.

Slides 29-31: Depot Area Additional Remedial Design Sampling

- Kevin asks about green triangles followed by red triangles on the north side of the figure.
  - Jed confirms that the green triangle is an excavation floor, and the red triangle is a wall.

Slide 32: Questions

- Nick asks if submittals will be staggered.
  - Jed responded that there is not a current plan to stagger submittals. Rather the Draft UFP-QAPPs will be submitted once reviewed by the Army and resolved.

ATTACHMENT A.1

Project Planning Session
For
Investigations at the Former Ravenna Army
Ammunition Plant
July 18, 2023
(Presentation)

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Project Planning Session
For
Investigations at the Former Ravenna Army Ammunition Plant

Presented by:
Leidos

July 18, 2023

US Army Corps of Engineers®

Purpose of Project Planning Session

- **Present the Project Team**
- **Discuss sampling strategy presented in UFP-QAPPs:**
  - RVAAP-34 Sand Creek Disposal Road Landfill – Additional Delineation Sampling
  - CC RVAAP-69 Building 1048 Fire Station – Vapor Intrusion Study for Building 1037
  - CC RVAAP-78 Quarry Pond Surface Dump - Remedial Investigation of Asbestos
  - Multiple Areas of Concern - Additional Remedial Design Sampling
    - RVAAP-38 NACA Test Area,
    - RVAAP-42 Load Line 9,
    - RVAAP-45 Wet Storage Area,
    - CC RVAAP-76 Depot Area

Project Team

- **Army National Guard (lead agency)**
- **Ohio Army National Guard**
- **U.S. Army Corps of Engineers**
- **Ohio Environmental Protection Agency**
- **Leidos (performing contractor)**

RVAAP-34

Sand Creek Disposal Road Landfill Additional Delineation Sampling

- **Driver of additional sampling?**
  - Confirmation sampling completed under the *Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern* (Alaniz-Endpoint 2022) determined that project Cleanup Goals (CUGs) for soil were not achieved at four excavations.
    - ➢ SCsb-037M, SCsb-049M, SCss-060M, and SCss-062M
- **Goal of delineation sampling**
  - Prepare an RI Addendum that presents the results of the delineation sampling and recommend extents of soil removal to achieve the goals of the remedial action.

RVAAP-34

Sand Creek Disposal Road Landfill Additional Delineation Sampling

- **Project Cleanup Goals (CUGs)**

Excavation Area	COC	Cleanup Goal (mg/kg)
SCsb-037M	Arsenic	20.1
SCsb-049M	Benzo(a)pyrene	1.1
SCss-060M	Benzo(a)pyrene	1.1
SCss-062M	Arsenic	20.1

- **Exceedances**
  - SCsb-037M: arsenic – north, east, south, and west sidewalls of excavation, and floor of excavation.
  - SCsb-049M: benzo(a)pyrene – east and south sidewalls of excavation.
  - SCss-060M: benzo(a)pyrene – northwest and southeast sidewalls of excavation.
  - SCss-062M: arsenic - northwest, southwest, northeast, and southeast sidewalls, and floor of excavation.

RVAAP-34

Sand Creek Disposal Road Landfill Additional Delineation Sampling

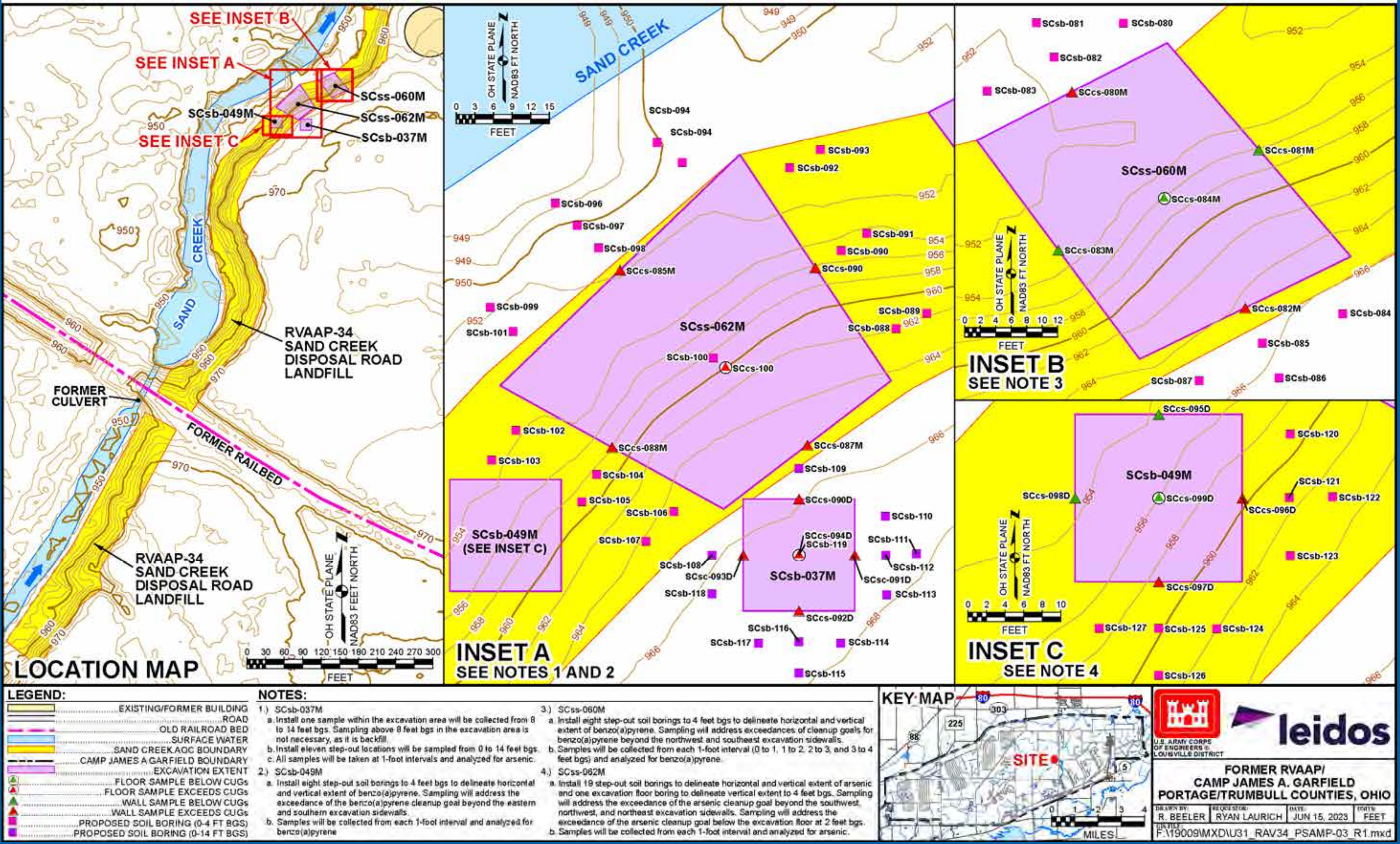
- **Proposed Delineation Sampling Breakdown**

Excavation Area	Soil Borings	Soil Samples	
		Surface	Subsurface
SCsb-037M	12	11	149
SCsb-049M	8	8	24
SCss-060M	8	8	24
SCss-062M	20	20	60

- **Soil Samples**
  - Surface: 0-1 ft bgs (SCsb-037 only at step-out locations)
  - Subsurface: 1 ft intervals
    - ➢ SCsb-037M: to a depth of 14 ft bgs (step-out begin at 1 ft bgs, within excavation area begin at 8 ft bgs).
    - ➢ SCsb-049M, SCss-060M, and SCss-062M: 1 ft intervals down to 4 ft bgs.
- **Analytes**
  - SCsb-037M: arsenic
  - SCsb-049M: benzo(a)pyrene
  - SCss-060M: benzo(a)pyrene
  - SCss-062M: arsenic

RVAAP-34

Sand Creek Disposal Road Landfill Additional Delineation Sampling



LEGEND:

- 🟨 EXISTING/FORMER BUILDING
- ═ ROAD
- ━ ━ OLD RAILROAD BED
- 🟦 SURFACE WATER
- 🟨 SAND CREEK AOC BOUNDARY
- ━ ‒ ━ CAMP JAMES A GARFIELD BOUNDARY
- 🟪 EXCAVATION EXTENT
- ▲ FLOOR SAMPLE BELOW CUGs
- ▲ FLOOR SAMPLE EXCEEDS CUGs
- ▲ WALL SAMPLE BELOW CUGs
- ▲ WALL SAMPLE EXCEEDS CUGs
- ■ PROPOSED SOIL BORING (0-4 FT BGS)
- ■ PROPOSED SOIL BORING (0-14 FT BGS)

NOTES:

1.) SCsb-037M
   a. Install one sample within the excavation area will be collected from 8 to 14 feet bgs. Sampling above 8 feet bgs in the excavation area is not necessary, as it is backfill.
   b. Install eleven step-out locations will be sampled from 0 to 14 feet bgs.
   c. All samples will be taken at 1-foot intervals and analyzed for arsenic.

