

Final

**Uniform Federal Policy-Quality Assurance Project Plan
for Additional Remedial Design Sampling
at Multiple Areas of Concern
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**

February 13, 2024

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at Multiple Areas of Concern**

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REPORT DOCUMENTATION PAGE

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None.

14. ABSTRACT
The UFP QAPP provides a plan to perform additional RD sampling to define the extent of contamination at areas above CUGs at RVAAP-38 National Advisory Committee on Aeronautics (NACA) Test Area, RVAAP-42 Load Line 9, RVAAP-45 Wet Storage Area, and CC RVAAP-76 Depot Area located within Camp James A. Garfield (CJAG).

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a. REPORT U	b. ABSTRACT U	c. THIS PAGE U			19b. TELEPHONE NUMBER (Include area code) 502-315-2624

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PLACEHOLDER FOR:

Documentation of Ohio EPA Concurrence of Final Document

(Documentation to be provided once concurrence is issued.)

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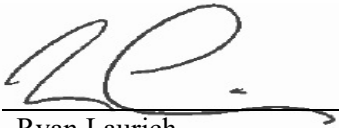
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Contract and Delivery Order Number: Contract No. W912QR-21-D-0016, Delivery Order No. W912QR23F0014

Document Name: Uniform Federal Policy-Quality Assurance Project Plan for Additional Remedial Design Sampling at Multiple Areas of Concern, Ravenna Army Ammunition Plant Restoration Program, Camp James A. Garfield Joint Military Training Center, Portage and Trumbull Counties, Ohio

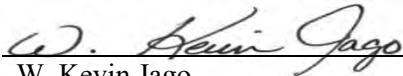
Notice is hereby given that an independent technical review, that is appropriate to the level of risk and complexity inherent in the project, has been conducted. During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions, 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.



Ryan Laurich
Study/Design Team Leader

2/13/2024

Date



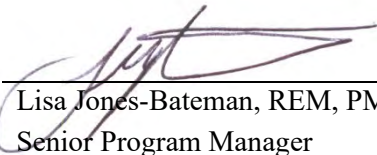
W. Kevin Jago
Independent Technical Review Team Leader

2/13/2024

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.



Lisa Jones-Bateman, REM, PMP
Senior Program Manager

2/13/2024

Date

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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

AOC	Area of Concern
Army	U.S. Army
ARNG	Army National Guard
CIH	Certified Industrial Hygienist
CJAG	Camp James A. Garfield
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	Chemical of Concern
CSP	Certified Safety Professional
CUG	Cleanup Goal
DoD	U.S. Department of Defense
IDW	Investigation-Derived Waste
NACA	National Advisory Committee on Aeronautics
Ohio EPA	Ohio Environmental Protection Agency
OHARNG	Ohio Army National Guard
P.E.	Professional Engineer
P.G.	Professional Geologist
PMP	Project Management Professional
QA	Quality Assurance
QC	Quality Control
RA	Remedial Action
RD	Remedial Design
REM	Registered Environmental Manager
RVAAP	Ravenna Army Ammunition Plant
SVOC	Semivolatile Organic Compound
UFP-QAPP	Uniform Federal Policy-Quality Assurance Project Plan
USACE	U.S. Army Corps of Engineers
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 additional remedial design (RD) sampling at four areas of concern (AOCs) within the former Ravenna Army Ammunition Plant (RVAAP), now known as Camp James A. Garfield (CJAG). Leidos has prepared this Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) to conduct additional RD sampling at RVAAP-38 National Advisory Committee on Aeronautics (NACA) Test Area, RVAAP-42 Load Line 9, RVAAP-45 Wet Storage Area, and CC RVAAP-76 Depot Area located within 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 the U.S. Department of Defense. The Ohio Environmental Protection Agency (Ohio EPA) is the supporting state regulatory agency. The remedies for soil, sediment, and surface water have been selected 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, and are documented in the following records of decision:

- *Record of Decision for Soil, Sediment, and Surface Water at RVAAP-38 NACA Test Area* (Leidos 2019a)
- *Record of Decision for Soil, Sediment, and Surface Water at RVAAP-42 Load Line 9* (Leidos 2019b).
- *Record of Decision for Soil, Sediment, and Surface Water at RVAAP-45 Wet Storage Area* (Leidos 2019c).
- *Record of Decision for CC RVAAP-76 Depot Area* (Parsons 2019).

To execute the selected remedy for the soil, sediment, and surface water media at the four AOCs, the Army developed the following RDs:

- *Remedial Design for Soil, Sediment, and Surface Water at RVAAP-38 NACA Test Area* (Alaniz-Endpoint 2021a)
- *Remedial Design for Soil, Sediment, and Surface Water at RVAAP-42 Load Line 9* (Alaniz-Endpoint 2021b)
- *Remedial Design for Soil, Sediment, and Surface Water at RVAAP-45 Wet Storage Area* (Alaniz-Endpoint 2021c)
- *Remedial Design for Soil, Sediment, and Surface Water at CC RVAAP-76 Depot Area* (Alaniz-Endpoint 2021d).

No chemicals of concern (COCs) required remediation in sediment or surface water at any of these AOCs; therefore, no remedial actions (RAs) are required for those media. From June 2021 to September 2022, remedial activities were conducted to address contaminated soil at these sites. Upon completion of the contracted remedial activities, COC concentrations at various locations at these

AOCs were still above cleanup goals (CUGs), as presented in the *Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern* (Alaniz-Endpoint 2022).

SCOPE

The scope of work, as presented in this UFP-QAPP, is to develop a plan to perform additional RD sampling to define the extent of contamination at areas above CUGs. This consists of four inter-related tasks: 1) prepare a UFP-QAPP, 2) conduct additional RD sampling data collection activities to refine the extent of soil above CUGs, 3) conduct data validation and laboratory oversight activities, and 4) evaluate data from the field effort and applicable historical information to produce individual RD Addenda for RVAAP-38 NACA Test Area, RVAAP-42 Load Line 9, RVAAP-45 Wet Storage Area, and CC RVAAP-76 Depot Area.

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

PROJECT OBJECTIVES

The objectives of the additional RD sampling at the four AOCs are to:

- Further delineate contamination of semivolatile organic compounds (SVOCs) in soil at three excavations (Area 1, Area 2, and Area 3) at RVAAP-38 NACA Test Area where project CUGs were not achieved
- Further delineate contamination of metals and SVOCs in soil at two excavations (Area 1 and Area 2) at RVAAP-42 Load Line 9 where CUGs were not achieved
- Further delineate contamination of SVOCs in soil at two excavations (Area 1 and Area 2) at RVAAP-45 Wet Storage Area where CUGs were not achieved
- Further delineate contamination of SVOCs in soil at two excavations around Building U-4 and Building U-5 at CC RVAAP-76 Depot Area
- 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.

Laboratory analyses will be conducted in accordance with project 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. RVAAP-38 NACA Test Area, RVAAP-42 Load Line 9, RVAAP-48 Wet Storage Area, and CC RVAAP-76 Depot Area Additional Remedial Design Sampling
- 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 Project Manager

Signature, Date

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

Signature, Date

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

Signature, Date

3. State Regulatory Agency

- a. Ohio Environmental Protection Agency (Ohio EPA)
Edward D'Amato, Site Coordinator

Signature, Date

4. Other Stakeholders – None

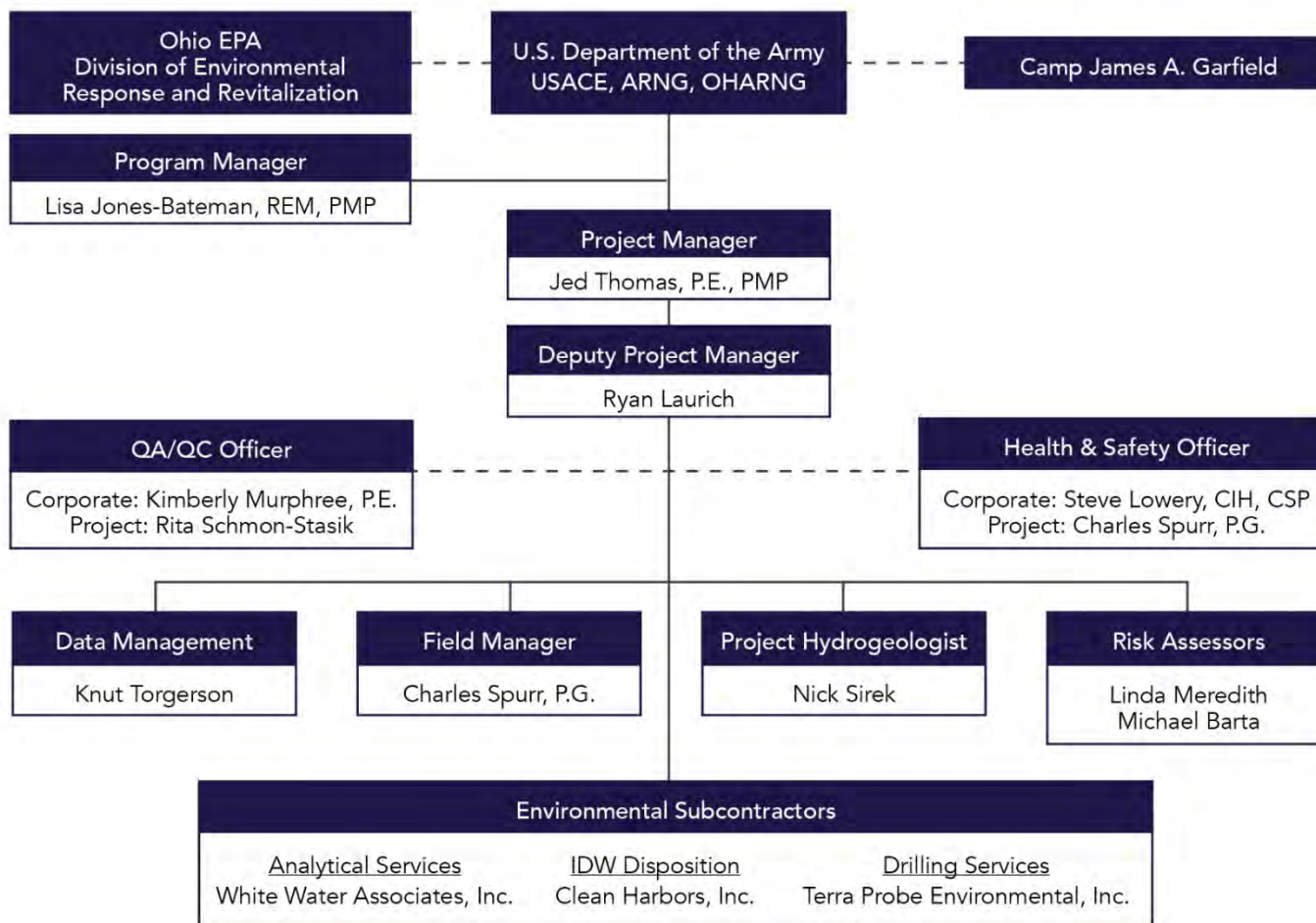
5. Plans and reports from previous investigations relevant to this project:

Alaniz-Endpoint. 2021a. *Final Remedial Design for Soil, Sediment, and Surface Water at RVAAP-38 NACA Test Area*. March.

- Alaniz-Endpoint. 2021b. *Final Remedial Design for Soil, Sediment, and Surface Water at RVAAP-42 Load Line 9*. March.
- Alaniz-Endpoint. 2021c. *Final Remedial Design for Soil, Sediment, and Surface Water at RVAAP-45 Wet Storage Area*. March.
- Alaniz-Endpoint. 2021d. *Final Remedial Design for Soil, Sediment, and Surface Water at CC RVAAP-76 Depot Area*. March.
- Alaniz-Endpoint. 2022. *Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern, Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, OH*. Final. November.
- Leidos. 2019a. *Final Record of Decision for Soil, Sediment, and Surface Water at RVAAP-38 NACA Test Area, Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio*. December 5.
- Leidos. 2019b. *Final Record of Decision for Soil, Sediment, and Surface Water at RVAAP-42 Load Line 9, Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio*. February 22.
- Leidos. 2019c. *Final Record of Decision for Soil, Sediment, and Surface Water at RVAAP-45 Wet Storage Area, Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio*. February 22.
- Parsons. 2019. *Final Record of Decision for CC RVAAP-76 Depot Area, Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio*. January 8.

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

3.1 PROJECT ORGANIZATION





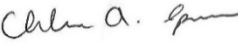


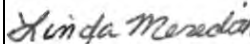
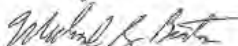
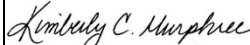


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QAPP Worksheets #4, #7, and #8 – Personnel Qualifications and Sign-Off Sheet

Organization: Leidos

Project Personnel	Title/Role	Education/Experience	Specialized Training/Certifications	Additional Required Training	Signature ^b
Jed Thomas	Project Manager	M.S., Chemical Engineering 21 years of experience	P.E., PMP, HAZWOPER Supervisor ^a	None	
Ryan Laurich	Deputy Project Manager	M.S., Environmental Science 15 years of experience	HAZWOPER 40-Hour Supervisor ^a	None	
Charles Spurr	Field Manager	B.A., Geology M.S., Geology/Geophysics 6 years of experience	P.G., HAZWOPER 40-Hour, HAZWOPER Supervisor ^a	None	
Rita Schmon-Stasik	Project Chemist	B.S., Chemistry 36 years of experience		None	
Nick Sirek	Project Hydrogeologist	M.S., Hydrogeology 16 years of experience	HAZWOPER 40-Hour	None	
Linda Meredith	Human Health Risk Assessor	B.A., Chemistry 35 years of experience		None	
Michael Barta	Ecological Risk Assessor	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	
Knut Torgerson	Data Manager	B.S., Environmental Sciences 27 years of experience		None	
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	

^aAll 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.

^bSignatures 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 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	
Vanessa Badman, ELLE	Project Manager	B.S., Biology 20 Years of experience	N/A	
Richard Karam, ELLE	ELLE Laboratory Manager	B.A., Environmental Studies 23 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

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 ARNG, OHARNG, and USACE by the Leidos Project Manager (or designee). Only with approval from the 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 the 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 FM 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 the 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.
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 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.

QAPP Worksheet #6 – Communication Pathways (Continued)

Communication Drivers	Responsible Entity	Name	Telephone Number/ Email Address	Procedure (timing, pathway, etc.)
	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 E for the Project Planning Session presentation and meeting minutes.

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QAPP Worksheet #10 – Conceptual Site Model

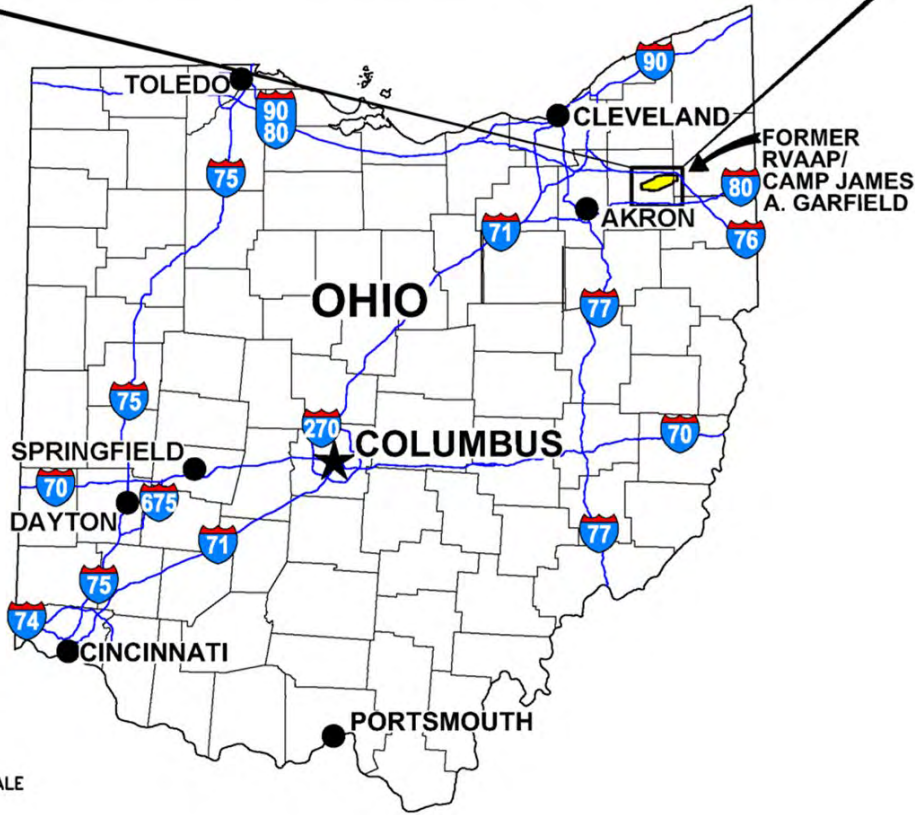
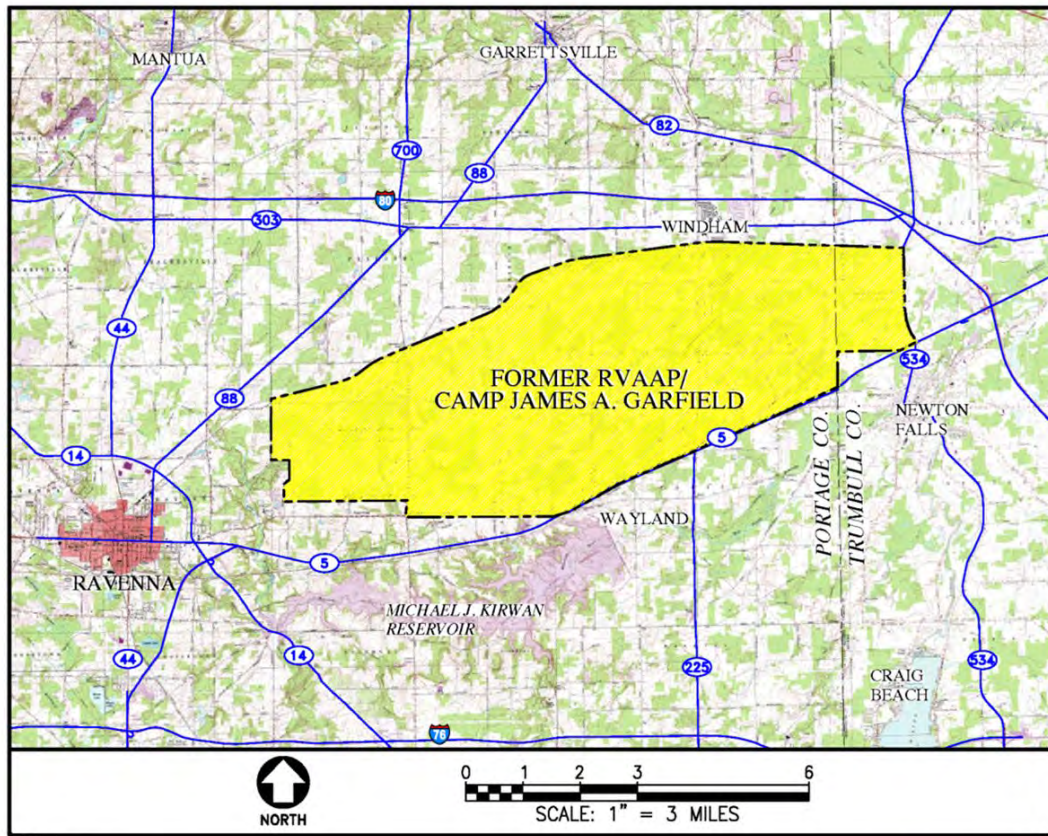
10.1 INTRODUCTION

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 a parcel of property 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 on the south; Garrett, McCormick, and Berry Roads on the west; the Norfolk Southern Railroad on the north; and State Route 534 on 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 Installation Restoration Program, managed by ARNG and OHARNG, encompasses investigation and cleanup of past activities over the entire 21,683 acres of the former RVAAP/CJAG.