2.) SCsb-049M
   a. Install eight step-out soil borings to 4 feet bgs to delineate horizontal and vertical extent of benzo(a)pyrene. Sampling will address the exceedance of the benzo(a)pyrene cleanup goal beyond the eastern and southern excavation sidewalls.
   b. Samples will be collected from each 1-foot interval and analyzed for benzo(a)pyrene

3.) SCss-060M
   a. Install eight step-out soil borings to 4 feet bgs to delineate horizontal and vertical extent of benzo(a)pyrene. Sampling will address exceedances of cleanup goals for benzo(a)pyrene beyond the northwest and southeast excavation sidewalls.
   b. Samples will be collected from each 1-foot interval (0 to 1, 1 to 2, 2 to 3, and 3 to 4 feet bgs) and analyzed for benzo(a)pyrene.

4.) SCss-062M
   a. Install 19 step-out soil borings to delineate horizontal and vertical extent of arsenic and one excavation floor boring to delineate vertical extent to 4 feet bgs. Sampling will address the exceedance of the arsenic cleanup goal beyond the southwest, northwest, and northeast excavation sidewalls. Sampling will address the exceedance of the arsenic cleanup goal below the excavation floor at 2 feet bgs.
   b. Samples will be collected from each 1-foot interval and analyzed for arsenic.

FORMER RVAAP/
CAMP JAMES A. GARFIELD
PORTAGE/TRUMBULL COUNTIES, OHIO

DRAWN BY:	REQUESTOR:	DATE:	UNITS:
R. BEELER	RYAN LAURICH	JUN 15, 2023	FEET

GIS FILE: F:\19009\MXD\U31_RAV34_PSAMP-03_R1.mxd

Questions?

CC RVAAP-69

Building 1048 Fire Station
Vapor Intrusion Study of Building 1037

- **Driver of additional sampling?**
  - Multiple VOCs have been detected in environmental media (i.e., soil and groundwater) at the CC RVAAP-69 Building 1048 Fire Station AOC, which is immediately upgradient of Building 1037. VOCs may pose unacceptable risk for vapor intrusion.
  - Soil vapor sampling has not been completed at Building 1037.
  - Additional groundwater sampling as due diligence to determine the presence of groundwater concentrations exceeding Vapor Intrusion Screening Levels that would cause a concern for potential VOC vapors
- **Goal of VI Study at Building 1037 and groundwater sampling at existing wells at Building 1048 and Building 1034 (Motor Pool Hydraulic Lift).**
  - Provide supplemental data to support the Feasibility Study.
  - Determine if vapors are posing an unacceptable risk to human health for occupants at Building 1037.

CC RVAAP-69

Building 1048 Fire Station
Vapor Intrusion Study of Building 1037

- **Vapor Intrusion Sampling**
  - 5 Sub-slab Soil Vapor Sampling locations will be installed at Building 1037.
    - Per Ohio EPA guidance – building >5,000 ft² does not require biased samples.
  - Indoor Air sample will be collected to characterize background indoor air conditions of Building 1037.
  - Ambient Air will be collected to characterize atmospheric/upgradient background air outside of Building 1037.
  - Two sampling events will be completed to assess temporal and spatial variations at the site for any VOC constituents that are detected during the first event.
  - VOCs will be analyzed USEPA Method TO-15.
  - Screening Levels – Developed from U.S. EPA VISL Calculator
    - HQ = 0.1 and ILCR = 1 × 10-6

CC RVAAP-69

Building 1048 Fire Station

Vapor Intrusion Sampling Locations at Building 1037

NOTES:

1.) SAMPLE LOCATION 069vp-006 IS AN AMBIENT AIR SAMPLE COLLECTION POINT WITHIN BUILDING 1037.

2.) SAMPLE LOCATION 069vp-007 IS AN AMBIENT AIR SAMPLE COLLECTION POINT OUTSIDE BUILDING 1037.

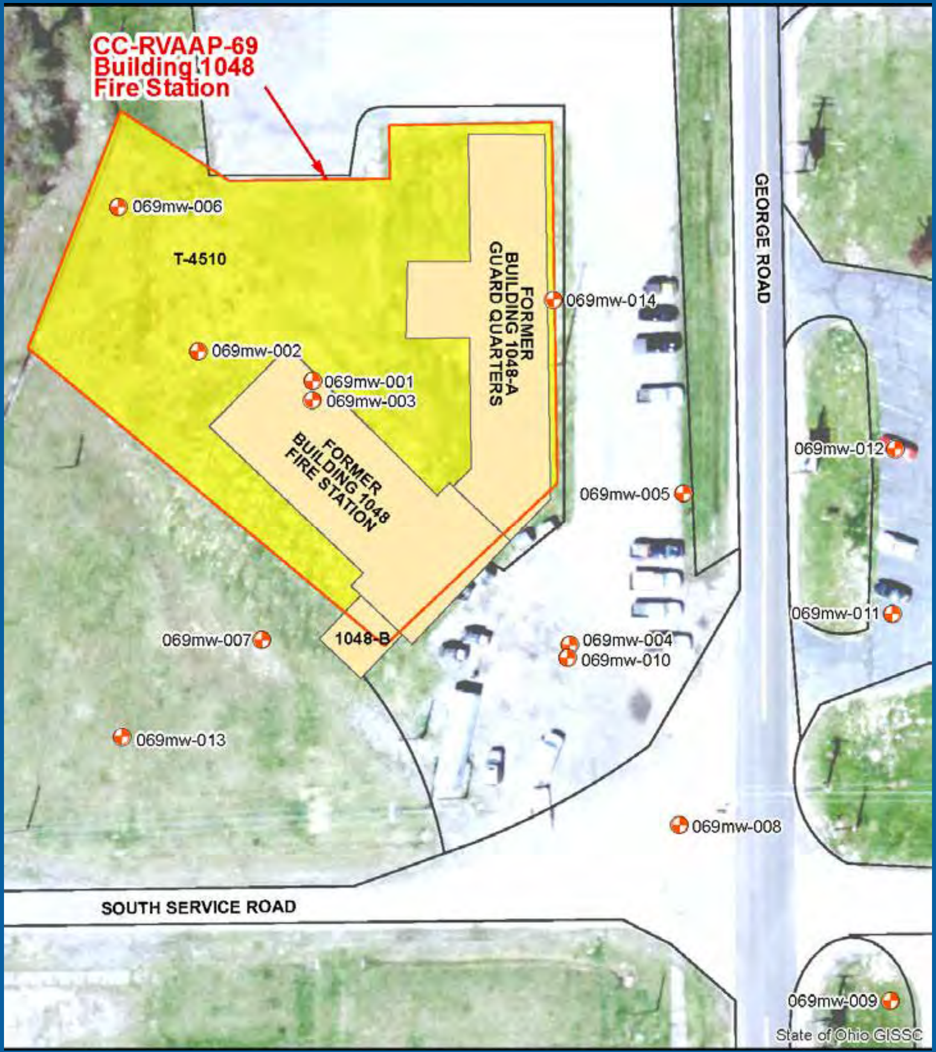
CC RVAAP-69
Building 1048 Fire Station

- **Groundwater Sampling**
  - 14 existing monitoring wells at CC RVAAP-69 Building 1048 Fire Station.
  - 3 existing monitoring wells at CC RVAAP-74 Motor Pool Hydraulic Lift (downgradient of CC RVAAP-69).
  - One sampling event to analyze for the site groundwater COCs (carbon tetrachloride and chloroform).
  - Screening Levels – Developed from U.S. EPA VISL Calculator
  - HQ = 0.1 and ILCR = 1 × 10-6