The remedies for soil, sediment, and surface water have been selected in accordance with the CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986 and the NCP, for four AOCs within the former RVAAP. Those four AOCs are RVAAP-38 NACA Test Area, RVAAP-42 Load Line 9, RVAAP-45 Wet Storage Area, and CC RVAAP-76 Depot Area (Figure 10-2). No COCs required remediation in sediment or surface water at any of these AOCs, therefore, no RAs are required for those media.

From June 2021 to September 2022, remedial activities were conducted to address contaminated soil at these sites. Upon completion of the contracted remedial activities, COC concentrations in soil at various locations at these AOCs were still above CUGs, as presented in the *Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern* (Alaniz-Endpoint 2022). The following sections, for each of the four AOCs, provide a site description, summarize the soil remedial activities performed to date, and identify areas with residual contamination that will require additional RD sampling. The proposed strategy for additional RD sampling is presented on Worksheet #17.



1/22/19 c:\06042\DWGS\564-ADDEN FIGURE-1

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

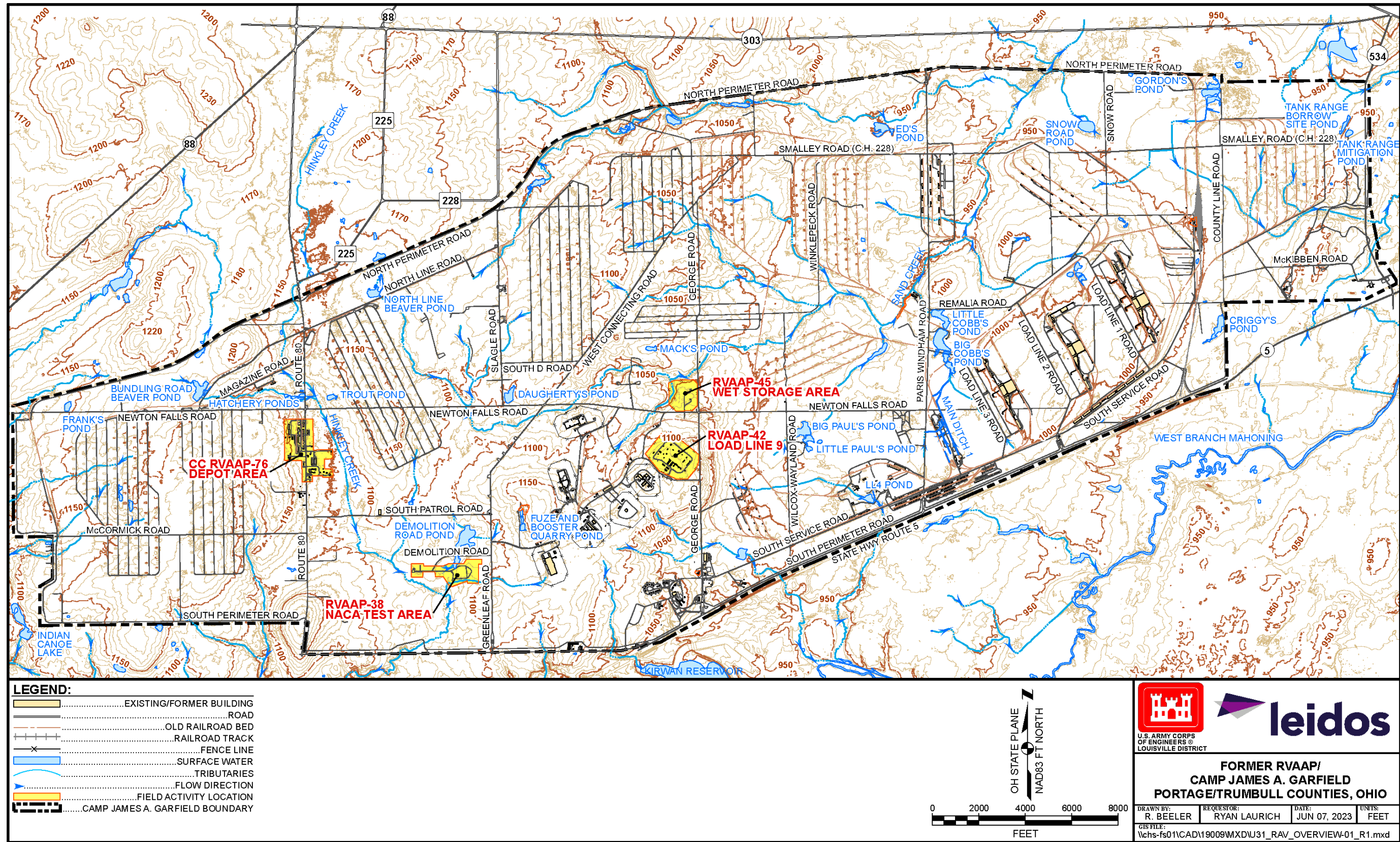


Figure 10-2. Location of Four Areas of Concern within Camp James A. Garfield

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10.2 RVAAP-38 NACA TEST AREA

10.2.1 Site Description

RVAAP-38 NACA Test Area is located west of Greenleaf Road at the southern end of Demolition Road in the southwestern portion of Camp Ravenna (Figure 10-3). NACA Test Area was designed and used by NACA from 1947 to 1953 to simulate a takeoff accident in which an airplane fails to become airborne and strikes an embankment, which results in rupturing of the fuel tanks (NACA 1952). Crash tests were performed on 17 excess military airplanes provided by the U.S. Air Force to develop explosion-proof fuel tanks and fuel for airplanes.

Historical features of the site included gravel access roads, plane storage areas, a concrete runway and monorail, camera stations, a fuel shack, a metal building, observation towers, and storage shacks near the observation towers. In addition, a fire protection system was installed in the southwestern portion of the crash area.

Combustible liquids involved in testing activities included 100/130 octane aviation fuels, low-volatility fuel, flame retardants, lubricating oil, coolant compounds, hydraulic fluids, alcohol, and brake fluid. Each airplane carried approximately 1,050 gallons of gasoline or low-volatility fuel (NACA 1953).

Physical characteristics including physiographic setting, climate, surface features and site topography, geology, hydrogeology, demography and land use, potential receptors, and information inputs for the CSMs were presented in the *Record of Decision for Soil, Sediment, and Surface Water at RVAAP-38 NACA Test Area* (Leidos 2019a).

10.2.2 Soil Excavation and Residual Contamination

As summarized in the *Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern* (Alaniz-Endpoint 2022), excavations at three areas (Area 1, Area 2, and Area 3) and the former production well pit were conducted (Figure 10-4). The former production well was abandoned, and the well vault and lead-impacted soil were removed and disposed of offsite. No further action is required at the well pit. However, concentrations of the PAH-impacted soil at Areas 1, 2, and 3 remained that were greater than CUGs, and each area requires additional RD sampling to guide additional soil excavation. The COCs and CUGs for NACA Test Area are presented in Table 10-1.

10.2.2.1 NACA Test Area, Area 1

After the initial excavation at Area 1, the concentration of benzo(a)pyrene (1.7 mg/kg) was greater than the CUG at the excavation sidewall confirmation sample NTAcS-186M. Further delineation and excavation to meet the CUGs was not completed at this area. All other confirmation samples collected from Area 1 had COC concentrations less than the CUGs.

10.2.2.2 NACA Test Area, Area 2

After the initial excavation at Area 2, all four sidewalls had COC concentrations greater than the CUGs. The excavation floor had concentrations less than the CUG, and further excavation to depth is not required. Additional step-out excavations were completed laterally to 5 feet, and confirmation sampling was completed. Additional confirmation sampling indicated that CUGs had not been achieved with the exception of benz(a)anthracene at the east and south sidewalls. COC concentrations greater than the CUGs were detected at the following excavation sidewall confirmation samples:

- NTAcS-180M-SO1: Benz(a)anthracene at 21 mg/kg, benzo(a)pyrene at 20 mg/kg, benzo(b)fluoranthene at 24 mg/kg, and dibenz(a,h)anthracene at 3.9 mg/kg
- NTAcS-181M-SO1: Benzo(a)pyrene at 1.8 mg/kg
- NTAcS-182M-SO1: Benzo(a)pyrene at 11 mg/kg, benzo(b)fluoranthene at 14 mg/kg, and dibenz(a,h)anthracene at 1.6 mg/kg
- NTAcS-183M-SO1: Benzo(a)pyrene at 9.9 mg/kg, benzo(b)fluoranthene at 14 mg/kg, and dibenz(a,h)anthracene at 1.6 mg/kg.

10.2.2.3 NACA Test Area, Area 3

After the initial excavation at Area 3, concentrations of COCs detected at the sidewalls were less than the CUG. However, the excavation floor did not achieve the CUG for benzo(a)pyrene. Additional excavation was completed to a total depth of 2 feet bgs, and an additional confirmation sample was collected. Benzo(a)pyrene was detected at a concentration of 6.6 mg/kg, greater than the CUG, in the second confirmation sample NTAcS-207M-SO1 from the excavation floor. Further excavation and confirmation sampling was not conducted.

Table 10-1. Chemicals of Concern and Cleanup Goals for RVAAP-38 NACA Test Area

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	

*Cleanup goals as presented in *Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern* (Alaniz-Endpoint 2022).

AOC = Area of Concern
 mg/kg = Milligrams per Kilogram
 NACA = National Advisory Committee on Aeronautics
 RVAAP = Ravenna Army Ammunition Plant

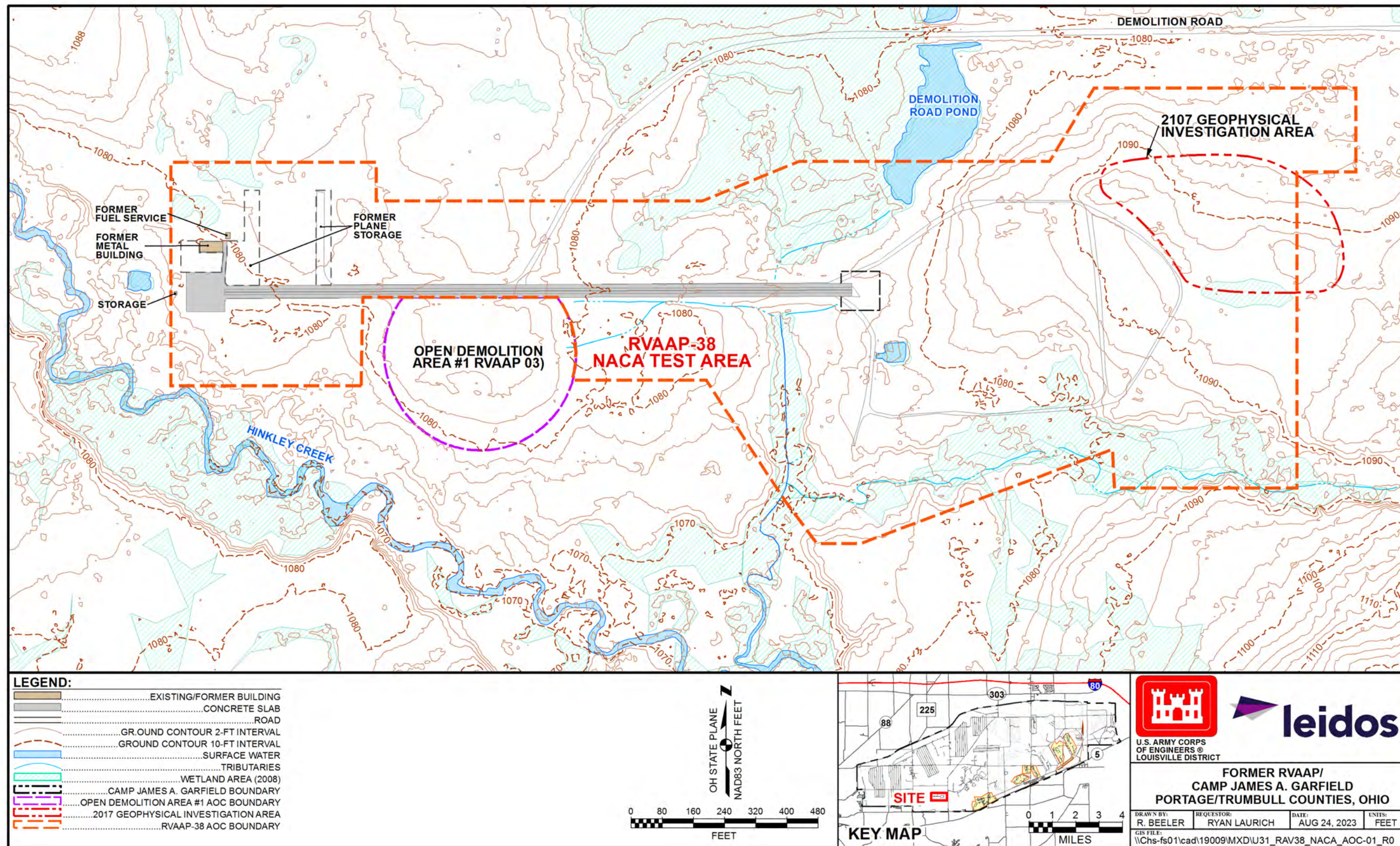


Figure 10-3. RVAAP-38 NACA Test Area – Map and AOC Features

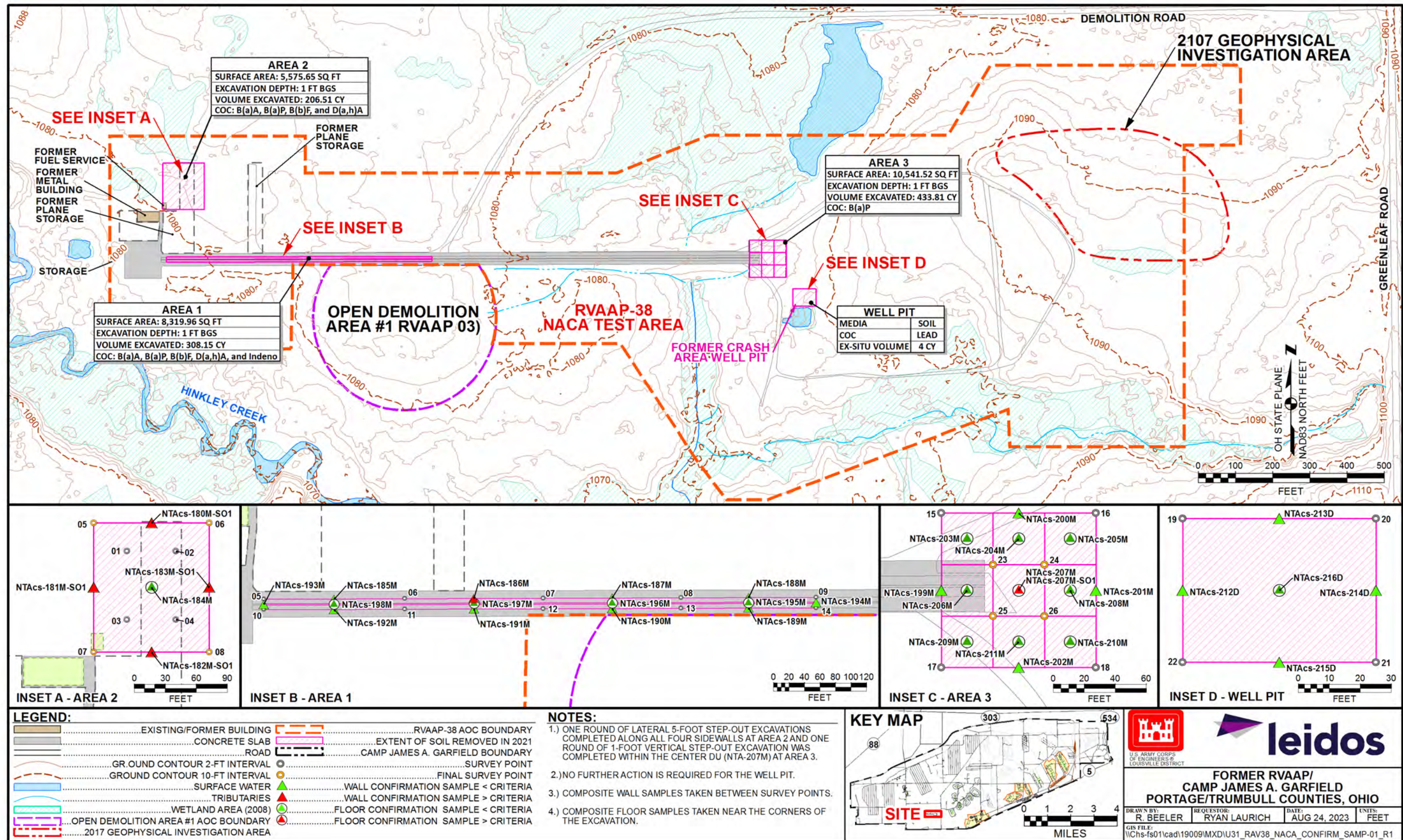


Figure 10-4. RVAAP-38 NACA Test Area – Confirmation Samples Exceeding Project Cleanup Goals

10.3 RVAAP-42 LOAD LINE 9

RVAAP-42 Load Line 9, formerly known as the detonator line, is a 69-acre, fenced AOC located north of Fuze and Booster Road, west of George Road, and northeast of Load Line 10 in the south-central portion of Camp Ravenna (Figure 10-5).

From 1941 to 1945, fuze component parts for artillery projectiles were produced at Load Line 9. Load Line 9 was deactivated at the end of World War II, and the process equipment was removed. Load Line 9 has not been used since 1945, and no historical information exists to indicate Load Line 9 was used for any other processes.

All buildings within the AOC were demolished in 2003, and slabs and foundations were removed in 2003 and 2007. An old, elevated water tank (WW-32) and perimeter fence are still in place. The elevated water tank is no longer connected to a water distribution system and is currently used for a radio antenna. Gravel perimeter roads are inside the AOC, as well as two dirt mounds immediately north-northeast of the locations of former Buildings DT-2 and DT-5. Small construction drainage ditches border the gravel perimeter road. Buildings DT-30 and DT-31 (shipping and storing inert material) remain northwest of the Load Line 9 boundary along Detonator Spur Road and are not part of the AOC.

Physical characteristics, including physiographic setting, climate, surface features and site topography, geology, hydrogeology, demography and land use, potential receptors, and information inputs for the CSMs, were presented in the *Record of Decision for Soil, Sediment, and Surface Water at RVAAP-42 Load Line 9* (Leidos 2019b).

10.3.1 Soil Excavation and Residual Contamination

As summarized in the *Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern* (Alaniz-Endpoint 2022), excavations at two areas (Area 1 and Area 2) were conducted (Figure 10-6). However, concentrations of soil at Areas 1 and 2 remained that were greater than CUGs, and each area requires additional RD sampling to guide additional soil excavation. The COCs and CUGs for Load Line 9 are presented in Table 10-2.

10.3.1.1 Load Line 9, Area 1

After the initial excavation at Area 1, the confirmation sample (LL9cs-138M) collected from the southern wall was less than CUGs. However, confirmation samples from the north, east, and west sidewalls, along with the bottom of the excavation, were greater than CUGs. Additional step-out excavations were completed laterally to 5 feet at the north, west, and east sidewalls and to a depth of 6 inches below the bottom of the excavation. A second round of confirmation sampling confirmed that the north sidewall (LL9cs-136M-SO1) and the bottom of the excavation (LL9cs-140M) were less than CUGs. The concentrations of lead (460 mg/kg) and mercury (94 mg/kg) at the east sidewall confirmation sample LL9cs-137M-SO1 were greater than the CUGs. The concentration of lead (1,200 mg/kg) at the west sidewall confirmation sample LL9cs-139M-SO1 was greater than the CUG.

10.3.1.2 Load Line 9, Area 2

After the initial excavation at Area 2, sample locations associated with the northwestern excavation wall (LL9cs-145M and LL9cs-146M) and the northeastern wall (LL9cs-141M) were less than the CUGs. Samples associated with the excavation floor (LL9cs-147M and LL9cs-148M) were also less than the CUGs. Sample locations associated with the southwestern wall and southeastern wall were greater than the CUGs.

Additional step-out excavations were completed laterally to 5 feet at the southeast and southwest sidewalls of the excavation. The concentrations of benz(a)anthracene (13 mg/kg), benzo(a)pyrene (11 mg/kg), benzo(b)fluoranthene (13 mg/kg), and dibenz(a,h)anthracene (1.4 mg/kg) at the excavation sidewall confirmation sample LL9cs-143M-SO1 were greater than the CUGs. The concentrations of benzo(a)pyrene (3.8 mg/kg) at the excavation sidewall confirmation sample LL9cs-144M-SO1 were greater than the CUGs.

Table 10-2. Chemicals of Concern and Cleanup Goals for RVAAP-42 Load Line 9

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

*Cleanup goals as presented in *Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern* (Alaniz-Endpoint 2022).

AOC = Area of Concern

mg/kg = Milligrams per Kilogram

RVAAP = Ravenna Army Ammunition Plant

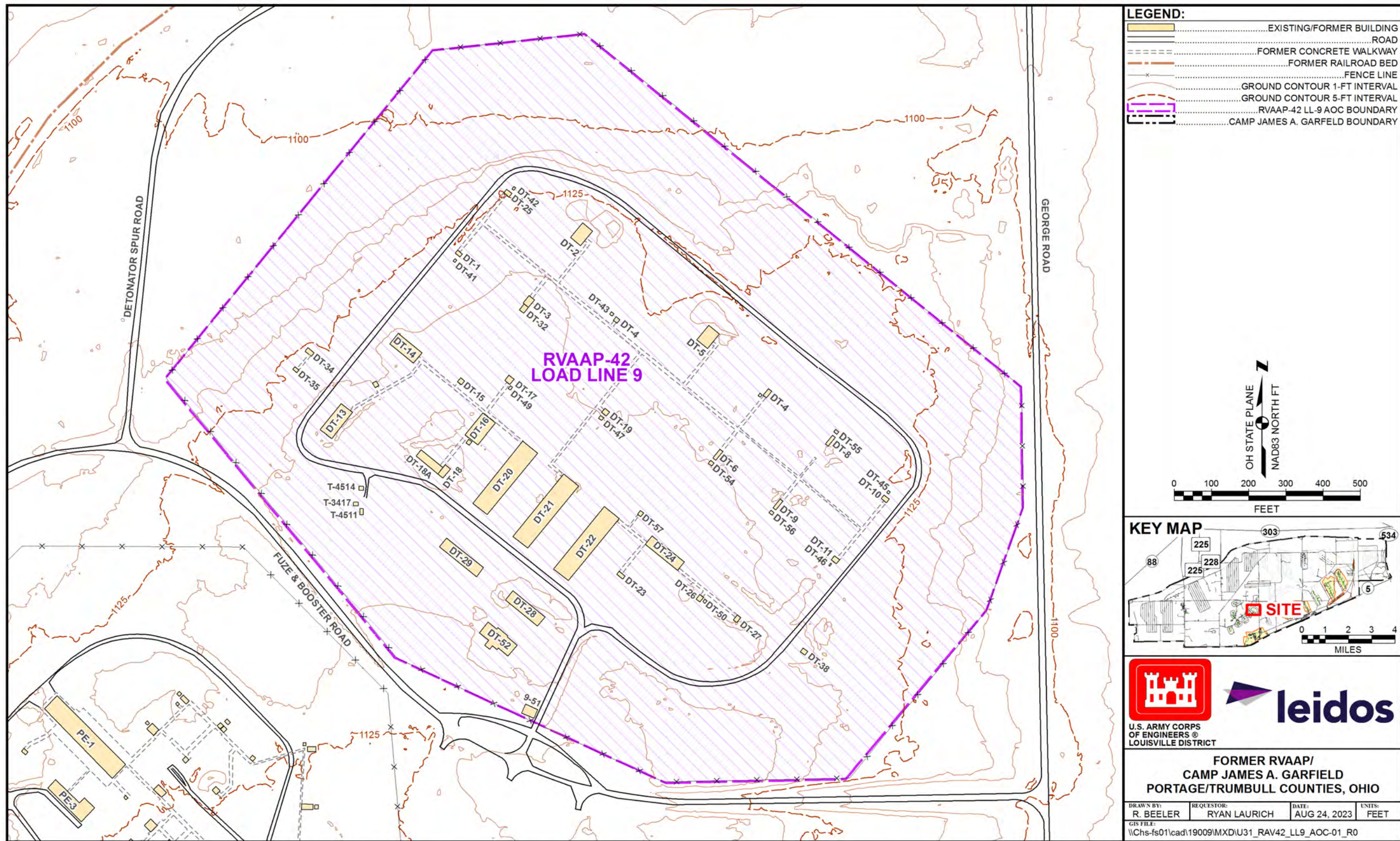


Figure 10-5. RVAAP-42 Load Line 9 – Map and AOC Features

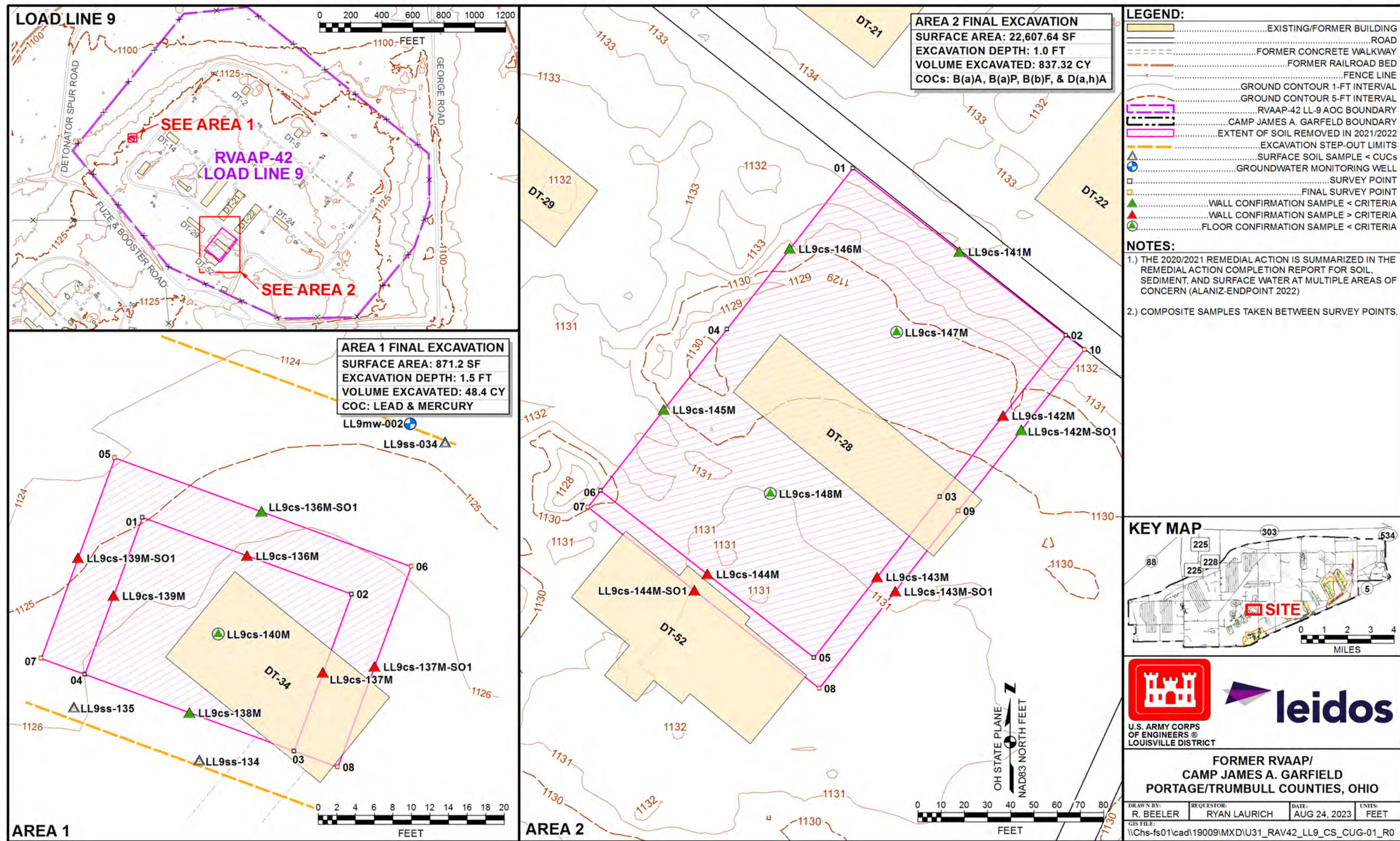


Figure 10-6. RVAAP-42 Load Line 9 – Confirmation Samples Exceeding Project Cleanup Goals

10.4 RVAAP-45 WET STORAGE AREA

10.4.1 Site Description

RVAAP-45 Wet Storage Area is a 36-acre fenced AOC located near the geographic center of RVAAP (Figure 10-7). The AOC is located directly northwest of the intersection of George Road and Newton Falls Road. An unnamed tributary to Sand Creek is located in the western portion of the AOC, and Sand Creek is located outside the AOC, north of the fence line.

From 1941 to 1945, Wet Storage Area was used to store highly explosive, shock-sensitive, primary explosives, including lead azide, mercury fulminate, and tetryl (USACHPPM 1998), and potentially nitroguanidine (USACE 2015). During storage activities, explosive material was containerized and covered with water within drums that were stored separately in six storage igloos at the AOC. No documentation exists indicating any spills occurred at the AOC. No historical information exists to indicate a fuel storage tank was present at Wet Storage Area; however, Building PS-7 was a generator house, which likely used diesel fuel.

Four storage igloos located in the western portion of the AOC (designated WS-1, WS-1A, WS-2, and WS-2A) were built approximately 150 feet apart and were removed in 2003-2004. Two igloos (WS-3 and WS-3A) are located in the eastern portion of the AOC and are spaced 400 feet apart. All six igloos were earth-covered, and the floors, walls, and ceilings were constructed of reinforced concrete. The four westernmost igloos were constructed with a conductive lead floor liner to dissipate static electricity.

Remaining features at Wet Storage Area include storage igloos WS-3 and WS-3A and access roads that enter the AOC from the south. The Wet Storage Area perimeter fence is still in place but is not currently maintained. Small construction drainage ditches border the access roads near the igloo locations.

Physical characteristics, including physiographic setting, climate, surface features and site topography, geology, hydrogeology, demography and land use, potential receptors, and information inputs for the CSMs, were presented in the *Record of Decision for Soil, Sediment, and Surface Water at RVAAP-45 Wet Storage Area* (Leidos 2019c).

10.4.2 Soil Excavation and Residual Contamination

As summarized in the *Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern* (Alaniz-Endpoint 2022), excavations at two areas (Area 1 and Area 2) were conducted (Figure 10-8). However, concentrations of PAH-impacted soil at Areas 1 and 2 remained that were greater than CUGs, and each area requires additional RD sampling to guide additional soil excavation. The COCs and CUGs for Wet Storage Area are presented in Table 10-3.

10.4.2.1 Wet Storage Area, Area 1

After the initial excavation at Area 1, the concentrations of benzo(a)pyrene in the west and south sidewalls of the excavation were less than the CUG. However, the concentrations of benzo(a)pyrene in

the north and east sidewalls of the excavation were greater than the CUG. Additional excavations were completed laterally to 5 feet at the north and east sidewalls. The concentration of benzo(a)pyrene (5.9 mg/kg) at the excavation sidewall confirmation sample WSACs-041M-SO1 was greater than the CUG. The concentration of benzo(a)pyrene (6.0 mg/kg) at the excavation sidewall confirmation sample WSACs-042M-SO1 was greater than the CUG. Further excavation was not completed laterally for either sidewall.

The floor required three excavations to result in the confirmation samples being less than the CUG. To achieve the CUG, the northern half of Area 1 was excavated to 2.5 feet bgs, and the southern half of Area 1 was excavated to 1 foot bgs.

10.4.2.2 Wet Storage Area, Area 2

After the initial excavation at Area 2, the concentration of benzo(a)pyrene in the southern wall was less than the CUG. However, confirmation samples from the north, east, and west sidewalls exceeded the CUG. Additional excavations were completed laterally to 5 feet at the north, east, and west sidewalls. A second round of confirmation sampling indicated that the confirmation samples from the north and west sidewalls were less than the CUG. However, the concentration of benzo(a)pyrene (8.6 mg/kg) at the east sidewall confirmation sample WSACs-048M-SO1 was greater than the CUG.

The floor required three excavations to result in the confirmation samples being less than the CUG. To achieve the CUG, Area 2 was excavated to 2.5 feet bgs.

Table 10-3. Chemicals of Concern and Cleanup Goals for RVAAP-45 Wet Storage Area

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

*Cleanup goals as presented in *Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern* (Alaniz-Endpoint 2022).