CC RVAAP-69

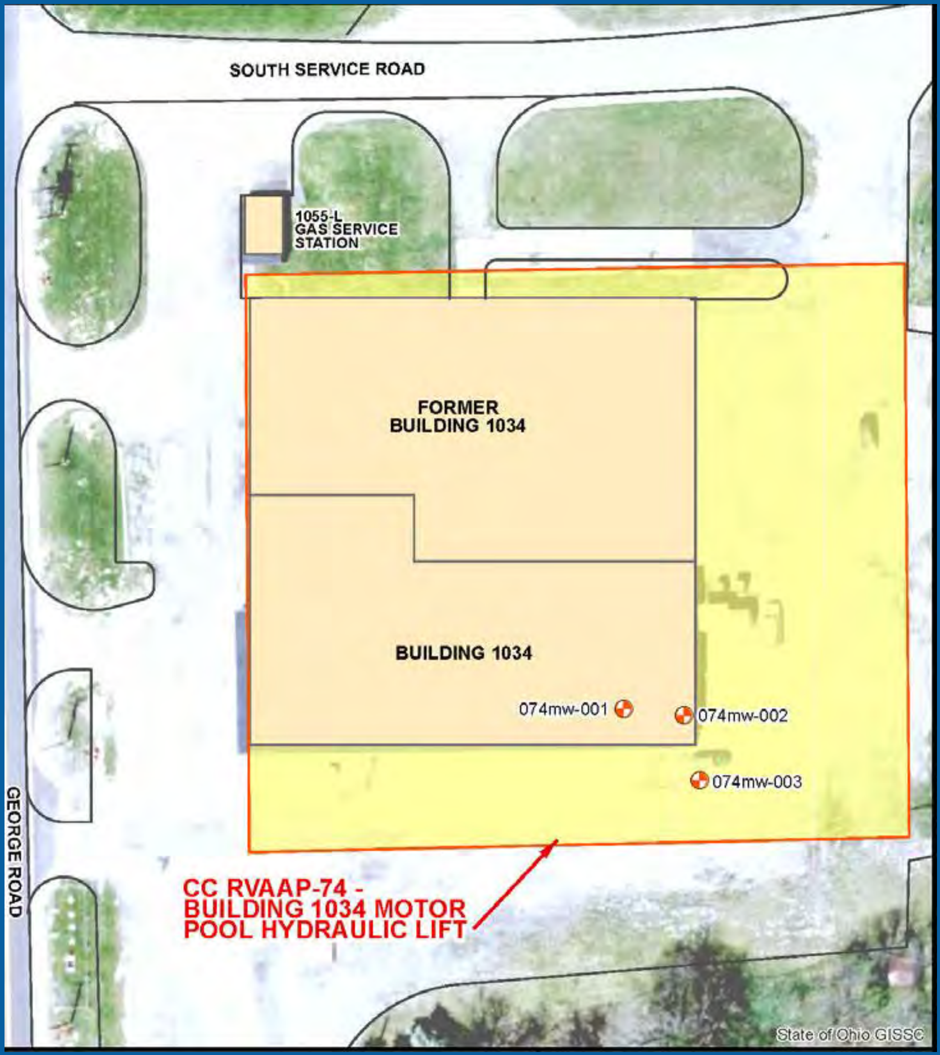
Building 1048 Fire Station

Groundwater Sampling Locations at Building 1048



CC RVAAP-69

Building 1048 Fire Station
Groundwater Sampling Locations at Building 1034



Questions?

CC RVAAP-78
Quarry Pond Surface Dump
Remedial Investigation of Asbestos

- **Driver of Remedial Investigation of Asbestos?**
  - Non Time-Critical Removal Action (NTCRA) completed at Debris Pile C at the Quarry Pond Surface Dump in 2020.
    - NTCRA was scoped to remove asbestos-contaminated soil.
    - NTCRA discovered previously unidentified and unexpected ACM in the excavation.
- **Goal of RI of Asbestos at Quarry Pond Surface Dump**
  - Visually identify friable Asbestos Containing Material (ACM) in the subsurface.
  - Complete horizontal and vertical delineation of ACM in and around Debris Pile C.
  - Prepare an RI Report that recommends the horizontal and vertical extent of friable ACM removal to protect human health and the environment.

CC RVAAP-78

Quarry Pond Surface Dump Remedial Investigation of Asbestos

- **Project CUGs**

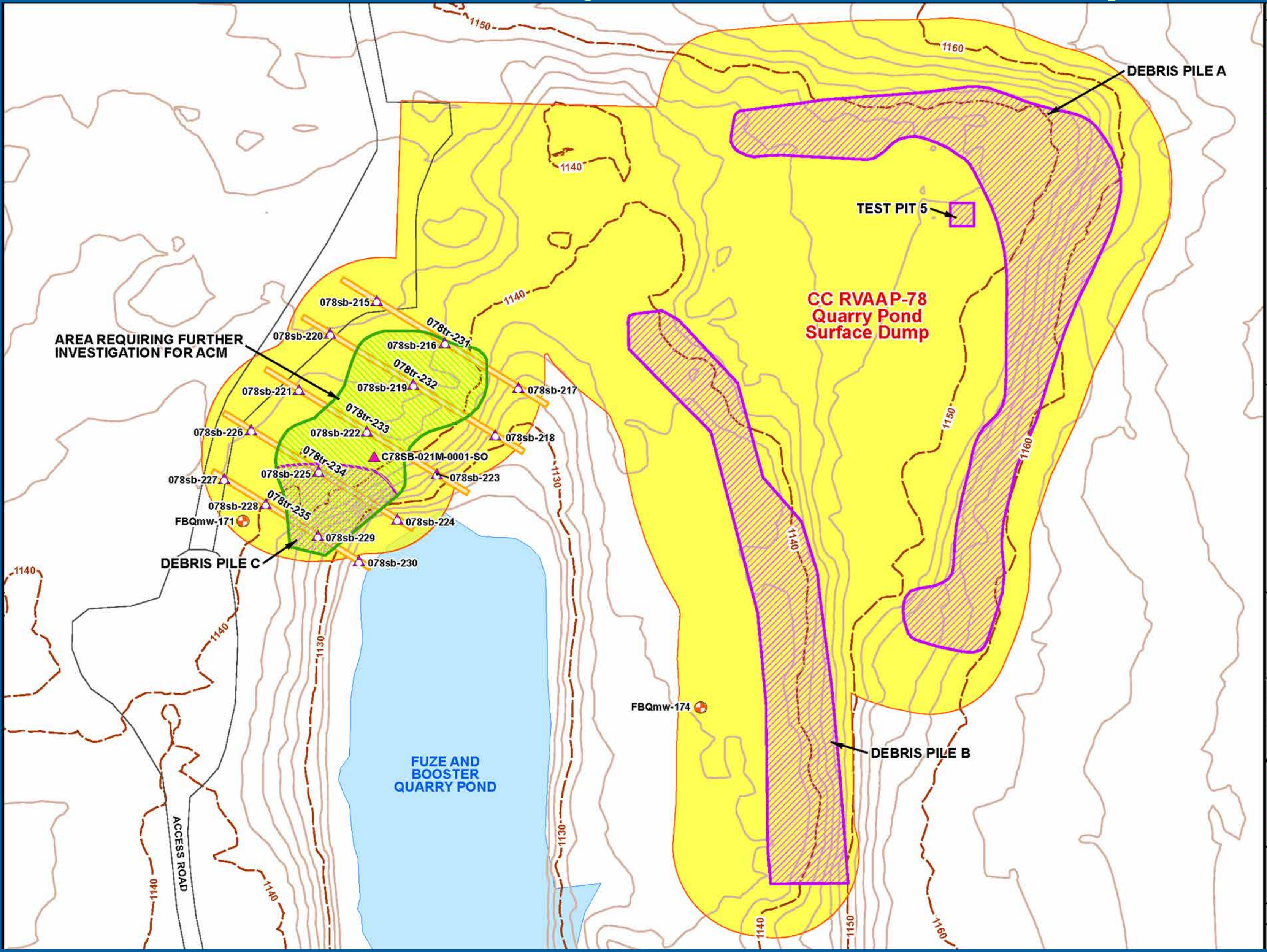
Analyte	Method	CAS Number	Screening Value	Source	Sensitivity	Units
Asbestos	PLM CARB 435 (Level B)	1332-21-4	1%	USEPA Target Level	0.25*	%

- **Proposed delineation sampling**

RVAAP AOC	Site Name	Trenches	Soil Samples	
			Surface	Subsurface
CC RVAAP-78	Quarry Pond Surface Dump	5	14	96

  - Trench sampling
    - ➢ 5 trenches will transect Debris Pile C from northwest to southeast.
    - ➢ Each trench will initiate 30 ft outside the extent of the debris pile and will terminate 30 ft outside the extent of the debris pile.
    - ➢ Trench dimensions – width of an excavator bucket, depth to 14 ft bgs.
      - Resident Receptor exposure depth only extends to 13 ft bgs.
    - ➢ A Certified Asbestos Hazard Evaluation Specialist will be onsite to observe any ACM
    - ➢ Soil samples will target location of ACM, anticipated to be collected at 2 ft intervals down to 14 ft bgs.
    - ➢ Removed soil will be returned to the trenches.

CC RVAAP-78
Quarry Pond Surface Dump



LEGEND:

.....ASPHALT ROAD
.....CC-RVAAP-78 AOC BOUNDARY
.....CAMP JAMES A. GARFIELD BOUNDARY
.....GROUND CONTOUR 2-FT INTERVAL
.....GROUND CONTOUR 10-FT INTERVAL
▨ ..2021 NTCRA COMPLETED DEBRIS & SOIL REMOVAL
▨ .....2021 NTCRA AREA REQUIRING FURTHER INVESTIGATION FOR ACM
.....TRENCH
▲.....SOIL BORING
△.....PROPOSED SOIL BORING
.....MONITORING WELL

NOTES:

1.) THE 2020 REMEDIAL ACTION IS SUMMARIZED IN THE REMEDIAL ACTION COMPLETION REPORT, NON TIME-CRITICAL REMOVAL ACTION FOR CC RVAAP-78 QUARRY POND SURFACE DUMP (PARS 2021).

2.) DEBRIS AND SOIL REMOVAL IN DEBRIS PILE C OCCURRED FROM 0 TO 1.5 FEET BGS IN THE AREA INDICATED. IN ADDITION ASBESTOS IMPACTED SOIL WAS EXCAVATED TO APPROXIMATELY 13 FT BGS AT THE SOUTHWEST CORNER OF SAMPLE C78SB-021M-001-SO AND ACM WAS STILL OBSERVED AT THE BASE OF THE EXCAVATION. IN AN ATTEMPT TO FIND THE SOUTHERN LIMITS OF THE DEBRIS PILE, EXCAVATION CONTINUED TO APPROXIMATELY 15 FT TO THE SOUTH OF THE SOIL EXCAVATION LIMITS. ACM WAS OBSERVED BETWEEN 3 TO 8 FT BGS IN ALL THREE OF THE EXCAVATION SIDEWALLS.