AOC = Area of Concern

mg/kg = Milligrams per Kilogram

RVAAP = Ravenna Army Ammunition Plant

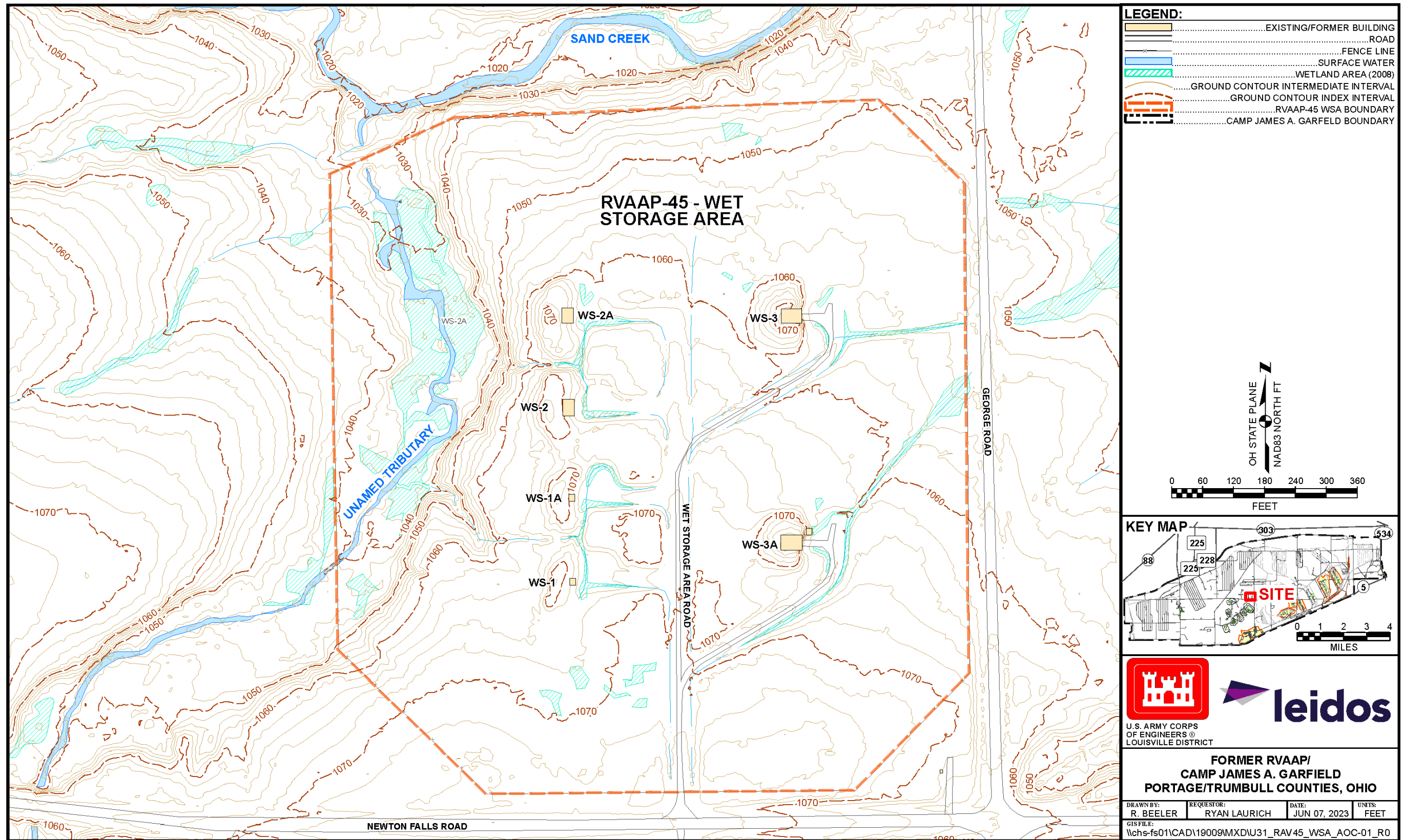


Figure 10-7. RVAAP-45 Wet Storage Area – Map and AOC Features

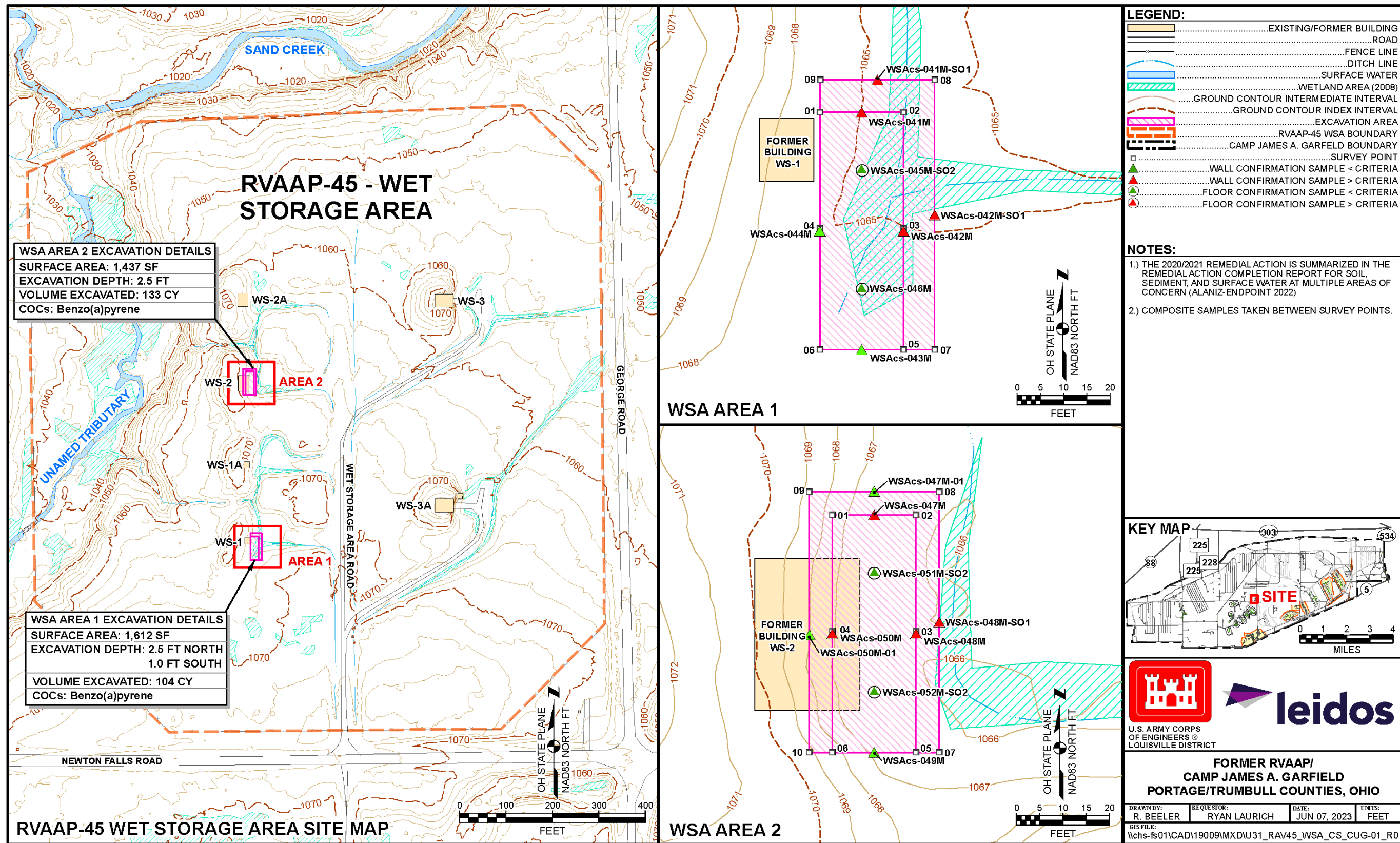


Figure 10-8. RVAAP-45 Wet Storage Area – Confirmation Samples Exceeding Project Cleanup Goals

10.5 CC RVAAP-76 DEPOT AREA

10.5.1 Site Description

CC RVAAP-76 Depot Area is located in the western portion of the facility primarily along Route 80, south of Newton Falls Road, and north of South Patrol Road (Figure 10-9). The buildings associated with the AOC included Building A-2 – Motor Repair Building, Building A-3 – Service Garage/Tool Crib, Building U-4 – Material Handling Equipment Repair Shop, Building U-5 – Equipment Repair Building, Building U-10 – Box Repair Shop, Building U-20 – Incinerator, and Building EE-102 – Bolton Barn. The AOC still has several of the original structures, which are mostly used for storage (ECC and AMEC 2016).

Historical operations conducted at the AOC included fueling operations, locomotive repair, petroleum oil and lubricant storage, solid waste incinerator activities, and vehicle repair and maintenance. Munitions demilitarization activities were conducted in Building U-10. OHARNG currently uses this area (ECC and AMEC 2016).

Physical characteristics, including physiographic setting, climate, surface features and site topography, geology, hydrogeology, demography and land use, potential receptors, and information inputs for the CSMs, were presented in the *Record of Decision for CC RVAAP-76 Depot Area* (Parsons 2019).

10.5.2 Soil Excavation and Residual Contamination

As summarized in the *Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern* (Alaniz-Endpoint 2022), excavations at two areas (Buildings U-4 and U-5) were conducted (Figure 10-10). However, concentrations of PAH-impacted soil at Buildings U-4 and U-5 remained that were greater than CUGs, and each area requires additional RD sampling to guide additional soil excavation. The COCs and CUGs for the Depot Area are presented in Table 10-4.

10.5.2.1 Building U-4

After the initial excavation at Building U-4, the concentration of benzo(a)pyrene in the west and south sidewalls were less than the CUG. However, the concentration of benzo(a)pyrene (2.3 mg/kg) at the excavation sidewall confirmation sample 076cs-110M was greater than the CUG, and the concentration of benzo(a)pyrene (1.3 mg/kg) at the excavation sidewall confirmation sample 076cs-111M was greater than the CUG. All four confirmation samples from the excavation floor were below the CUGs.

10.5.2.2 Building U-5

After the initial excavation at Building U-5, the concentration of benzo(a)pyrene in the east and west sidewalls were less than the CUG. However, the concentrations of benz(a)anthracene (15 mg/kg), benzo(a)pyrene (11 mg/kg), benzo(b)fluoranthene (19 mg/kg), and dibenz(a,h)anthracene (3.8 mg/kg) at the excavation sidewall confirmation sample 076cs-118M were greater than the CUGs. In addition, the concentration of benzo(a)pyrene (4.1 mg/kg) and dibenz(a,h)anthracene (1.7 mg/kg) at the

excavation sidewall confirmation sample 076cs-120M were greater than the CUGs. All four confirmation samples from the excavation floor were below the CUGs.

Table 10-4. Chemicals of Concern and Cleanup Goals for CC RVAAP-76 Depot Area

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

*Cleanup goals as presented in *Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern* (Alaniz-Endpoint 2022).

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

CSM = Conceptual Site Model

CUG = Cleanup Goal

mg/kg = Milligrams per Kilogram

NACA = National Advisory Committee on Aeronautics

NCP = National Oil and Hazardous Substances Pollution Contingency Plan

OHARNG = Ohio Army National Guard

PAH = Polycyclic Aromatic Hydrocarbon

RA = Remedial Action

RD = Remedial design

RVAAP = Ravenna Army Ammunition Plant

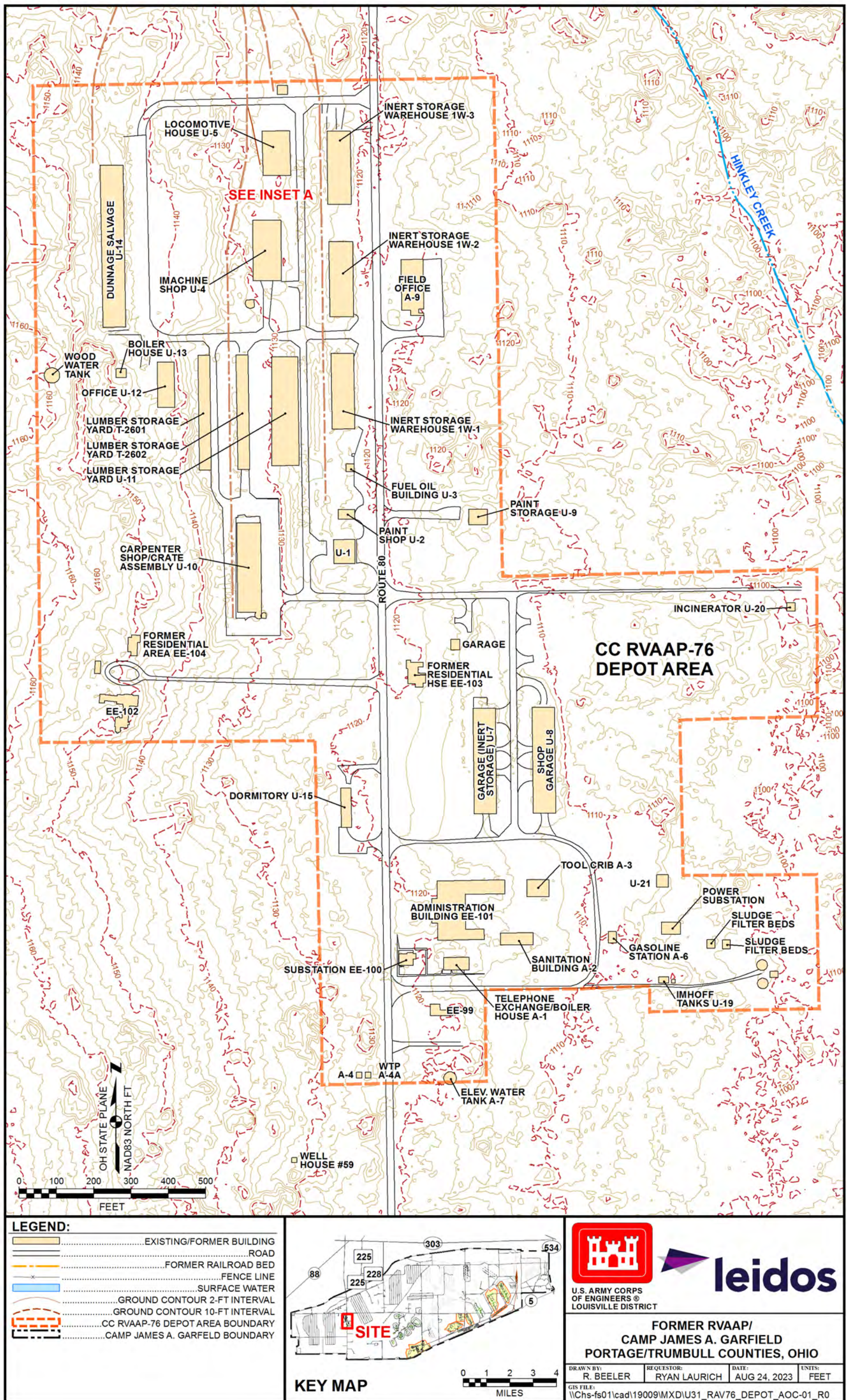


Figure 10-9. CC RVAAP-76 Depot Area – Map and AOC Features

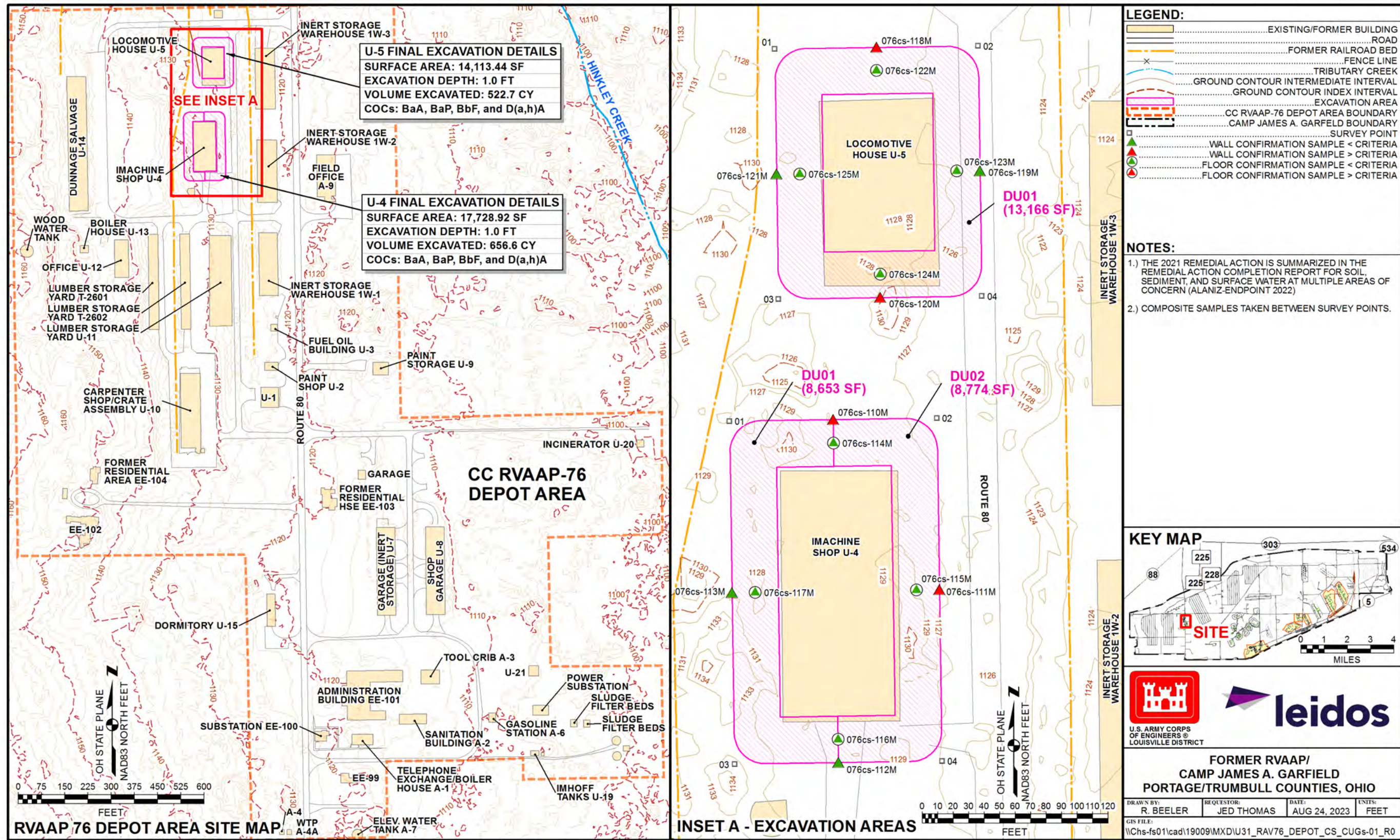


Figure 10-10. CC RVAAP-76 Depot Area – Confirmation Samples Exceeding Project Cleanup Goals

QAPP Worksheet #11 – Project/Data Quality Objectives

11.1 INTRODUCTION

This worksheet documents the problem statement and project goals, identifies the information inputs and boundaries of the field investigation, and provides a high-level overview of the investigative approach. More detailed descriptions of site-specific investigative approaches are presented in subsequent worksheets. Data quality objectives, discussed herein, were developed in accordance with USACE Technical Planning Process (USACE 1998) and the Optimized UFP-QAPP worksheets (IDQTF 2012).

As discussed on Worksheet #10, the *Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern* (Alaniz-Endpoint 2022) identified excavations completed at RVAAP-38 NACA Test Area (Area 1, Area 2, and Area 3), RVAAP-42 Load Line 9 (Area 1 and Area 2), RVAAP-45 Wet Storage Area (Area 1 and Area 2), and CC RVAAP-76 Depot Area (Building U-4 and Building U-5) that did not achieve CUGs.

11.2 STEP 1: STATE THE PROBLEM

At RVAAP-38 NACA Test Area, RA confirmation sampling indicated the following:

- Area 1: Concentrations of benzo(a)pyrene were greater than CUGs along the north sidewall of the Area 1 excavation. Floor sampling confirmed that the bottom of the excavation had achieved the CUGs.
- Area 2: Concentrations of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene were greater than the CUGs along all four sidewalls of the Area 2 excavation. Floor sampling confirmed that the bottom of the excavation had achieved CUGs.
- Area 3: Concentrations of benzo(a)pyrene were greater than the CUGs in the central portion of the Area 3 excavation floor. Sidewall sampling confirmed the lateral extents of the excavation had achieved CUGs.

At RVAAP-42 Load Line 9, RA confirmation sampling indicated the following:

- Area 1: Concentrations of lead and mercury were greater than the CUGs at the east and west sidewalls of the Area 1 excavation. Sampling at the north and south sidewalls and at the excavation floor confirmed that the vertical extent of the excavation, along with the northern and southern lateral extents of the excavation, had achieved CUGs.
- Area 2: Concentrations of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene were greater than the CUGs at the southeast sidewall of the Area 2 excavation. Concentrations of benzo(a)pyrene were greater than the CUGs at the southwest sidewall of the Area 2 excavation. Sampling along the northeast and northwest sidewalls and at the excavation floor confirmed that the vertical extent of the excavation, along with the northeastern and northwestern lateral extents of the excavation, had achieved CUGs.

At RVAAP-45 Wet Storage Area, RA confirmation sampling indicated the following:

- Area 1: Concentrations of benzo(a)pyrene were greater than the CUGs at the north and east sidewalls of the Area 1 excavation. Sampling at the excavation floor and at the south and west sidewalls confirmed that the vertical extent, along with the northern and southern lateral extents of the excavation, had achieved CUGs.
- Area 2: Concentrations of benzo(a)pyrene were greater than the CUGs at the east sidewall of the Area 2 excavation. Sampling at the excavation floor and at the north, south, and west sidewalls confirmed that the vertical extent, along with the northern, southern, and western lateral extents of the excavation, had achieved CUGs.

At CC RVAAP-76 Depot Area, RA confirmation sampling indicated the following:

- Building U-4: Concentrations of benzo(a)pyrene were greater than the CUGs at the north and east sidewalls of the excavation surrounding Building U-4. Sampling at the excavation floor and at the south and west sidewalls confirmed that the vertical extent, along with the southern and western lateral extents of the excavation, had achieved CUGs.
- Building U-5: Concentrations of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene were greater than the CUGs at the north sidewall of the excavation surrounding Building U-5. Concentrations of benzo(a)pyrene and dibenz(a,h)anthracene were greater than the CUGs at the south sidewall of the excavation surrounding Building U-5. Sampling at the excavation floor and at the east and west sidewalls confirmed that the vertical extent, along with the eastern and western lateral extents of the excavation, had achieved CUGs.

11.3 STEP 2: IDENTIFY THE GOALS OF THE STUDY

The goal of the study will be to collect additional data to refine the soil contamination above CUGs within excavation areas at RVAAP-38 NACA Test Area (Area 1, Area 2, and Area 3), RVAAP-42 Load Line 9 (Area 1 and Area 2), RVAAP-45 Wet Storage Area (Area 1 and Area 2) and CC RVAAP-76 Depot Area (Building U-4 and Building U-5). Results from the sampling will not change the selected remedy for the AOCs or the required additional soil removal on sidewalls and/or floors of previous excavations that did not meet CUGs.

The following outlines the primary goals of this UFP-QAPP:

- Design an investigative approach inclusive of soil boring sample locations; perform sampling and analysis of surface and subsurface soil; and conduct data validation and interpretation.
- Delineate the vertical and lateral extent of AOC-specific COCs exceeding CUGs in soil at multiple excavations for RVAAP-38 NACA Test Area, RVAAP-42 Load Line 9, RVAAP-45 Wet Storage Area, and CC RVAAP-76 Depot Area. RD samples will be screened with the CUGs outlined in Tables 10-1 to 10-4 of the UFP-QAPP.
- Prepare an addendum to the RD for each of the four AOCs that presents the results of the RD sampling and recommend extents of soil removal to achieve the goals of the RA.

The following questions will be addressed during this study:

- Has the horizontal and vertical extent of the benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene in impacted soils at Area 1, Area 2, and Area 3 of RVAAP-38 NACA Test Area been delineated?
- Has the horizontal and vertical extent of the lead, mercury, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene in impacted soils at Area 1 and Area 2 of RVAAP-42 Load Line 9 been delineated?
- Has the horizontal and vertical extent of the benzo(a)pyrene in impacted soils at Area 1 and Area 2 of RVAAP-45 Wet Storage Area been delineated?
- Has the horizontal and vertical extent of the benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene in impacted soils at Building U-4 and Building U-5 of CC RVAAP-76 Depot Area been delineated?

The alternative outcomes for this study are as follows:

- COCs are detected in additional RD soil samples collected from any of the four AOC excavations, and the detections exceed the CUGs presented on Worksheet #15. The soil contamination has not been delineated, and further evaluation may be warranted.
- COCs are detected in additional RD soil samples collected from any of the four AOC excavations, but the detections are less than the CUGs presented on Worksheet #15.

11.4 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 meetings that will share status updates, provide results, solicit input, foster collaboration, and achieve consensus.
- Analytical results of the soil sampling outlined on Worksheets #17 and #18.
- Field observations made during preliminary site visits and execution of field activities per this UPF-QAPP.
- Analytical results from the additional RD sampling.
- GPS and professional land surveying data collected during field investigations.

11.5 STEP 4: DEFINE 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 additional RD sampling, the target population consists of the concentrations detected above CUGs in the samples collected from the soil at each of the four AOCs.
 - 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**
 - The additional RD sampling will focus on the four AOCs and seek to define the lateral and/or vertical extent of contamination in soil. Current boundaries of these areas are presented on the Worksheet #17 figures.
- **Temporal Boundaries**
 - The schedule for the RD Addendum 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 in the time required to complete the additional RD sampling (e.g., optimally April 1 through October 30). If sampling occurs outside of this time frame, biological precautions (e.g., avoid removing bat roosting trees) may need to be taken.
- **Chemical Boundaries** –Target analytes for the additional RD sampling are presented in Table 11-1.

Table 11-1. Target Analytes for Additional RD Sampling

Chemical	Chemical Abstracts Service Registry Number
Benz(a)anthracene	56-55-3
Benzo(a)pyrene	50-32-8
Benzo(b)fluoranthene	205-99-2
Dibenz(a,h)anthracene	53-70-3
Indeno(1,2,3-cd)pyrene	193-39-5
Lead	7439-92-1
Mercury	7439-97-6

11.6 STEP 5: DEVELOP THE ANALYTIC APPROACH

Sampling of soil at each of the four AOCs is necessary to redefine the extents of the excavation boundaries that will achieve CUGs. LC/MS/MS will be used to analyze the samples in accordance with the DoD QSM Version 5.3 (DoD and DoE 2019) (or most current version) or the most up-to-date, USEPA-approved method, based on DoD guidance and direction.

Worksheet #18 outlines the samples that will be collected and analyzed to meet project goals. Soil is the only environmental medium that will be collected under this investigation. As stated in the RACR (Alaniz-Endpoint 2022), no RAs were required for sediment or surface water at any of the four AOCs. In addition, groundwater will be further evaluated under RVAAP-66 Facility-Wide Groundwater Monitoring Program.

The CUGs presented in Tables 10-1 to 10-4 will be used to determine the lateral and vertical extent of residual soil contamination. In addition, Worksheet #15 identifies the CUGs, detection limits, limits of detection, and limits of quantitation for determining the presence of SVOCs (benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, dibenz[a,h]anthracene, and indeno[1,2,3-cd]pyrene), mercury, and lead in soil. Field investigative activities will be conducted in one mobilization. In general, the additional RD sampling will use a step-out sampling approach, wherein proposed sample locations will be biased by known detections exceeding CUGs.

11.7 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 RD Addenda developed for each of the four AOCs.

The following performance and acceptance criteria will be used during the additional RD sampling activities:

- The Field Manager will complete the daily standardized PPE/equipment checklist.
- 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 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 RD Addenda 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 RD Addenda prior to submittal for regulatory review and approval.

11.8 STEP 7: DEVELOP THE DETAILED 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	QSM = Quality Systems Manual
COC = Chemical of Concern	RA = Remedial Action
CUG = Cleanup Goal	RACR = Remedial Action Completion Report
DoD = U.S. Department of Defense	RD = Remedial Design
DUA = Data Usability Assessment	RVAAP = Ravenna Army Ammunition Plant
GPS = Global Positioning System	SVOC = Semivolatile Organic Compound
LC/MS/MS = Liquid Chromatography with Tandem Mass Spectrometry	UFP-QAPP = Uniform Federal Policy-Quality Assurance Project Plan
NACA = National Advisory Committee on Aeronautics	USACE = U.S. Army Corps of Engineers
PPE = Personal Protective Equipment	USEPA = U.S. Environmental Protection Agency
QA = Quality Assurance	
QC = Quality Control	

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QAPP Worksheet #12 – Measurement Performance Criteria

Matrix: Solid		
Analytical Group: PAH SW846 8270E SIM		
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 \leq 50% when detected in both samples \geq 5 \times sample-specific LOQ. If one or both results are $<$ 5 \times sample-specific LOQ, criteria are the absolute difference between results \leq 3 \times sample-specific LOQ.
Analytical Accuracy/Bias Laboratory – LCS/LCSD	LCS/LCSD	See QSM 5.4 Table C-27 for recovery limits. RPD \leq 20% (if LCSD analyzed).
Analytical Precision Laboratory and Matrix Effects – MS/MSD	MS/MSD	See QSM 5.4 Table C-27 for recovery limits. RPD \leq 20%.
Laboratory Accuracy/Bias (Contamination)	Method blank	No target analyte concentrations \geq 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-27 or statistical laboratory control limits.
	IS	Retention time \pm 30 seconds. Area within -50% to +100% of midpoint standard in ICAL.
Accuracy/Field Contamination	Field blank, rinsate blank	No detected target compounds \geq 1/2 LOQ; no common laboratory contaminants $>$ LOQ.
Sensitivity	Lowest calibration standard	See Worksheet #15.
Completeness	Number of valid data points attained versus the planned number	90%.

QAPP Worksheet #12 – Measurement Performance Criteria (Continued)

Matrix: Solid		
Analytical Group: Metals – SW3050A/6020B		
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 \leq 50% when detected in both samples \geq 5 \times sample-specific LOQ. If one or both results are $<$ 5 \times sample-specific LOQ, criteria are the absolute difference between results \leq 3 \times sample-specific LOQ.
Analytical Accuracy/Bias Laboratory – LCS Laboratory and Matrix Effects – MS	LCS/MS	See QSM 5.4 Table C-5 for recovery limits.
Analytical Precision Laboratory and Matrix Effects – MSD	MSD or laboratory duplicate	See QSM 5.4 Table C-5 for recovery limits (if MSD analyzed), RPD \leq 20%.
Laboratory Accuracy/Bias (Contamination)	Method blank	No analytes detected $>$ 1/2 LOQ or $>$ 1/10 sample concentration or $>$ 1/10 regulatory limit.
Analytical Accuracy/Bias Laboratory Accuracy/Bias	ICB, CCB	No analytes detected $>$ 1/2 LOQ.
	ICS	ICS-A: Absolute value of concentration for all nonspiked project analytes $<$ LOD (unless they are a verified trace impurity from one of the spiked analytes). ICS-B: Within \pm 20% of true value.
	IS	IS intensity in sample 30-120% of the intensity of the ICB.
Accuracy/Field Contamination	Field blank, rinsate blank	No detected target compounds detected $>$ 1/2 LOQ or $>$ 1/10 sample concentration.
Sensitivity	Low-level calibration check standard	Within \pm 20% of true value. See Worksheet #15.
Completeness	Number of valid data points attained versus the planned number	90%.
Accuracy/Bias	Serial dilution (ICP only)	Required if MS or MSD fails. Five-fold dilution must agree within \pm 10% of the original measurement for samples with concentrations $>$ 50 \times LOQ.
	Post digestion spike (ICP only)	Required if MS or MSD fails. 80-120%R for samples with concentrations $<$ 50 \times LOD.

%R = Percent Recovery
CCB = Continuing Calibration Blank
ICAL = Initial Calibration
ICB = Initial Calibration Blank
ICP = Inductively Coupled Plasma
ICS = Interference Check Sample

IS = Internal Standard
LCS = Laboratory Control Sample
LCSD = Laboratory Control Sample Duplicate
LOD = Limit of Detection
LOQ = Limit of Quantitation
MS = Matrix Spike

MSD = Matrix Spike Duplicate
PAH = Polycyclic Aromatic Hydrocarbon
QC = Quality Control
QSM = Quality Systems Manual
RPD = Relative percent Difference
SIM = Selected Ion Monitoring

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	<p>Leidos. 2016. <i>Final Phase II Remedial Investigation and Feasibility Study for Soil, Sediment, and Surface Water at RVAAP-42 Load Line 9. Former Ravenna Army Ammunition Plant, Trumbull and Portage Counties, Ohio.</i> June 16.</p> <p>Leidos. 2017. <i>Final Remedial Investigation/Feasibility Study Report for Soil, Sediment, and Surface Water at RVAAP-45 Wet Storage Area. Former Ravenna Army Ammunition Plant, Trumbull and Portage Counties, Ohio.</i> February 10.</p> <p>Leidos. 2018. <i>Final Phase II Remedial Investigation and Feasibility Study for Soil, Sediment, and Surface Water at RVAAP-38 NACA Test Area. Former Ravenna Army Ammunition Plant, Trumbull and Portage Counties, Ohio.</i> July 16.</p> <p>ECC (Environmental Chemical Corporation) and AMEC (Amalgamated Mechanical Engineering and Construction). 2016. <i>Final Remedial Investigation/Feasibility Study CC RVAAP-76 Depot Area. Former Ravenna Army Ammunition Plant, Trumbull and Portage Counties, Ohio.</i> November 22.</p>	Contribute to the understanding of historical activities at CJAG and corresponding restoration activities.	<ul style="list-style-type: none"> • 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.

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
Historical data, including site photographs and aerial photographs	<p>SAIC (Science Applications International Corporation). 1996. <i>Preliminary Assessment for the Characterization of Areas of Contamination, Ravenna Army Ammunition Plant, Ravenna, Ohio</i>. February.</p> <p>Alaniz-Endpoint. 2022. <i>Final Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern, Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, OH</i>. November.</p>	Contribute to the understanding of historical activities and site conditions as they pertain to potential and/or known contamination source areas.	<ul style="list-style-type: none"> • Potential errors in reported analytical or survey data. • Potential errors in data outputs provided by REIMS.
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.	<ul style="list-style-type: none"> • 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. 1996. <i>Preliminary Assessment for the Characterization of Areas of Contamination, Ravenna Army Ammunition Plant, Ravenna, Ohio</i> . February.	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.	<ul style="list-style-type: none"> • 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.