3.) NO FURTHER ACTION IS REQUIRED FOR DEBRIS PILES A & B.

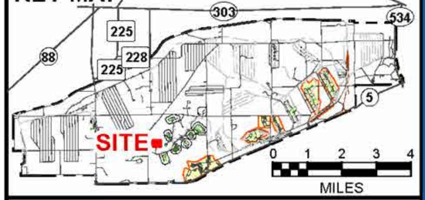
ACRONYMS:

ACM	ASBESTOS-CONTAINING MATERIAL
BGS	BELOW GROUND SURFACE
CC	COMPLIANCE-RELATED CLEANUP PROGRAM
NTCRA	NON-TIME-CRITICAL REMOVAL ACTION
RVAAP	RAVENNA ARMY AMMUNITION PLANT

TN STATE PLANE
NAD83 FEET

0 25 50 75 100
FEET

KEY MAP



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LOUISVILLE DISTRICT

leidos

FORMER RVAAP/
CAMP JAMES A. GARFIELD
PORTAGE/TRUMBULL COUNTIES, OHIO

DRAWN BY:	REQUESTOR:	DATE:	UNITS:
R. BEELER	SARAH KOSBAB	JUN 06, 2023	FEET

GIS FILE:
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Questions?

Multiple Areas of Concern

NACA Test Area, LL-9, WSA, Depot Area Additional Remedial Design Sampling

- **Driver of additional sampling?**
  - Confirmation sampling completed under the *Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern* (Alaniz-Endpoint 2022) determined that project Cleanup Goals (CUGs) were not achieved at excavations for 4 AOCs.
    - RVAAP-38 NACA Test Area: Area 1, Area 2, and Area 2
    - RVAAP-42 Load Line 9: Area 1 and Area 2
    - RVAAP-45 Wet Storage Area: Area 1 and Area 2
    - CC RVAAP-76 Depot Area: Building U-4 and Building U-5
- **Goal of RD sampling**
  - Develop an Addendum to the RD for each of the four AOCs that presents the results of the additional RD sampling and provides recommendations for the extent of soil removal required to achieve the CUGs of their respective RA.

Multiple Areas of Concern
RVAAP-38 NACA Test Area
Additional Remedial Design Sampling

- **Project CUGs**

AOC	Area	Chemical of Concern	Cleanup Goal (mg/kg)*
RVAAP-38 NACA Test Area	Area 1	Benz(a)anthracene	11
		Benzo(a)pyrene	1.1
		Benzo(b)fluoranthene	11
		Dibenz(a,h)anthracene	1.1
		Indeno(1,2,3-cd)pyrene	11
	Area 2	Benz(a)anthracene	11
		Benzo(a)pyrene	1.1
		Benzo(b)fluoranthene	11
		Dibenz(a,h)anthracene	1.1
	Area 3	Benzo(a)pyrene	1.1

- **Exceedances**
  - Area 1: benzo(a)pyrene – north sidewall of excavation
  - Area 2: benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene – All sidewalls of excavation
  - Area 3: benzo(a)pyrene – floor of excavation

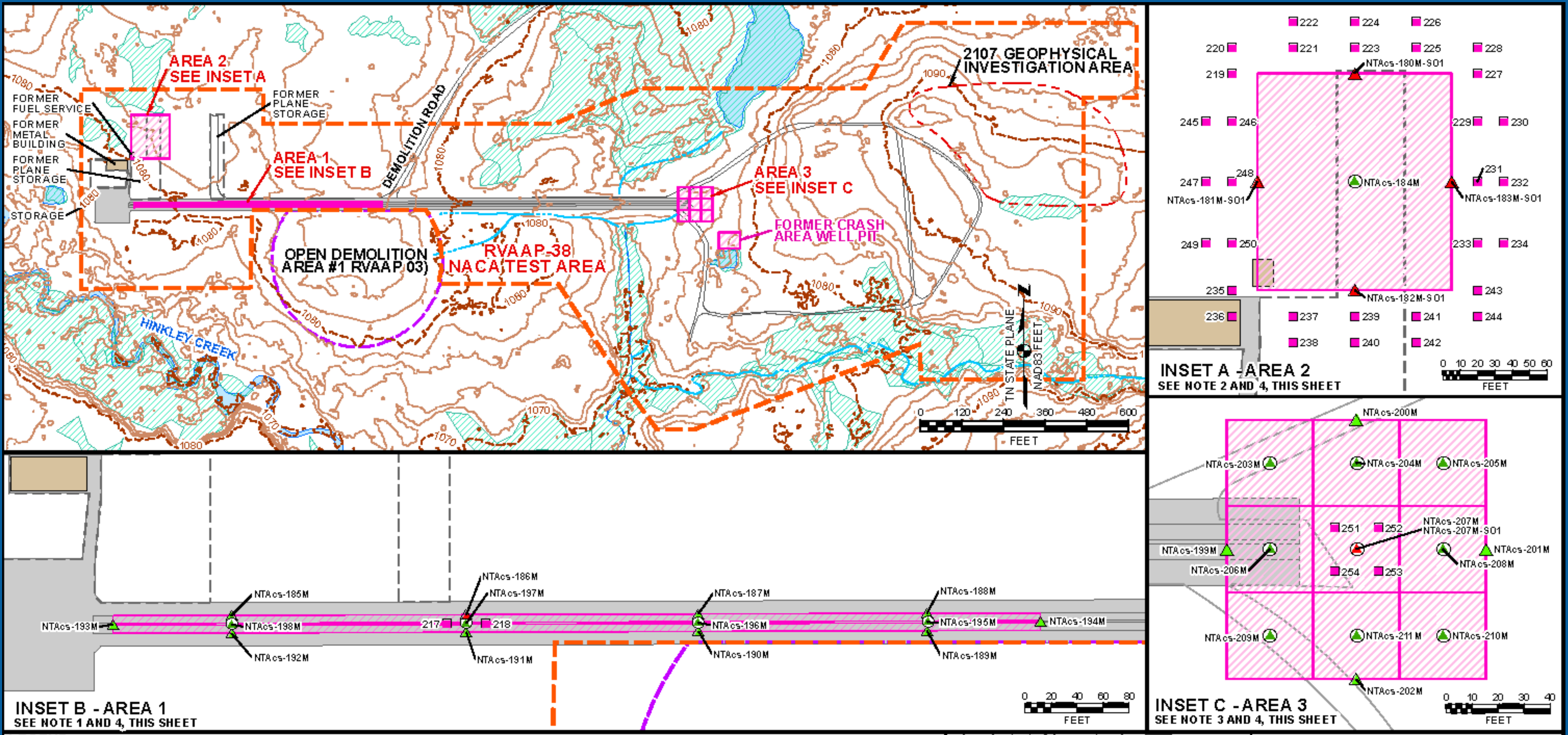
Multiple Areas of Concern
RVAAP-38 NACA Test Area
Additional Remedial Design Sampling

- **Proposed RD Sampling Breakdown**

RVAAP AOC	Excavation Area	Soil Borings	Soil Samples	
			Surface	Subsurface
RVAAP-38 NACA Test Area	Area 1	2	2	0
RVAAP-38 NACA Test Area	Area 2	32	32	96
RVAAP-38 NACA Test Area	Area 3	4	0	8

- **Soil Samples**
  - Surface: 0-1 ft bgs
  - Subsurface: 1 ft intervals down to 4 ft bgs
- **Sampling Analytes**
  - Area 1: benzo(a)pyrene
  - Area 2: benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene
  - Area 3: benzo(a)pyrene

Multiple Areas of Concern
RVAAP-38 NACA Test Area
Exceedances and Proposed RD Sampling



LEGEND:

▭	EXISTING/FORMER BUILDING
▭	CONCRETE SLAB
═	ROAD
⌒	GR.OUND CONTOUR 2-FT INTERVAL
⌒	GROUND CONTOUR 10-FT INTERVAL
▭	SURFACE WATER
⌒	TRIBUTARIES
▨	WETLAND AREA (2008)
▭	CAMP JAMES A. GARFIELD BOUNDARY
▭	OPEN DEMOLITION AREA #1 AOC BOUNDARY
▭	2017 GEOPHYSICAL INVESTIGATION AREA
▭	RVAAP-38 AOC BOUNDARY
▨	EXTENT OF SOIL REMOVED IN 2021
▲	WALL CONFIRMATION SAMPLE < CRITERIA
▲	WALL CONFIRMATION SAMPLE > CRITERIA
●	FLOOR CONFIRMATION SAMPLE < CRITERIA
●	FLOOR CONFIRMATION SAMPLE > CRITERIA
■	PROPOSED SOIL BORING (SEE NOTES)

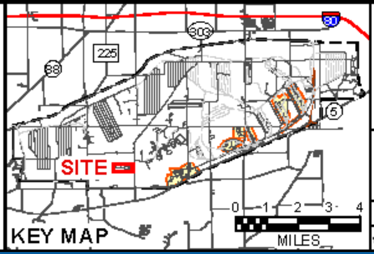
NOTES:

1.) Sample locations are preceded by "NTAsb-". However, this is omitted from the figure for brevity.

2.) Inset A, Area 2:
   a. Samples collected from 0-1, 1-2, 2-3, and 3-4 ft bgs.
   b. North sidewall: Soil samples collected north of NTAcs-180M-SO1 will be analyzed for benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene.
   c. West sidewall: Soil samples collected west of NTAcs-181M-SO1 will be analyzed for benzo(a)pyrene.
   d. South sidewall: Soil samples collected south of NTAcs-182M-SO1 will be analyzed for benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene.
   e. East sidewall: Soil samples collected east of NTAcs-183M-SO1 will be analyzed for benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene.

3.) Inset B, Area 1:
   a. Samples collected from 0-1 ft bgs
   b. Soil samples analyzed for benzo(a)pyrene.

4.) Inset C, Area 3:
   a. Samples collected from 2-3 and 3-4 ft bgs. (The 0–2-foot interval is backfill from previous excavation).
   b. Soil samples analyzed for benzo(a)pyrene.



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Multiple Areas of Concern

RVAAP-42 Load Line 9
Additional Remedial Design Sampling

- **Project CUGs**

AOC	Area	Chemical of Concern	Cleanup Goal (mg/kg)*
RVAAP-42 Load Line 9	Area 1	Lead	400
		Mercury	22.7
	Area 2	Benz(a)anthracene	11
		Benzo(a)pyrene	1.1
		Benzo(b)fluoranthene	11
		Dibenz(a,h)anthracene	1.1

- **Exceedances**
  - Area 1: lead and mercury – east and west sidewalls of excavation
  - Area 2:
    - ➢ benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene – Southeast sidewall of excavation
    - ➢ benzo(a)pyrene – southwest sidewall of excavation

Multiple Areas of Concern

RVAAP-42 Load Line 9
Additional Remedial Design Sampling

- **Proposed RD Sampling Breakdown**

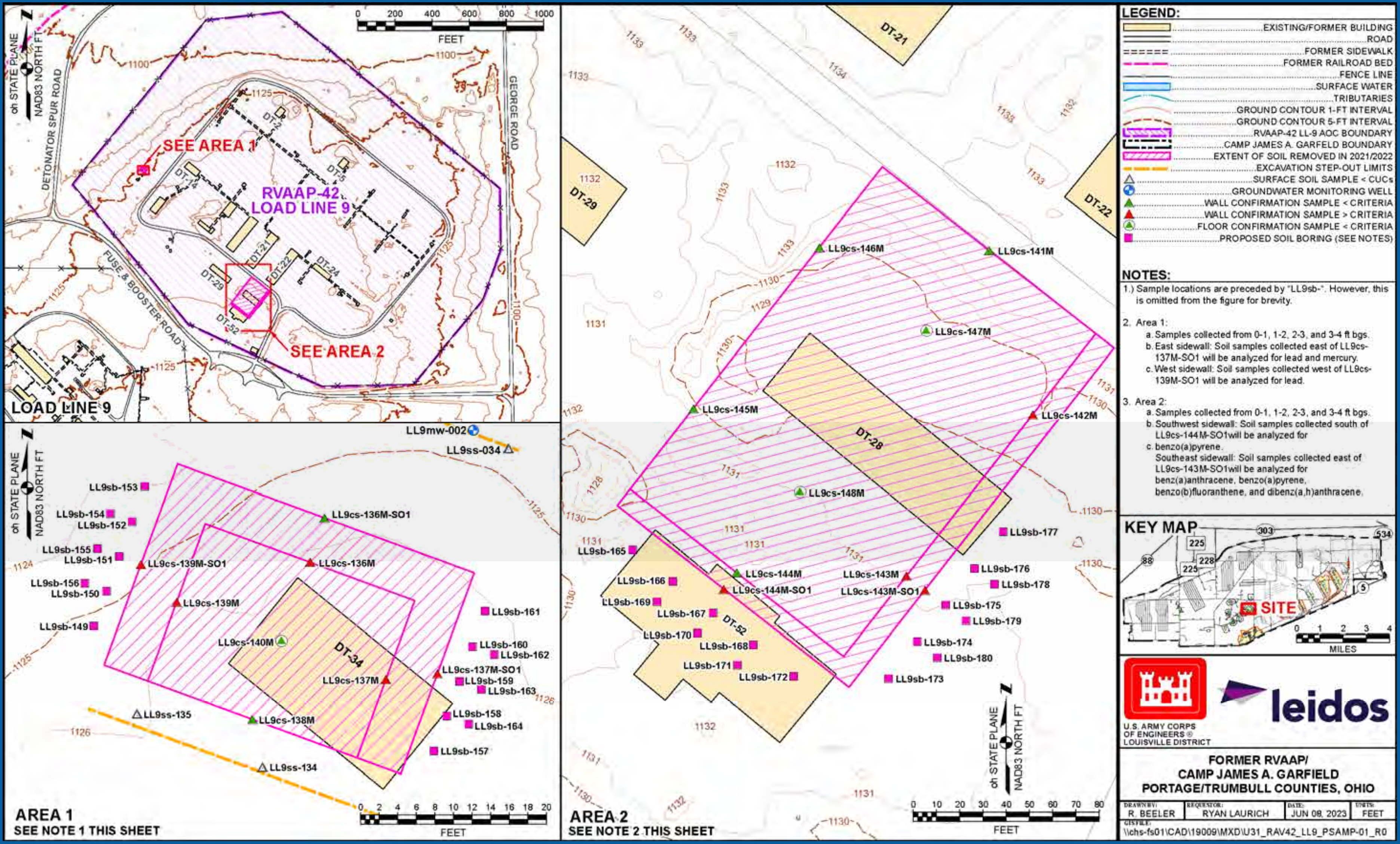
RVAAP AOC	Excavation Area	Soil Borings	Soil Samples	
			Surface	Subsurface
RVAAP-42 Load Line 9	Area 1	16	16	48
RVAAP-42 Load Line 9	Area 2	16	16	48

- **Soil Samples**
  - Surface: 0-1 ft bgs
  - Subsurface: 1 ft intervals down to 4 ft bgs
- **Sampling Analytes**
  - Area 1: lead and mercury
  - Area 2:
    - benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene – southeast sidewall
    - benzo(a)pyrene – southwest sidewall

Multiple Areas of Concern

RVAAP-42 Load Line 9

Exceedances and Proposed RD Sampling



LEGEND:

- ▭ EXISTING/FORMER BUILDING
- ═ ROAD
- ====== FORMER SIDEWALK
- — — FORMER RAILROAD BED
- —— FENCE LINE
- ▭ SURFACE WATER
- ~ TRIBUTARIES
- — GROUND CONTOUR 1-FT INTERVAL
- — — GROUND CONTOUR 5-FT INTERVAL
- ▨ RVAAP-42 LL-9 AOC BOUNDARY
- ▭ CAMP JAMES A. GARFELD BOUNDARY
- ▨ EXTENT OF SOIL REMOVED IN 2021/2022
- — — EXCAVATION STEP-OUT LIMITS
- △ SURFACE SOIL SAMPLE < CUCs
- ● GROUNDWATER MONITORING WELL
- ▲ WALL CONFIRMATION SAMPLE < CRITERIA
- ▲ WALL CONFIRMATION SAMPLE > CRITERIA
- ◉ FLOOR CONFIRMATION SAMPLE < CRITERIA
- ■ PROPOSED SOIL BORING (SEE NOTES)

NOTES:

1.) Sample locations are preceded by "LL9sb-". However, this is omitted from the figure for brevity.

2. Area 1:
   - a. Samples collected from 0-1, 1-2, 2-3, and 3-4 ft bgs.
   - b. East sidewall: Soil samples collected east of LL9cs-137M-SO1 will be analyzed for lead and mercury.
   - c. West sidewall: Soil samples collected west of LL9cs-139M-SO1 will be analyzed for lead.

3. Area 2:
   - a. Samples collected from 0-1, 1-2, 2-3, and 3-4 ft bgs.
   - b. Southwest sidewall: Soil samples collected south of LL9cs-144M-SO1will be analyzed for
   - c. benzo(a)pyrene.
     Southeast sidewall: Soil samples collected east of LL9cs-143M-SO1will be analyzed for benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene.