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
Analytical data collected during prior investigations	<p>Alaniz-Endpoint. 2022. <i>Final Remedial Action Completion Report for Soil, Sediment and Surface Water at Multiple Areas of Concern, Former Ravenna Army Ammunition Plant Portage and Trumbull Counties, OH</i>, November.</p> <p>ECC and AMEC. 2016. <i>Final Remedial Investigation/Feasibility Study CC RVAAP-76 Depot Area. Former Ravenna Army Ammunition Plant, Trumbull and Portage Counties, Ohio</i>. November 22.</p> <p>Leidos 2016. <i>Final Phase II Remedial Investigation and Feasibility Study for Soil, Sediment, and Surface Water at RVAAP-42 Load Line 9. Former Ravenna Army Ammunition Plant, Trumbull and Portage Counties, Ohio</i>. June 16.</p> <p>Leidos 2017. <i>Final Remedial Investigation/Feasibility Study Report for Soil, Sediment, and Surface Water at RVAAP-45 Wet Storage Area. Former Ravenna Army Ammunition Plant, Trumbull and Portage Counties, Ohio</i>. February 10.</p> <p>Leidos. 2018. <i>Final Phase II Remedial Investigation and Feasibility Study for Soil, Sediment, and Surface Water at RVAAP-38 NACA Test Area. Former Ravenna Army Ammunition Plant, Trumbull and Portage Counties, Ohio</i>. July 16.</p>	Contribute to the understanding of current arsenic, benzo(a)pyrene, and benzo(b)fluoranthene distribution in environmental media throughout the four AOCs.	<ul style="list-style-type: none"> • Potential errors in reported analytical or survey data. • Potential errors in data outputs provided by REIMS. • Variations of screening levels or CUGs during the PA, RI, and RA.

AOC = Area of Concern
 CJAG = Camp James A. Garfield
 CSM = Conceptual Site Model
 CUG = Cleanup Goal
 NACA = National Advisory Council on Aeronautics
 PA = Preliminary Assessment
 RA = Remedial Action
 REIMS = Ravenna Environmental Information Management System
 RI = Remedial Investigation
 RVAAP = Ravenna Army Ammunition Plant

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

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s)	Deliverable Due Date
Mobilization	Leidos	1/6/24	2/4/24	Field Notes	3/3/2024
Sample Collection	Leidos	2/5/24	2/6/24	Field Notes Field Scoping Session Summaries Remedial Addendum Design	3/3/2024
Analysis	WWA	2/7/24	3/5/24	Laboratory EDDs	3/3/2024
Validation	Leidos	3/6/24	4/4/24	REIMS Data Submittal Data Verification Reports Remedial Addendum Design	3/3/2024
Data Usability	Leidos	4/5/24	4/24/24	Data Usability Reports Remedial Addendum Design	3/3/2024

Field schedule anticipates the following activities will be performed in one mobilization: additional delineation sampling at RVAAP-34 Sand Creek Disposal Road Landfill; asbestos investigation at RVAAP-78 Quarry Pond Surface Dump; and remedial design sampling at RVAAP-38 National Advisory Committee on Aeronautics (NACA) Test Area, RVAAP-42 Load Line 9, RVAAP-45 Wet Storage Area, and CC RVAAP-76 Depot Area.

EDD = Electronic Data Deliverable

REIMS = Ravenna Environmental Information Management System

WWA = White Water Associates, Inc.

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

15.1 PAHs IN SOLID MATRIX

Analyte	CAS Number	Project CUGs (mg/kg)*	Achievable Laboratory Limits (µg/kg)		
			DL	LOD	LOQ
Benzo(a)anthracene	56-55-3	11	3.33	13.3	16.7
Benzo(a)pyrene	50-32-8	1.1	3.33	6.66	16.7
Benzo(b)fluoranthene	205-99-2	11	3.33	6.66	16.7
Dibenz(a,h)anthracene	53-70-3	1.1	6.67	13.3	16.7
Indeno(1,2,3-cd)pyrene	193-39-5	11	4.00	8.00	16.7

*Project CUGs are presented as defined by *Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern* (Alaniz-Endpoint 2022).

µg/kg = Micrograms per Kilogram

CAS = Chemical Abstracts Service

CUG = Cleanup Goal

DL = Detection Limit

LOD = Limit of Detection

LOQ = Limit of Quantitation

mg/kg = Milligrams per Kilogram

PAH = Polycyclic Aromatic Hydrocarbon

15.2 METALS IN SOLID MATRIX

Analyte	CAS Number	Project CUGs (mg/kg)*	Achievable Laboratory Limits (mg/kg)		
			DL	LOD	LOQ
Lead	7439-92-1	400	0.0380	0.0800	0.100
Mercury	7439-97-6	22.7	0.0200	0.0400	0.0600

*Project CUGs are presented as defined by *Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern* (Alaniz-Endpoint 2022).

CUGs are not available for all analytes, unless specified. CUGs are for soil samples.

CAS = Chemical Abstracts Service

CUG = Cleanup Goal

DL = Detection Limit

LOD = Limit of Detection

LOQ = Limit of Quantitation

mg/kg = Milligrams per Kilogram

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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 additional RD sampling will investigate the AOCs listed on Worksheet #10 and redefine the extents of the former excavations that did not achieve CUGs. Soil will be the only medium sampled at each site. As specified on Worksheet #11, samples analytes per individual AOC include:

- RVAAP-38 NACA Test Area – Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene
- RVAAP-42 Load Line 9 – Lead, mercury, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene
- RVAAP-45 Wet Storage Area – Benzo(a)pyrene
- CC RVAAP-76 Depot Area – Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene.

Field investigative activities will be conducted under a single mobilization. Results from the sampling activities will be used to define the boundaries of step-out excavations. In general, the additional RD sampling will use a step-out sampling approach, wherein sampling activities will seek to identify the boundary of contamination at each excavation that will meet the CUGs.

17.2 SAMPLING AREAS AND RATIONALE

The sampling area includes four AOCs at CJAG, as discussed on Worksheet #10. Confirmation sampling conducted during remedial activities (excavation) at all four AOCs confirmed the presence of contamination exceeding CUGs (Alaniz-Endpoint 2022) and the need for step-out excavations to remove additional contaminated soil to achieve CUGs. The additional RD sampling will be used to develop the extents of the step-out excavations required to achieve the CUGs. The results of the additional RD sampling will be presented in an RD Addenda for each of the four AOCs.

The results from historical investigations are discussed in the site-specific CSMs within Worksheet #10. Results from the historical investigations are presented and screened against CUGs within this worksheet.

The additional RD sampling will delineate the lateral and vertical extent of residual contamination in soil. The study boundaries will be defined based on analytical results compared to the CUGs provided on Worksheet #10.

Leidos assumes that the historical data and additional RD sampling will be adequate for Ohio EPA's acceptance for completion of the RD Addendum. In addition, Leidos assumes the RD Addendum will be for purposes of presenting results of the additional RD sampling. The RD Addendum will not require additional calculation of risks.

17.3 SAMPLING OVERVIEW

The following sections detail the sample naming conventions, sample locations, and types of samples planned for each of the four AOCs. Table 17-1 (located at the end of this worksheet) lists the number of samples proposed for each site, and Worksheet #18 specifies the sample names and rationale for each sample. Each sample collected during the field effort will be analyzed for the analytes specified on Worksheet #11 and will receive a unique sample number, as listed on Worksheet #18. Final sample decisions will be based on field conditions. The number for each sample will be in the pattern XXXsb-YYY-ZZZZ-##.

Where:

- XXX = Three-digit REIMS AOC ID code (e.g., NTA = RVAAP-38 NACA Test Area, LL9 = RVAAP-42 Load Line 9, WSA = RVAAP-45 Wet Storage Area, 076 = CC RVAAP-76 Depot Area).
- sb = Sample location type (e.g., sb = soil boring).
- YYY = The sequential sample location number available for an AOC based on location type (based on REIMS records, the next available soil boring location for RVAAP-38 NACA Test Area is “217,” the next available soil boring location for RVAAP-42 Load Line 9 is “149,” the next available soil boring location for RVAAP-45 Wet Storage Area is “053,” and the next available soil boring location for CC RVAAP-76 Depot Area is “127”).
- ZZZZ = The sequential sample number taken from an individual location
 - 0001 = Soil sample collected from the 0- to 1-foot bgs interval
 - 0002 = Soil sample collected from the 1- to 2-foot bgs interval
 - 0003 = Soil sample collected from the 2- 3-foot bgs interval
 - 0004 = Soil sample collected from the 3- to 4-foot bgs interval.
- ## = Sample matrix type
 - SO = Subsurface soil sample (greater than 1 foot bgs)
 - SS = Surface soil sample (less than 1 foot bgs)
 - WW = Wastewater (IDW)
 - WS = Waste soil (IDW)
 - Duplicate samples will include a ZZZZ sequence in the 2000s (i.e., 2001 = duplicate at 0 to 1 foot bgs, 2002 = duplicate at 1 to 2 feet bgs, 2003 = duplicate at 2 to 3 feet bgs, 2004 = duplicate at 3 to 4 feet bgs)
 - MS/MSD samples will include “MS” or “MSD” following the sequence number (e.g., NTAsb-217-0001-SS-MSD).

The following sections provide an overview of the sampling planned at each AOC.

17.3.1 RVAAP-38 NACA Test Area

Based on results presented in the *Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern* (Alaniz-Endpoint 2022), additional investigation is required to determine the extent of soil contamination exceeding CUGs for excavations at Area 1, Area 2, and Area 3 of RVAAP-38 NACA Test Area. Proposed RD sampling locations are presented in Figure 17-1 and summarized below:

- Area 1 – Additional RD Sampling
 - Residual contamination: excavation sidewall confirmation sampling at NTAcS-186M failed to meet the CUG for benzo(a)pyrene.
 - Sampling scheme:
 - Advance two soil borings to a depth of 1 foot bgs to delineate lateral extent of soil contamination to the east and west of NTAcS-186M.
 - Soil collected from the 0- to 1-foot bgs interval will be analyzed for benzo(a)pyrene.
- Area 2 – Additional RD Sampling
 - Residual contamination:
 - North sidewall (NTAcS-180M-SO1): Concentrations of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene to meet CUGs.
 - West sidewall (NTAcS-181M-SO1): Concentrations of benzo(a)pyrene at the failed to meet the CUG.
 - South sidewall (NTAcS-182M-SO1): Concentrations of benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene failed to meet CUGs.
 - East sidewall (NTAcS-183M-SO1): Concentrations of benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene failed to meet CUGs.
 - Sampling scheme:
 - Advance 32 soil borings to a depth of 4 feet bgs and sample from 0 to 4 feet bgs at 1-foot intervals.
 - Two rows of step-out samples at 20-foot spacing will be collected to further delineate the exceedances detected along all four sidewalls of the excavation.
 - 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.
 - West sidewall: Soil samples collected west of NTAcS-181M-SO1 will be analyzed for benzo(a)pyrene.
 - 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.
 - 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.
- Area 3 – Additional RD Sampling
 - Residual contamination: Excavation floor confirmation sampling at NTAcS-207M-SO1 failed to meet CUGs for benzo(a)pyrene.
 - Sampling scheme:
 - Advance four soil borings to a depth of 4 feet bgs to delineate the vertical extent of soil contamination below NTAcS-207M-SO1.
 - Soil will only be collected from the 2- to 3-foot and 3- to 4-foot bgs intervals and will be analyzed for benzo(a)pyrene.

17.3.2 RVAAP-42 Load Line 9

Based on results presented in the *Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern* (Alaniz-Endpoint 2022), additional investigation is required to

determine the extent of soil contamination exceeding CUGs for excavations at Area 1 and Area 2 of RVAAP-42 Load Line 9. Proposed additional RD sampling locations are presented in Figure 17-2 and are summarized below:

- Area 1 – Additional RD Sampling
 - Residual contamination: Sidewall confirmation sampling at LL9cs-137M-SO1 (east sidewall) failed to meet CUGs for lead and mercury, and sidewall confirmation sampling at LL9cs-139M-SO1 (west sidewall) failed to meet the CUG for lead.
 - Sampling scheme:
 - Advance 16 soil borings to a depth of 4 feet bgs and sample from 0 to 4 feet bgs at 1-foot intervals.
 - Two rows of step-out samples at 20-foot spacing will be collected to further delineate the exceedances detected along the east and west sidewalls of the excavation.
 - East sidewall: Soil samples collected east of LL9cs-137M-SO1 will be analyzed for lead and mercury.
 - West sidewall: Soil samples collected west of LL9cs-139M-SO1 will be analyzed for lead.
- Area 2 – Additional RD Sampling
 - Residual contamination: Sidewall confirmation sampling at LL9cs-143-SO1 (southeast sidewall) failed to meet the CUGs for benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene. Sidewall confirmation sampling at LL9cs-144-SO1 (southwest sidewall) failed to meet CUGs for benzo(a)pyrene and dibenz(a,h)anthracene.
 - Sampling scheme:
 - Advance 16 soil borings to a depth of 4 feet bgs and sample from 0 to 4 feet bgs at 1-foot intervals.
 - Two rows of step-out samples at 20-foot spacing will be collected to further delineate the exceedances detected along the southeast and southwest sidewalls of the excavation.
 - Southwest sidewall: Soil samples collected south of LL9cs-144M-SO1 will be analyzed for benzo(a)pyrene.
 - Southeast sidewall: Soil samples collected east of LL9cs-143M-SO1 will be analyzed for benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene.

17.3.3 RVAAP-45 Wet Storage Area

Based on results presented in the *Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern* (Alaniz-Endpoint 2022), additional investigation is required to determine the extent of soil contamination exceeding CUGs for excavations at Area 1 and Area 2 of RVAAP-45 Wet Storage Area. Proposed additional RD sampling locations are presented in Figure 17-3 and are summarized below:

- Area 1 – Additional RD Sampling

- Residual contamination: Sidewall confirmation sampling at WSACs-041M-SO1 (north sidewall) and WSACs-42M-SO1 (east sidewall) failed to meet CUGs for benzo(a)pyrene.
- Sampling scheme:
 - Advance 24 soil borings to a depth of 4 feet bgs and sample from 0 to 4 feet bgs at 1-foot intervals.
 - Two rows of step-out samples at 15-foot spacing will be collected to delineate the exceedances detected along the north and east sidewalls of the excavation.
 - Soil samples collected east of WSACs-042M-SO1 and north of WSACs-041M-SO1 will be analyzed for benzo(a)pyrene.
- Area 2 – Additional RD Sampling
 - Residual contamination: sidewall confirmation sampling at WSACs-48M-SO1 (east sidewall) failed to meet CUGs for benzo(a)pyrene.
 - Sampling scheme:
 - Advance 16 soil borings to a depth of 4 feet bgs and sample from 0 to 4 feet bgs at 1-foot intervals.
 - Two rows of step-out samples at 15-foot spacing will be collected to delineate the exceedances detected along the east sidewall of the excavation.
 - Soil samples collected east of WSACs-048M-SO1 will be analyzed for benzo(a)pyrene.

17.3.4 CC RVAAP-76 Depot Area

Based on results presented in the *Remedial Action Completion Report for Soil, Sediment, and Surface Water at Multiple Areas of Concern* (Alaniz-Endpoint 2022), additional investigation is required to determine the extent of soil contamination exceeding CUGs for excavations at Building U-4 and Building U-5 of CC RVAAP-76 Depot Area. Proposed additional RD sampling locations are presented in Figure 17-4 and are summarized below:

- Building U-4 – Additional RD Sampling
 - Residual contamination: sidewall confirmation sampling at 076cs-110M (north sidewall) and 076cs-111M (east sidewall) failed to meet CUGs for benzo(a)pyrene.
 - Sampling scheme:
 - Advance 24 soil borings to a depth of 4 feet bgs and sample from 0 to 4 feet bgs at 1-foot intervals.
 - Two rows of step-out samples at 20-foot spacing will be collected to delineate the exceedances detected along the north and east sidewalls of the excavation.
 - Soil samples collected north of 076cs-110M and east of 076cs-111M will be analyzed for benzo(a)pyrene.
- Building U-5 – Additional RD Sampling
 - Residual contamination: sidewall confirmation sampling at 076cs-118M (north sidewall) failed to meet CUGs for benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene. Sidewall confirmation sampling at 076cs-120M (south sidewall) failed to meet CUGs for benzo(a)pyrene and dibenz(a,h)anthracene.
 - Sampling scheme

- Advance 24 soil borings to a depth of 4 feet bgs and sample from 0 to 4 feet bgs at 1-foot intervals.
- Two rows of step-out samples at 20-foot spacing will be collected to delineate the exceedances detected along the north and south sidewalls of the excavation.
- 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.
- South sidewall: Soil samples collected south of 076cs-120M will be analyzed for benzo(a)pyrene and dibenz(a,h)anthracene.

Table 17-1. Summary of Proposed Sampling for Additional RD Sampling

RVAAP AOC	Excavation Area	Soil Borings	Soil Samples	
			Surface	Subsurface
RVAAP-38 NACA Test Area	Area 1	2	2	6
RVAAP-38 NACA Test Area	Area 2	32	32	96
RVAAP-38 NACA Test Area	Area 3	4	0	8
RVAAP-42 Load Line 9	Area 1	16	16	48
RVAAP-42 Load Line 9	Area 2	16	16	48
RVAAP-45 Wet Storage Area	Area 1	24	24	72
RVAAP-45 Wet Storage Area	Area 1	16	16	48
CC RVAAP-76 Depot Area	Building U-4	24	24	72
CC RVAAP-76 Depot Area	Building U-5	24	24	72

Note: The number of soil samples (surface/subsurface) only includes parent samples.

AOC = Area of Concern

bgs = Below Ground Surface

CJAG = Camp James A. Garfield

CSM = Conceptual Site Model

CUG = Cleanup Goal

ID = Identifier

IDW = Investigation-Derived Waste

MS = Matrix Spike

MSD = Matrix Spike Duplicate

NACA = National Advisory Committee on Aeronautics

Ohio EPA = Ohio Environmental Protection Agency

RD = Remedial Design

REIMS = Ravenna Environmental Information Management System

RVAAP = Ravenna Army Ammunition Plant

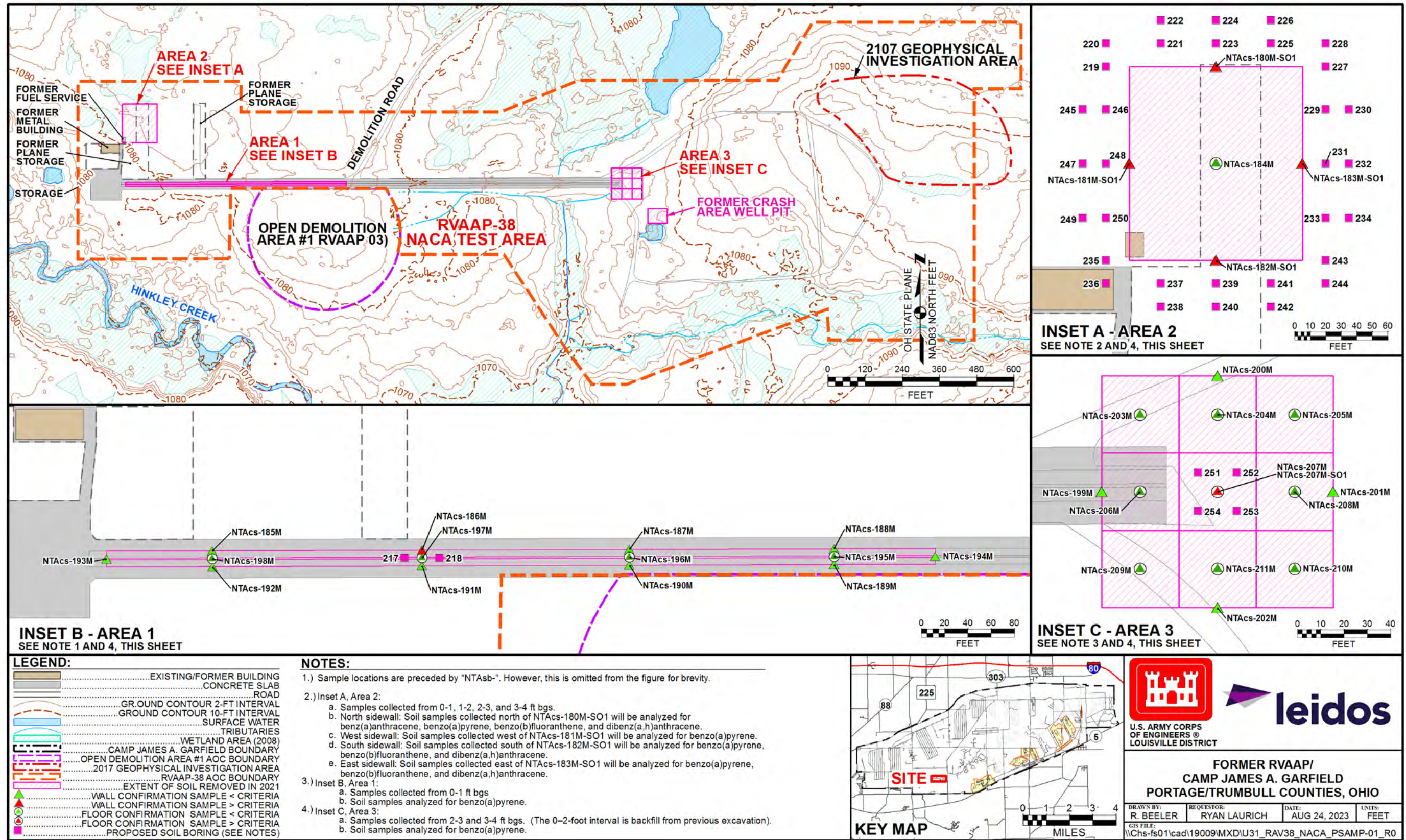


Figure 17-1. RVAAP-38 NACA Test Area – Proposed Additional RD Sampling Locations

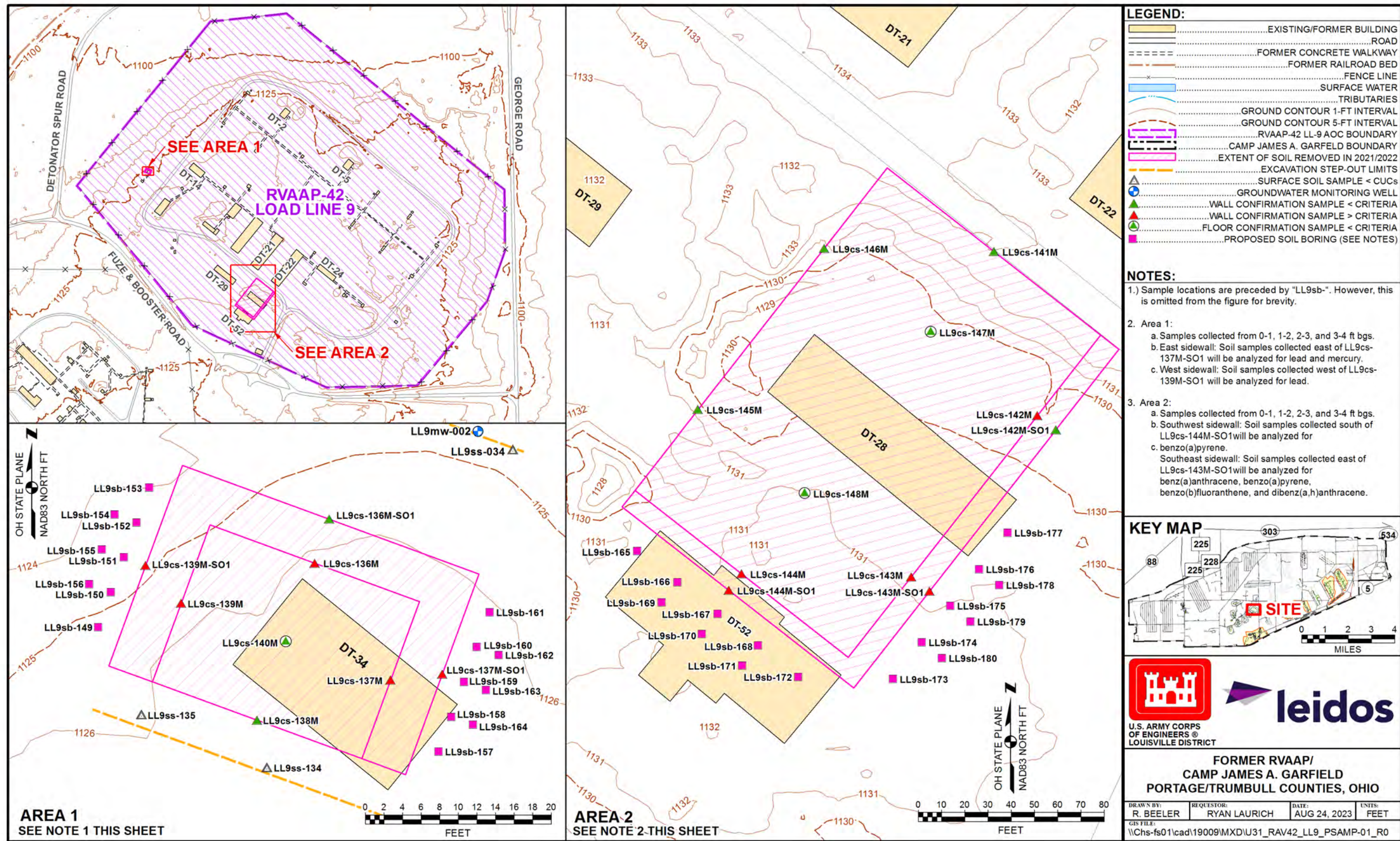


Figure 17-2. RVAAP-42 Load Line 9 – Proposed Additional RD Sampling Locations

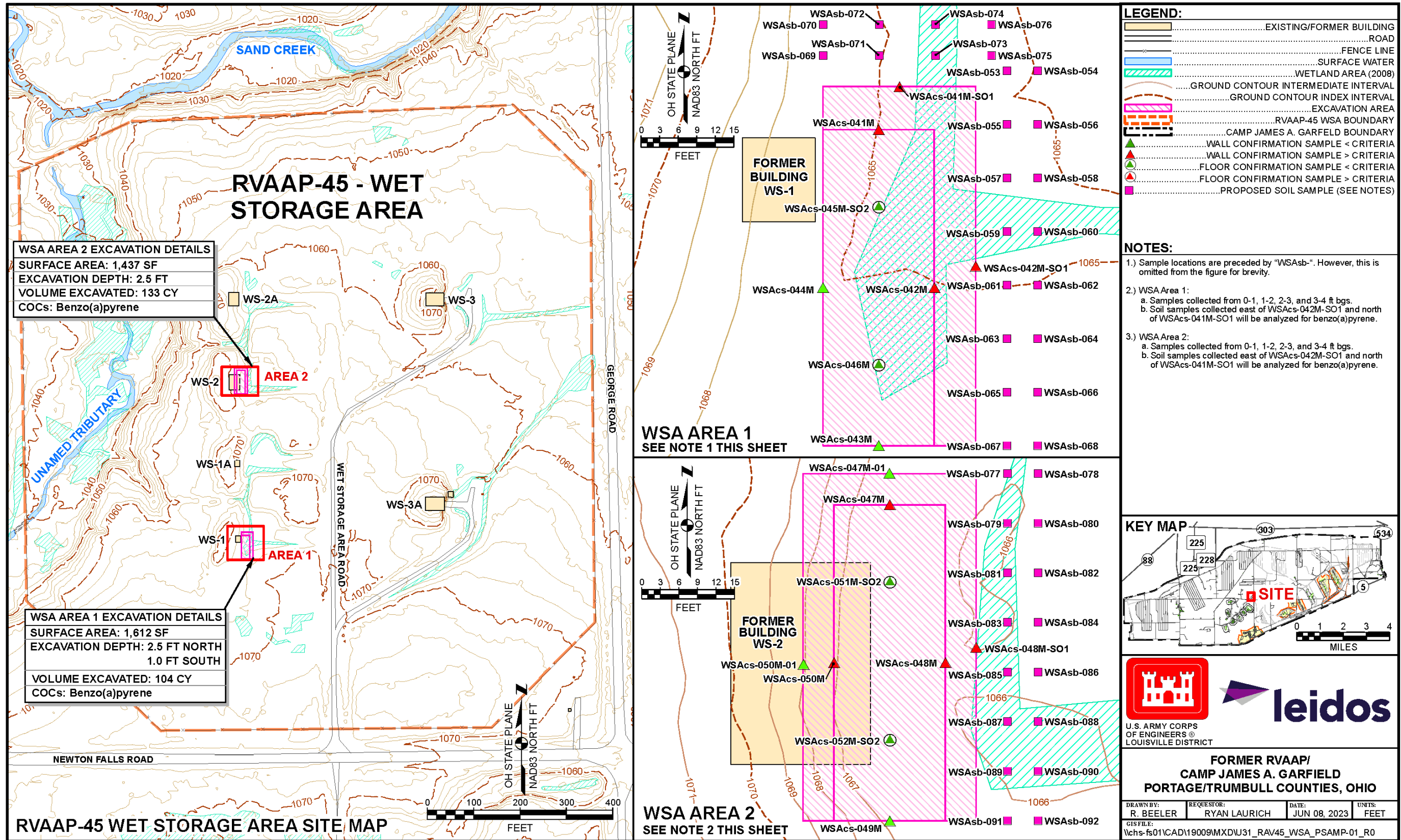


Figure 17-3. RVAAP-45 Wet Storage Area – Proposed Additional RD Sampling Locations

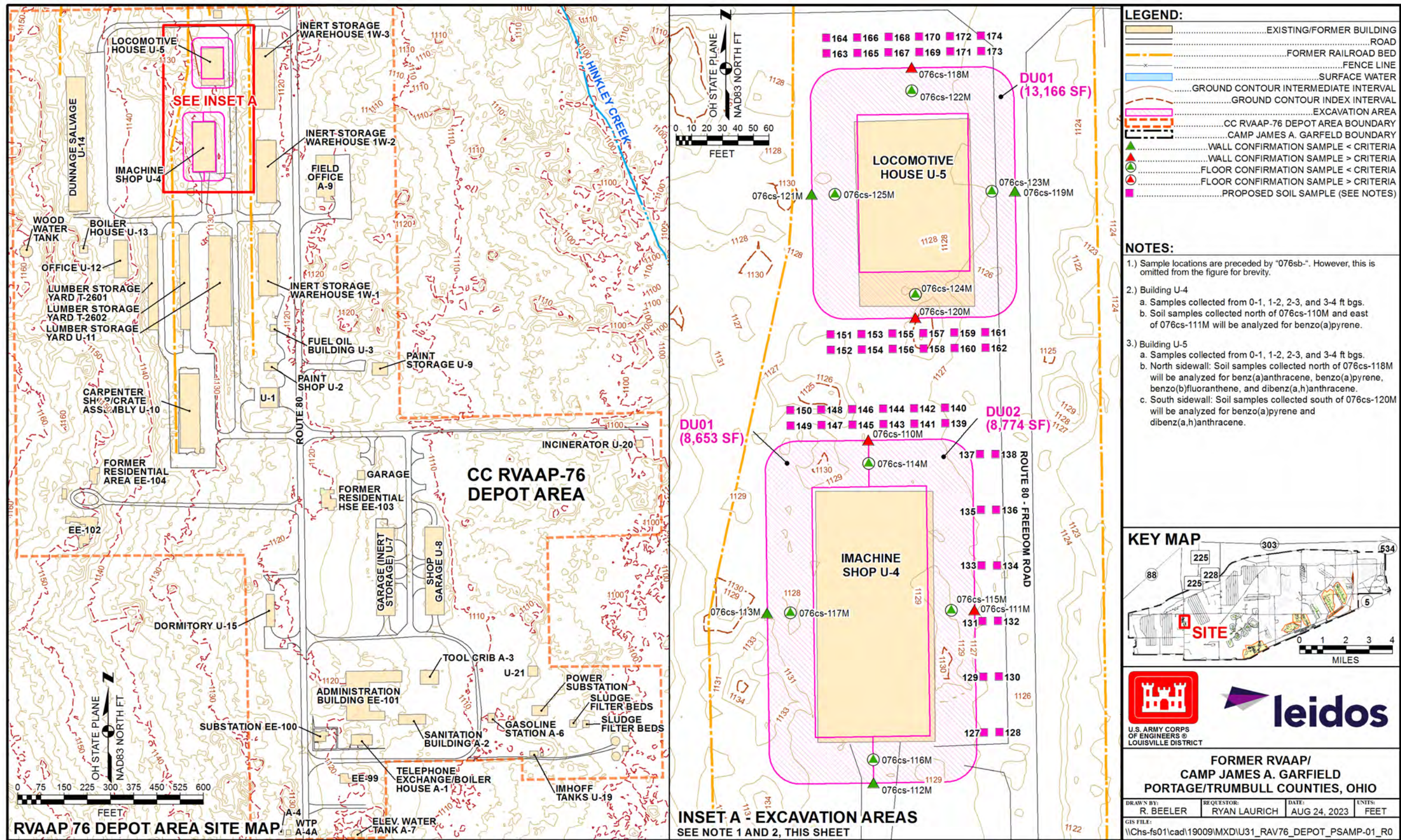


Figure 17-4. CC RVAAP-76 Depot Area – Proposed Additional RD Sampling Locations

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 and SOPs are presented in Appendix B. All samples will be analyzed in accordance with the guidance provided on Worksheets #11, #12, #15, #19, #20, and #30. Soil samples collected at the four AOCs will be analyzed as follows:

- RVAAP-38 NACA Test Area: Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene
- RVAAP-42 Load Line 9: Lead, mercury, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene
- RVAAP-45 West Storage Area: Benzo(a)pyrene
- CC RVAAP-76 Depot Area: Benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene.

18.2 SAMPLE LOCATION NUMBERS AND SAMPLE IDs

This section presents the location numbers for each sample location and sample IDs for all proposed samples for each AOC, as presented in Tables 18-1 through 18-4.

18.3 INVESTIGATIVE METHODS

The following sections provide a general overview of the investigative methods and procedures to conduct the additional RD sampling. In general, sampling protocols will follow the Facility-Wide Sampling and Analysis Plan (SAIC 2011). The CJAG utility clearance procedures are presented in Appendix A.

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. 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 approval from the CJAG Environmental Office. Leidos will take part in and document any necessary briefings regarding land use controls at a site.

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 onsite POC and OHARNG for access to the facility and to available infrastructure (e.g., buildings, roadways, other facilities). Leidos will provide sanitary facilities for its employees.

The 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 Wetlands Delineation and Stream Avoidance Management

An initial review of available data indicates wetlands may be present near or adjacent to sampling locations at RVAAP-38 NACA Test Area (Area 2 and Area 3) and RVAAP-45 Wet Storage Area (Area 1 and Area 2). It is not anticipated that a stream or ditch will be crossed to access these locations.

If wetlands or streams are observed, access routes using heavy equipment (e.g., Geoprobe[®]) and soil boring locations may be altered. Crane mats will be used if a wetland, stream, or ditch must be temporarily crossed by heavy equipment to access a sampling location. In addition, soil samples may be collected via hand auger if soil boring locations are not accessible by a drill rig. Attempts will be made to conduct sampling activities during days that the ground surface is dry.