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Multiple Areas of Concern
RVAAP-45 Wet Storage Area
Additional Remedial Design Sampling

- **Project CUGs**

AOC	Area	Chemical of Concern	Cleanup Goal (mg/kg)*
RVAAP-45 West Storage Area	WSA Area 1	Benzo(a)pyrene	1.1
	WSA Area 2	Benzo(a)pyrene	1.1

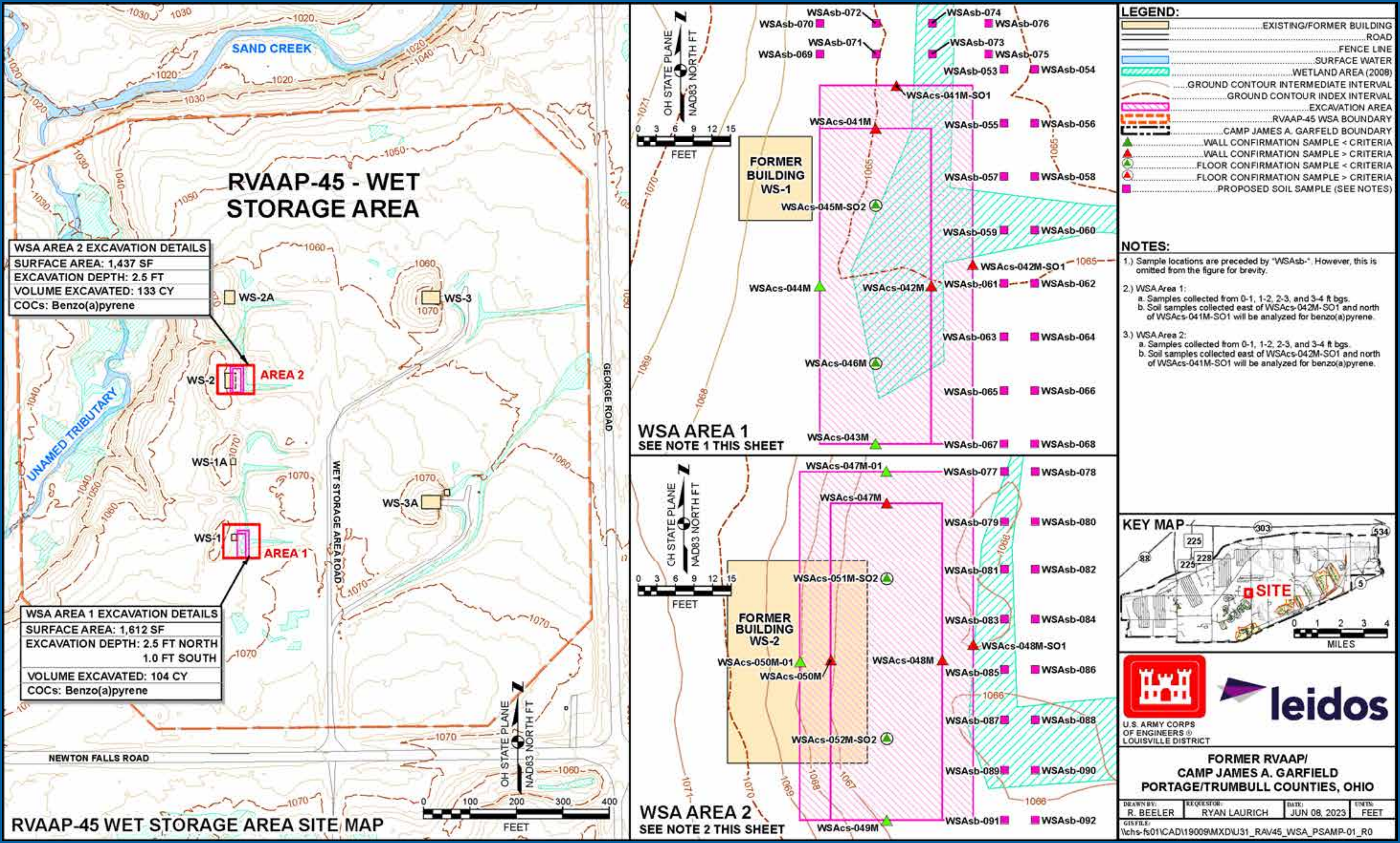
- **Exceedances**
  - Area 1: benzo(a)pyrene – north and east sidewalls of excavation
  - Area 2: benzo(a)pyrene – east sidewall of excavation
- **Proposed RD Sampling Breakdown**

RVAAP AOC	Excavation Area	Soil Borings	Soil Samples	
			Surface	Subsurface
RVAAP-45 Wet Storage Area	Area 1	24	24	72
RVAAP-45 Wet Storage Area	Area 1	16	16	48

- **Soil Samples**
  - Surface: 0-1 ft bgs
  - Subsurface: 1 ft intervals down to 4 ft bgs
- **Sampling Analytes**
  - Area 1 and Area 2: benzo(a)pyrene

Multiple Areas of Concern

RVAAP-45 Wet Storage Area
Exceedances and Proposed RD Sampling



WSA AREA 2 EXCAVATION DETAILS
SURFACE AREA: 1,437 SF
EXCAVATION DEPTH: 2.5 FT
VOLUME EXCAVATED: 133 CY
COCs: Benzo(a)pyrene

WSA AREA 1 EXCAVATION DETAILS
SURFACE AREA: 1,612 SF
EXCAVATION DEPTH: 2.5 FT NORTH 1.0 FT SOUTH
VOLUME EXCAVATED: 104 CY
COCs: Benzo(a)pyrene

LEGEND:

▭	EXISTING/FORMER BUILDING
═	ROAD
─	FENCE LINE
▭	SURFACE WATER
▨	WETLAND AREA (2008)
⌒	GROUND CONTOUR INTERMEDIATE INTERVAL
⌒	GROUND CONTOUR INDEX INTERVAL
▨	EXCAVATION AREA
▭	RVAAP-45 WSA BOUNDARY
▭	CAMP JAMES A. GARFELD BOUNDARY
▲	WALL CONFIRMATION SAMPLE < CRITERIA
▲	WALL CONFIRMATION SAMPLE > CRITERIA
◬	FLOOR CONFIRMATION SAMPLE < CRITERIA
◬	FLOOR CONFIRMATION SAMPLE > CRITERIA
■	PROPOSED SOIL SAMPLE (SEE NOTES)

NOTES:

1.) Sample locations are preceded by "WSAsb-". However, this is omitted from the figure for brevity.

2.) WSA Area 1:
  a. Samples collected from 0-1, 1-2, 2-3, and 3-4 ft bgs.
  b. Soil samples collected east of WSAcs-042M-SO1 and north of WSAcs-041M-SO1 will be analyzed for benzo(a)pyrene.

3.) WSA Area 2:
  a. Samples collected from 0-1, 1-2, 2-3, and 3-4 ft bgs.
  b. Soil samples collected east of WSAcs-042M-SO1 and north of WSAcs-041M-SO1 will be analyzed for benzo(a)pyrene.

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Multiple Areas of Concern

CC RVAAP-76 Depot Area
Additional Remedial Design Sampling

- **Project CUGs**

AOC	Area	Chemical of Concern	Cleanup Goal (mg/kg)*
CC RVAAP-76 Depot Area	Building U-4	Benz(a)anthracene	11
		Benzo(a)pyrene	1.1
		Benzo(b)fluoranthene	11
		Dibenz(a,h)anthracene	1.1
	Building U-5	Benz(a)anthracene	11
		Benzo(a)pyrene	1.1
		Benzo(b)fluoranthene	11
		Dibenz(a,h)anthracene	1.1

- **Exceedances**
  - Building U-4: benzo(a)pyrene – north and east sidewalls of excavation
  - Building U-5:
    - benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene – north sidewall of excavation
    - benzo(a)pyrene and dibenz(a,h)anthracene – south sidewall of excavation.

Multiple Areas of Concern
CC RVAAP-76 Depot Area
Additional Remedial Design Sampling

- **Proposed RD Sampling Breakdown**

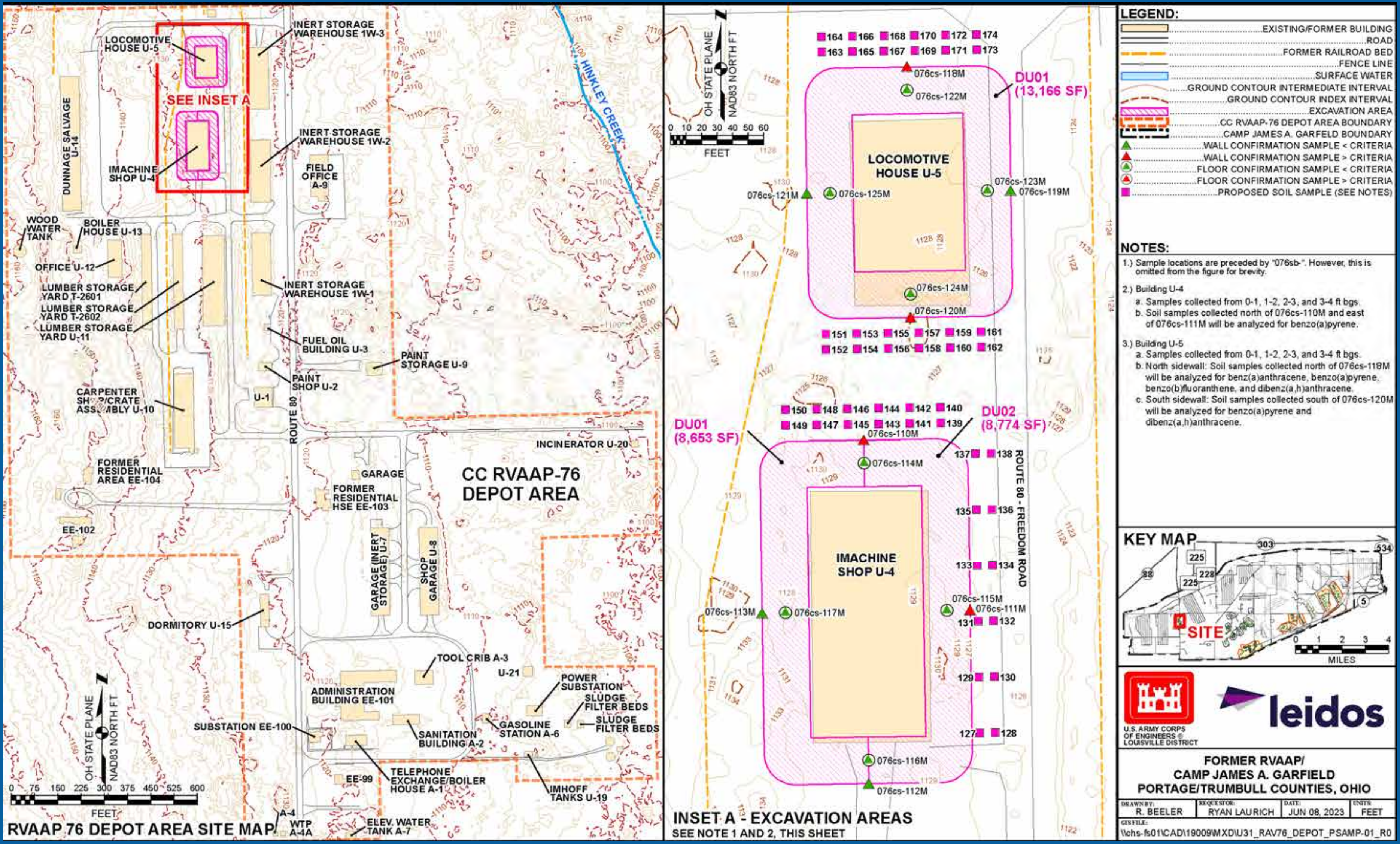
RVAAP AOC	Excavation Area	Soil Borings	Soil Samples	
			Surface	Subsurface
CC RVAAP-76 Depot Area	Building U-4	24	24	72
CC RVAAP-76 Depot Area	Building U-5	24	24	72

- **Soil Samples**
  - Surface: 0-1 ft bgs
  - Subsurface: 1 ft intervals down to 4 ft bgs
- **Sampling Analytes**
  - Building U-4: benzo(a)pyrene
  - Building U-5:
    - benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene – north sidewall
    - benzo(a)pyrene and dibenz(a,h)anthracene – south sidewall

Multiple Areas of Concern

CC RVAAP-76 Depot Area

Exceedances and Proposed RD Sampling



LEGEND:

- ....EXISTING/FORMER BUILDING
- ....ROAD
- ....FORMER RAILROAD BED
- ....FENCE LINE
- ....SURFACE WATER
- ....GROUND CONTOUR INTERMEDIATE INTERVAL
- ....GROUND CONTOUR INDEX INTERVAL
- ....EXCAVATION AREA
- ....CC RVAAP-76 DEPOT AREA BOUNDARY
- ....CAMP JAMES A. GARFIELD BOUNDARY
- ▲ ....WALL CONFIRMATION SAMPLE < CRITERIA
- ▲ ....WALL CONFIRMATION SAMPLE > CRITERIA
- ▲ ....FLOOR CONFIRMATION SAMPLE < CRITERIA
- ▲ ....FLOOR CONFIRMATION SAMPLE > CRITERIA
- ■ ....PROPOSED SOIL SAMPLE (SEE NOTES)

NOTES:

1.) Sample locations are preceded by "076sb-". However, this is omitted from the figure for brevity.

2.) Building U-4
  a. Samples collected from 0-1, 1-2, 2-3, and 3-4 ft bgs.
  b. Soil samples collected north of 076cs-110M and east of 076cs-111M will be analyzed for benzo(a)pyrene.

3.) Building U-5
  a. Samples collected from 0-1, 1-2, 2-3, and 3-4 ft bgs.
  b. North sidewall: Soil samples collected north of 076cs-118M will be analyzed for benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene.
  c. South sidewall: Soil samples collected south of 076cs-120M will be analyzed for benzo(a)pyrene and dibenz(a,h)anthracene.

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Questions?

APPENDIX E

OHIO EPA COMMENTS

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Environmental
Protection
Agency

EPA.Ohio.gov

Mike DeWine, *Governor* Jon Husted, *Lt. Governor* Anne M. Vogel, *Director*

April 8, 2024

Received April 9, 2024

TRANSMITTED ELECTRONICALLY

Mr. Kevin M. Sedlak
Army National Guard
Installations & Environment - Cleanup
Branch IPA Designation
1438 State Route 534 SW
Newton Falls, OH 44444

RE: US Army Ravenna Ammunition
Remediation Response
Correspondence
Remedial Response
Portage County
267000859269

Sent via e-mail to: kevin.m.sedlak.ctr@army.mil

Subject: CC RVAAP-69 Building 1048 Fire Station Vapor Intrusion Study of Building 1037
Draft Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP)
Response to Comments, dated February 20, 2024
Ohio EPA Comment Letter

Dear Mr. Sedlak:

The Ohio Environmental Protection Agency (Ohio EPA) has received and reviewed the Response to comments received February 20, 2024, for the Ravenna Army Ammunition Plant (RVAAP) Restoration Program, Portage/Trumbull Counties, Draft Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP), CC RVAAP-69 Building 1048 Fire Station Vapor Intrusion Study of Building 1037[1]. The Plan was received via email by Ohio EPA's Northeast District Office (NEDO), Division of Environmental Response and Revitalization (DERR) on October 19, 2024[2], and Ohio EPA issued comments on February 2, 2024[1]. The Plan was prepared by Leidos for the Army National Guard in support of the RVAAP Restoration Program.

Ohio EPA has no additional comments and requests the final document in accordance with the Directors Findings and Orders.

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[1] http://edocpub.epa.ohio.gov/publicportal/ViewDocument.aspx?docid=2761874

[2] http://edocpub.epa.ohio.gov/publicportal/ViewDocument.aspx?docid=2608110

[3] http://edocpub.epa.ohio.gov/publicportal/ViewDocument.aspx?docid=2722640

If you have any questions, please contact me at (330) 963-1109 or by e-mail at craig.kowalski@epa.ohio.gov.

Sincerely,

Craig Kowalski

Craig Kowalski
Environmental Specialist
Division of Environmental Response and Revitalization

CK/cm

ec: Angela Cobbs, Chenega Reliable Services
Jennifer Tierney, Chenega Reliable Services
Nat Peters, USACE
Katie Tait, OHARNG RTLS
Steven Kvaal, USACE Kvaal
Natalie Oryshkewych, Ohio EPA, DERR, NEDO
Megan Oravec, Ohio EPA, DERR, NEDO
Liam McEvoy, Ohio EPA, DERR, NEDO
Thomas Schneider, Ohio EPA, DERR, SWDO
Carrie Rasik, Ohio EPA, DERR, CO

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

NATIONAL GUARD BUREAU
111 SOUTH GEORGE MASON DRIVE
ARLINGTON VA 22204-1373

February 20, 2024

Ohio Environmental Protection Agency
DERR-NEDO
Attn: Ms. Megan Oravec
2110 East Aurora Road
Twinsburg, OH 44087-1924

Subject: Ravenna Army Ammunition Plant (RVAAP) Restoration Program, Portage/Trumbull Counties, CC RVAAP-69 Building 1048 Fire Station, Responses to Comments on the Draft Uniform Federal Policy-Quality Assurance Project Plan for the CC RVAAP-69 Building 1048 Fire Station Vapor Intrusion Study of Building 1037 (Work Activity No. 267-000-859-269)

Dear Ms. Oravec:

The Army appreciates the Ohio EPA comments on the *Draft Uniform Federal Policy-Quality Assurance Project Plan for the CC RVAAP-69 Building 1048 Fire Station Vapor Intrusion Study of Building 1037*. Enclosed for your review are responses to those comments. Upon final resolution of the comments, the Army will provide a Final version of the report for Ohio EPA concurrence.

These comment responses were prepared for the Army National Guard in support of the RVAAP Restoration Program. Please contact the undersigned at (330) 235-2153 or kevin.m.sedlak.ctr@army.mil if there are issues or concerns with this submission.

Sincerely,

TAIT.KATHRYN.SERENA.1289508275
Digitally signed by TAIT.KATHRYN.SERENA.1289508275
Date: 2024.02.20 14:19:13 -05'00'

FOR Kevin M. Sedlak
Restoration Project Manager
Army National Guard Directorate

ec: Craig Kowalski, Ohio EPA, NEDO, DERR
Thomas Schneider, Ohio EPA, SWDO
Katie Tait, OHARNG
Steve Kvaal, USACE Louisville
Nathaniel Peters, USACE Louisville
T. Zack Bayne, USACE Louisville
Jed Thomas, Leidos
Ryan Laurich, Leidos
Jennifer Tierney, Chenega

Subject: Ravenna Army Ammunition Plant (RVAAP) Restoration Program, Portage/Trumbull Counties, CC RVAAP-69 Building 1048 Fire Station, Responses to Comments on the Draft Uniform Federal Policy-Quality Assurance Project Plan for the CC RVAAP-69 Building 1048 Fire Station Vapor Intrusion Study of Building 1037 (Work Activity No. 267-000-859-269)

COMMENTS

Ohio EPA Comment 1: Ohio EPA recommends adding a vapor intrusion sample location in the office nestled between the two restrooms (Figure 17-1: Building 1037 Vapor Point Sample Location). There may be subsurface preferential pathways in that general area from the water and sewer lines related to the restrooms, and these subsurface conveyances may assist the lateral movement of any vapors potentially beneath Building 1037 (Figure 10-7: Conceptual Site Model). However, proceed with caution: identify and avoid the location(s) of underground utilities and structures (for example, electric, gas, water, or sewer lines) to prevent damage to these lines; however, sample collection in close proximity to these lines may be warranted as building penetrations for these lines may pose openings for soil gas entry (U.S. EPA, 2015: https://www.epa.gov/sites/default/files/2015 09/documents/oswer-vapor-intrusiontechnical-guide-final.pdf).

> *Army Response*: Agree. Current funding for the study is for a total of 5 sub-slab vapor points. As the Radio Room may not be consistently occupied, vapor point location 069-vp004 will be moved to the office between the restrooms. Precautions will be taken prior to implementation, as recommended by Ohio EPA. As-builts of the building, physical surveys, and worker/site knowledge will be used to help avoid encountering any utilities.

Ohio EPA Comment 2: Ohio EPA recommends having an indoor air sample location paired with each sub-slab soil vapor location rather than collecting one ambient indoor air sample (069vp-006; Table 18-1 and Figure 17-1). This will allow a comparison of any chemicals detected in these samples which will aid in vapor intrusion assessment data interpretation and conclusions. If indoor air samples cannot be paired at each sub-slab vapor sample point due to allocated funding, Ohio EPA recommends at least an indoor air sample be collected in each of the three sections of the building, which from figure 17-1 appear to be the Boiler Room, the Office on the north end, and the main section in the middle. Also, if the building has multiple HVAC systems these can have varying effects on the potential for vapor intrusion and exposure concentrations in the areas they serve thus one ambient indoor air sample may not be representative for an entire building.

> *Army Response*: Clarification. Current funding for the study accounts for 5 sub-slab vapor point locations and one indoor ambient air sample locations. These will all be sampled in two events. Two additional indoor ambient samples exceed the current funding of the project. Based on site knowledge, the building only has one HVAC system, and the inside doors between rooms remain open during occupancy. The ambient air sample locations would be at a central area that connects to all rooms in the building.

Ohio EPA Comment 3: QAPP Worksheet #28 lists one field duplicate per 10 samples. Ohio EPA requests clarification that the language means if nine or less samples are collected one field duplicate will still be collected. Ohio EPA's Quality Assurance Project Plan for Federal Site Assessment recommends, "The minimum number of field duplicate samples required for each round of sampling is one for every 10 samples. If there are fewer than 10 samples per matrix, one field duplicate per matrix will be submitted" (Section A.8.1.1: Field Precision Objectives; https://epa.ohio.gov/static/Portals/30/rules/Ohio%20Superfund%20QAPP.pdf).

> *Army Response*: Clarification and agree. If nine or less samples are collected, one field duplicate will still be collected. Please reference Worksheet #20 showing that 1 duplicate sample will be collected with 7 field samples and 2 duplicate samples will be collected with 17 field samples.

Ohio EPA Comment 4: QAPP Worksheet #28 lists one equipment blank per 10 samples. Ohio EPA's Quality Assurance Project Plan for Federal Site Assessment recommends, "should there be a need for equipment blanks to be collected, a frequency of one for every 20 samples will be utilized, or, at a minimum, one per day collected." (Section A.8; https://epa.ohio.gov/static/Portals/30/rules/Ohio%20Superfund%20QAPP.pdf).

> *Army Response*: Agree. Worksheet #28 has been revised to specify the frequency of an Equipment Blank to "One per day".

Ohio EPA Comment 5: Clarification, no response necessary: Table 17-1 Building 1037 Proposed sample Design and Rationale has the language, "Building 1037 is less than 5,000 ft2; therefore, per Ohio EPA guidance, biased sample locations are not necessary (Ohio EPA 2020a)". How the recommendations are presented in Section 4.5 of the Ohio EPA Vapor Intrusion Guidance may be causing some confusion; it isn't that sampling locations shouldn't also be biased at buildings less than 5,000 ft2, it is that in spacing the samples out every 2,000 to 5,000 square for foundations greater than 5,000 square feet we didn't want the biasing of those sample locations to be overlooked.

> *Army Response*: Comment noted. Even though the building is less than 5,000 ft2, proposed samples provided in the UFP-QAPP are in locations biased towards a higher likelihood of having VOCs from a VI pathway.

Environmental Protection Agency

EPA.Ohio.gov

Mike DeWine, *Governor* Jon Husted, *Lt. Governor* Anne M. Vogel, *Director*

Received February 5, 2024

February 2, 2024

TRANSMITTED ELECTRONICALLY

Mr. Kevin M. Sedlak
Army National Guard
Installations & Environment - Cleanup
Branch IPA Designation
1438 State Route 534 SW
Newton Falls, OH 44444

RE: US Army Ravenna Ammunition
Remediation Response
Correspondence
Remedial Response
Portage County
267000859269

Sent via e-mail to: kevin.m.sedlak.ctr@army.mil

Subject: Ohio EPA Comments on the Draft Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP), CC RVAAP-69 Building 1048 Fire Station Vapor Intrusion Study of Building 1037

Dear Mr. Sedlak:

The Ohio Environmental Protection Agency (Ohio EPA) has received and reviewed the "Draft Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP), CC RVAAP-69 Building 1048 Fire Station Vapor Intrusion Study of Building 1037" at the Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio (Camp Garfield).[1] This plan was received via email at Ohio EPA's Northeast District Office (NEDO), Division of Environmental Response and Revitalization (DERR) on October 19, 2024. The plan was prepared by Leidos for the Army National Guard in support of the RVAAP Restoration Program.

Comments on the document based on Ohio EPA review are provided below. Please provide responses to the enclosed comments in accordance with the Directors Findings and Orders.

Comment 1: Ohio EPA recommends adding a vapor intrusion sample location in the office nestled between the two restrooms (Figure 17-1: Building 1037 Vapor Point Sample Location). There may be subsurface preferential pathways in that general area from the water and sewer lines related to the restrooms, and these subsurface conveyances may assist the lateral movement of any vapors potentially beneath Building 1037 (Figure 10-7: Conceptual Site

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[1] http://edocpub.epa.ohio.gov/publicportal/ViewDocument.aspx?docid=2608110

Model). However, proceed with caution: identify and avoid the location(s) of underground utilities and structures (for example, electric, gas, water, or sewer lines) to prevent damage to these lines; however, sample collection in close proximity to these lines may be warranted as building penetrations for these lines may pose openings for soil gas entry (U.S. EPA, 2015: https://www.epa.gov/sites/default/files/2015-09/documents/oswer-vapor-intrusion-technical-guide-final.pdf).

Comment 2: Ohio EPA recommends having an indoor air sample location paired with each sub-slab soil vapor location rather than collecting one ambient indoor air sample (069vp-006; Table 18-1 and Figure 17-1). This will allow a comparison of any chemicals detected in these samples which will aid in vapor intrusion assessment data interpretation and conclusions. If indoor air samples cannot be paired at each sub-slab vapor sample point due to allocated funding, Ohio EPA recommends at least an indoor air sample be collected in each of the three sections of the building, which from figure 17-1 appear to be the Boiler Room, the Office on the north end, and the main section in the middle. Also, if the building has multiple HVAC systems these can have varying effects on the potential for vapor intrusion and exposure concentrations in the areas they serve thus one ambient indoor air sample may not be representative for an entire building.

Comment 3: QAPP Worksheet #28 lists one field duplicate per 10 samples. Ohio EPA requests clarification that the language means if nine or less samples are collected one field duplicate will still be collected. Ohio EPA's Quality Assurance Project Plan for Federal Site Assessment recommends, "The minimum number of field duplicate samples required for each round of sampling is one for every 10 samples. If there are fewer than 10 samples per matrix, one field duplicate per matrix will be submitted" (Section A.8.1.1: Field Precision Objectives; https://epa.ohio.gov/static/Portals/30/rules/Ohio%20Superfund%20QAPP.pdf).

Comment 4: QAPP Worksheet #28 lists one equipment blank per 10 samples. Ohio EPA's Quality Assurance Project Plan for Federal Site Assessment recommends, "should there be a need for equipment blanks to be collected, a frequency of one for every 20 samples will be utilized, or, at a minimum, one per day collected." (Section A.8; https://epa.ohio.gov/static/Portals/30/rules/Ohio%20Superfund%20QAPP.pdf).

Comment 5: Clarification, no response necessary: Table 17-1 Building 1037 Proposed sample Design and Rationale has the language, "Building 1037 is less than 5,000 ft2; therefore, per Ohio EPA guidance, biased sample locations are not necessary (Ohio EPA 2020a)". How the recommendations are presented in Section 4.5 of the Ohio EPA Vapor Intrusion Guidance may be causing some confusion; it isn't that sampling locations shouldn't also be biased at buildings less than 5,000 ft2, it is that in spacing the samples out every 2,000 to 5,000 square for foundations greater than 5,000 square feet we didn't want the biasing of those sample locations to be overlooked.

If you have any questions, please contact me at (330) 963-1168 or by e-mail at: megan.oravec@epa.ohio.gov.

Sincerely,

Megan Oravec

Megan Oravec
Environmental Supervisor
Division of Environmental Response and Revitalization

MO/cm

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