18.3.3 Soil Sampling Methods

Sample locations will be biased toward known exceedances where excavation confirmation samples failed to achieve project specified CUGs. The number of soil samples collected per boring for laboratory analysis will be dependent upon the individual AOC and individual excavations, as follows:

- RVAAP-38 NACA Test Area
 - Area 1 and Area 2: Soil borings will be advanced to a depth of 4 feet bgs, and samples for laboratory analysis will be collected from the 0- to 1-foot, 1- to 2-foot, 2- to 3-foot, and 3- to 4-foot bgs intervals.
 - Area 3: Soil borings will be advanced to a depth of 4 feet bgs, and samples for laboratory analysis will be collected from the 2- to 3-foot and 3- to 4-foot bgs intervals. The 0- to 2-foot bgs soil interval at this excavation is composed of clean backfill.
- RVAAP-42 Load Line 9
 - Area 1 and Area 2: Soil borings will be advanced to a depth of 4 feet bgs, and samples for laboratory analysis will be collected from the 0- to 1-foot, 1- to 2-foot, 2- to 3-foot, and 3- to 4-foot bgs intervals.

- RVAAP-45 Wet Storage Area
 - Area 1 and Area 2: Soil borings will be advanced to a depth of 4 feet bgs, and samples for laboratory analysis will be collected from the 0- to 1-foot, 1- to 2-foot, 2- to 3-foot, and 3- to 4-foot bgs intervals.
- CC RVAAP-76 Depot Area
 - Building U-4 and Building U-5: Soil borings will be advanced to a depth of 4 feet bgs, and samples for laboratory analysis will be collected from the 0- to 1-foot, 1- to 2-foot, 2- to 3-foot, and 3- to 4-foot bgs intervals.

Borings will be advanced using a combination of hand auger and direct-push drilling methods. It is anticipated that the hand auger method will only be required in instances where a drill rig cannot safely access a proposed sampling location. Direct-push borings will continue to the target depth, or if refusal is encountered. At the completion of sampling, the borehole will be abandoned with bentonite and the surface will be restored to surrounding level using like materials, such as concrete, asphalt, or grass seed, as appropriate.

All soil sampling activities will be overseen by an experienced geologist. Each soil core will be logged for lithology in accordance with USACE guidance and EE FTP-525 Soil Sampling. Leidos FTPs are presented in Appendix B. Each soil boring log will fully describe the surface and subsurface environment and the procedures used to gain that description. All borehole data will be recorded in the field by the site geologist on Engineer Forms 5056-R and 5056A-R. Guidance on field logging of soil is provided in ASTM D5434-09, *Standard Guide for Field Logging of Subsurface Explorations of Soil and Rock* (ASTM 2012). Original borehole logs will be of sufficient legibility and contrast to provide comparable quality in reproduction and will be recorded directly in the field without transcribing from a field book or other document. All soil boring locations will be mapped with a handheld digital GPS device with sub-meter accuracy prior to demobilization.

Soil will be collected as discrete samples from the proposed sampling interval for chemical analysis. Soil from direct push (Geoprobe[®]) drilling activities will be emptied from acetate liners and placed into decontaminated stainless steel bowls for homogenization. Homogenization of soil will be completed with stainless steel tools. Samplers will wear new nitrile gloves, changing pairs in between sample collection of specified depth intervals. A stainless steel hand auger will be used for soil sampling in locations that may not be accessible to the Geoprobe[®] drill rig. A fresh, decontaminated auger bucket will be used for the collection of the sample from each discrete sampling interval. Soil from the auger bucket will be homogenized and processed with stainless steel bowls and tools. Alternatively, disposable, one-time use aluminum trays and scoops may be used to process and homogenize soil from each discrete sampling interval. The use of disposable aluminum trays and scoops will reduce the amount of IDW water generated during sampling activities.

All work will stop in the event artifacts or human remains are encountered during drilling and soil sampling activities. The field staff will follow the guidance provided under the OHARNG SOP for inadvertent discovery of cultural materials (Appendix D).

18.3.4 Location Surveys

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.

18.4 EQUIPMENT DECONTAMINATION

To ensure that chemical analysis results reflect the actual concentrations at sample locations, the non-dedicated, reusable equipment used in sampling activities must be rigorously cleaned and decontaminated between sampling events. The equipment used to conduct sampling activities will be decontaminated before sampling activities begin, between locations, between sampling events, and after sampling activities have been completed. Decontamination guidelines follow the direction provided in the March 2020 ITRC fact sheet that discusses site characterization considerations (ITRC 2020). Information associated with the decontamination procedures to be used during the additional RD sampling activities is summarized below.

18.4.1 Sampling Equipment

Non-dedicated sampling equipment, reusable sampling equipment, including stainless steel bowls, and stainless steel sampling tools (e.g., spoons, auger buckets) will be decontaminated prior to initial use and after each use during borehole interval sampling. The procedure for decontamination of sampling equipment will be as follows:

- Wash with approved water and phosphate-free detergent using various types of brushes required to remove particulate matter and surface films
- Rinse thoroughly with approved potable water
- If analyzing for metals and expecting high levels of contamination, rinse thoroughly with hydrochloric acid (2% solution) or nitric acid (10% solution)
- Rinse thoroughly with DI water with analytical certification
- If analyzing for organics and expecting high levels of contamination, rinse thoroughly with solvent grade isopropanol
- Rinse thoroughly with DI water with analytical certification
- Allow equipment to air dry as long as possible
- Place equipment on clean plastic if immediate use is anticipated or wrap in aluminum foil to prevent contamination if storage is required.

Decontamination activities will be conducted in a manner that will allow for the containment and control of all waste decontamination fluids. Every effort will be made to minimize the quantity of waste fluids generated during decontamination activities. Decontamination activities will be conducted at Building 1036.

Some items used during the field activities that do not directly contact sample media may require general decontamination to remove mud, dust, and other items. Items that may require general decontamination include, but are not limited to, shovels, spud bars, and safety-toe boots. These items

will be cleaned as appropriate before leaving the site. All waste decontamination fluids and materials will be containerized, labeled, and stored, as described in the IDW Management Plan (Appendix C).

18.4.2 Drilling Equipment

Equipment used to drill boreholes and collect soil samples during the AOC-specific investigations will be decontaminated within a temporary decontamination pad constructed at the AOC. The decontamination pad will be designed so that all decontamination liquids are contained from the surrounding environment and can be recovered for disposal as IDW. Drilling equipment will be decontaminated after each borehole is completed. The decontamination procedure for drilling equipment is as follows:

- Remove caked soil material from the exterior of the augers and cutting heads using a rod and/or brush
- Steam clean the equipment interior and exterior with approved water using a brush where steam cleaning is not sufficient to remove all soil material
- Rinse thoroughly with approved potable water
- Allow equipment to air dry as long as possible
- Place equipment on clean plastic if it will be used immediately or wrap in plastic to prevent contamination if storage is required.

Decontamination of downhole drill rig equipment will be completed prior to use, between locations, and after final use before departing the site. Downhole drilling equipment used will be decontaminated either by steam cleaning or pressure washing using potable water from an approved source. If a pressure wash is to be used, equipment will be moved to an established decontamination area (OHARNG/ARNG) where the equipment will be pressure or steam washed. Wastewater generated from decontamination activities will be handled as IDW.

Smaller non-dedicated tools or rods may be bucket washed in a bucket with potable water/biodegradable detergent and rinsed with potable at the drilling site. Alconox[®] and Liquinox[®] are acceptable detergents/soaps for decontamination procedures. Equipment can be scrubbed using brushes to remove particulates.

18.5 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 D.

The drill rig and support vehicle are anticipated to carry hazardous materials (i.e., hydraulic fluid, gasoline). The drill rig and support vehicle will be required to carry spill kits. All drilling equipment

will be inspected daily to ensure there are no broken or leaking hoses and/or connections. Refueling activities will be conducted over secondary containment to ensure any potential spills are contained. Drilling activities will follow the OHARNG Environmental Procedures and spill reporting protocols presented in Appendix D.

18.6 SITE RESTORATION

Soil borings advanced at all four AOCs will be limited to a depth of 4 feet bgs. All borings will be sealed with bentonite to a depth of approximately 2 feet bgs, hydrated, then completed with topsoil to the surface. Surface restoration (reseeding) will follow the protocol specified in Section 3 of the OHARNG Environmental Procedures (Appendix D). Field activities are not anticipated to disturb large areas requiring restoration beyond the sealing of soil boring locations.

AOC = Area of Concern
ARNG = Army National Guard
ASTM = ASTM International
bgs = Below Ground Surface
CJAG = Camp James A. Garfield
DI = Deionized
EE = Energy and Environmental
FTP = Field Technical Procedure
GPS = Global Positioning System
HAZWOPER = Hazardous Waste Operations and Emergency Response
ID = Identifier
IDW = Investigation-Derived Waste
ITRC = Interstate Technology & Regulatory Council
NACA = National Advisory Committee on Aeronautics
OHARNG = Ohio Army National Guard
POC = Point of Contact
RD = Remedial Design
RVAAP = Ravenna Army Ammunition Plant
SOP = Standard Operating Procedure
USACE = U.S. Army Corps of Engineers

Table 18-1. Sample Location IDs for RVAAP-38 NACA Test Area

Sample Location Number	Location Type	Sample ID	Sample Depth (feet bgs)	Purpose
NTAsb-217	Soil Boring	NTAsb-217-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Area 1, west of NTAcS-186M.
NTAsb-218	Soil Boring	NTAsb-218-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Area 1, east of NTAcS-186M.
NTAsb-219	Soil Boring	NTAsb-219-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, north of NTAcS-180M-SO1.
		NTAsb-219-0002-SO	1 – 2	
		NTAsb-219-0003-SO	2 – 3	
		NTAsb-219-0004-SO	3 – 4	
NTAsb-220	Soil Boring	NTAsb-220-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, north of NTAcS-180M-SO1.
		NTAsb-220-0002-SO	1 – 2	
		NTAsb-220-0003-SO	2 – 3	
		NTAsb-220-0004-SO	3 – 4	
NTAsb-221	Soil Boring	NTAsb-221-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, north of NTAcS-180M-SO1.
		NTAsb-221-0002-SO	1 – 2	
		NTAsb-221-0003-SO	2 – 3	
		NTAsb-221-0004-SO	3 – 4	
NTAsb-222	Soil Boring	NTAsb-222-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, north of NTAcS-180M-SO1.
		NTAsb-222-0002-SO	1 – 2	
		NTAsb-222-0003-SO	2 – 3	
		NTAsb-222-0004-SO	3 – 4	
NTAsb-223	Soil Boring	NTAsb-223-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, north of NTAcS-180M-SO1.
		NTAsb-223-0002-SO	1 – 2	
		NTAsb-223-0003-SO	2 – 3	
		NTAsb-223-0004-SO	3 – 4	
NTAsb-224	Soil Boring	NTAsb-224-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, north of NTAcS-180M-SO1.
		NTAsb-224-0002-SO	1 – 2	
		NTAsb-224-0003-SO	2 – 3	
		NTAsb-224-0004-SO	3 – 4	
NTAsb-225	Soil Boring	NTAsb-225-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, north of NTAcS-180M-SO1.
		NTAsb-225-0002-SO	1 – 2	
		NTAsb-225-0003-SO	2 – 3	
		NTAsb-225-0004-SO	3 – 4	

Table 18-1. Sample Location IDs for RVAAP-38 NACA Test Area (Continued)

Sample Location Number	Location Type	Sample ID	Sample Depth (feet bgs)	Purpose
NTAsb-226	Soil Boring	NTAsb-226-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, north of NTAs-180M-SO1.
		NTAsb-226-0002-SO	1 – 2	
		NTAsb-226-0003-SO	2 – 3	
		NTAsb-226-0004-SO	3 – 4	
NTAsb-227	Soil Boring	NTAsb-227-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, north of NTAs-180M-SO1.
		NTAsb-227-0002-SO	1 – 2	
		NTAsb-227-0003-SO	2 – 3	
		NTAsb-227-0004-SO	3 – 4	
NTAsb-228	Soil Boring	NTAsb-228-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, north of NTAs-180M-SO1.
		NTAsb-228-0002-SO	1 – 2	
		NTAsb-228-0003-SO	2 – 3	
		NTAsb-228-0004-SO	3 – 4	
NTAsb-229	Soil Boring	NTAsb-229-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, east of NTAs-183M-SO1.
		NTAsb-229-0002-SO	1 – 2	
		NTAsb-229-0003-SO	2 – 3	
		NTAsb-229-0004-SO	3 – 4	
NTAsb-230	Soil Boring	NTAsb-230-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, east of NTAs-183M-SO1.
		NTAsb-230-0002-SO	1 – 2	
		NTAsb-230-0003-SO	2 – 3	
		NTAsb-230-0004-SO	3 – 4	
NTAsb-231	Soil Boring	NTAsb-231-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, east of NTAs-183M-SO1.
		NTAsb-231-0002-SO	1 – 2	
		NTAsb-231-0003-SO	2 – 3	
		NTAsb-231-0004-SO	3 – 4	
NTAsb-232	Soil Boring	NTAsb-232-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, east of NTAs-183M-SO1.
		NTAsb-232-0002-SO	1 – 2	
		NTAsb-232-0003-SO	2 – 3	
		NTAsb-232-0004-SO	3 – 4	
NTAsb-233	Soil Boring	NTAsb-233-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, east of NTAs-183M-SO1.
		NTAsb-233-0002-SO	1 – 2	
		NTAsb-233-0003-SO	2 – 3	
		NTAsb-233-0004-SO	3 – 4	

Table 18-1. Sample Location IDs for RVAAP-38 NACA Test Area (Continued)

Sample Location Number	Location Type	Sample ID	Sample Depth (feet bgs)	Purpose
NTAsb-234	Soil Boring	NTAsb-234-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, east of NTAcS-183M-SO1.
		NTAsb-234-0002-SO	1 – 2	
		NTAsb-234-0003-SO	2 – 3	
		NTAsb-234-0004-SO	3 – 4	
NTAsb-235	Soil Boring	NTAsb-235-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, south of NTAcS-182M-SO1.
		NTAsb-235-0002-SO	1 – 2	
		NTAsb-235-0003-SO	2 – 3	
		NTAsb-235-0004-SO	3 – 4	
NTAsb-236	Soil Boring	NTAsb-236-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, south of NTAcS-182M-SO1.
		NTAsb-236-0002-SO	1 – 2	
		NTAsb-236-0003-SO	2 – 3	
		NTAsb-236-0004-SO	3 – 4	
NTAsb-237	Soil Boring	NTAsb-237-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, south of NTAcS-182M-SO1.
		NTAsb-237-0002-SO	1 – 2	
		NTAsb-237-0003-SO	2 – 3	
		NTAsb-237-0004-SO	3 – 4	
NTAsb-238	Soil Boring	NTAsb-238-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, south of NTAcS-182M-SO1.
		NTAsb-238-0002-SO	1 – 2	
		NTAsb-238-0003-SO	2 – 3	
		NTAsb-238-0004-SO	3 – 4	
NTAsb-239	Soil Boring	NTAsb-239-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, south of NTAcS-182M-SO1.
		NTAsb-239-0002-SO	1 – 2	
		NTAsb-239-0003-SO	2 – 3	
		NTAsb-239-0004-SO	3 – 4	
NTAsb-240	Soil Boring	NTAsb-240-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, south of NTAcS-182M-SO1.
		NTAsb-240-0002-SO	1 – 2	
		NTAsb-240-0003-SO	2 – 3	
		NTAsb-240-0004-SO	3 – 4	
NTAsb-241	Soil Boring	NTAsb-241-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, south of NTAcS-182M-SO1.
		NTAsb-241-0002-SO	1 – 2	
		NTAsb-241-0003-SO	2 – 3	
		NTAsb-241-0004-SO	3 – 4	

Table 18-1. Sample Location IDs for RVAAP-38 NACA Test Area (Continued)

Sample Location Number	Location Type	Sample ID	Sample Depth (feet bgs)	Purpose
NTAsb-242	Soil Boring	NTAsb-242-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, south of NTAcS-182M-SO1.
		NTAsb-242-0002-SO	1 – 2	
		NTAsb-242-0003-SO	2 – 3	
		NTAsb-242-0004-SO	3 – 4	
NTAsb-243	Soil Boring	NTAsb-243-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, south of NTAcS-182M-SO1.
		NTAsb-243-0002-SO	1 – 2	
		NTAsb-243-0003-SO	2 – 3	
		NTAsb-243-0004-SO	3 – 4	
NTAsb-244	Soil Boring	NTAsb-244-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, south of NTAcS-182M-SO1.
		NTAsb-244-0002-SO	1 – 2	
		NTAsb-244-0003-SO	2 – 3	
		NTAsb-244-0004-SO	3 – 4	
NTAsb-245	Soil Boring	NTAsb-245-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Area 2, west of NTAcS-181M-SO1.
		NTAsb-245-0002-SO	1 – 2	
		NTAsb-245-0003-SO	2 – 3	
		NTAsb-245-0004-SO	3 – 4	
NTAsb-246	Soil Boring	NTAsb-246-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Area 2, west of NTAcS-181M-SO1.
		NTAsb-246-0002-SO	1 – 2	
		NTAsb-246-0003-SO	2 – 3	
		NTAsb-246-0004-SO	3 – 4	
NTAsb-247	Soil Boring	NTAsb-247-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Area 2, west of NTAcS-181M-SO1.
		NTAsb-247-0002-SO	1 – 2	
		NTAsb-247-0003-SO	2 – 3	
		NTAsb-247-0004-SO	3 – 4	
NTAsb-248	Soil Boring	NTAsb-248-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Area 2, west of NTAcS-181M-SO1.
		NTAsb-248-0002-SO	1 – 2	
		NTAsb-248-0003-SO	2 – 3	
		NTAsb-248-0004-SO	3 – 4	
NTAsb-249	Soil Boring	NTAsb-249-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Area 2, west of NTAcS-181M-SO1.
		NTAsb-249-0002-SO	1 – 2	
		NTAsb-249-0003-SO	2 – 3	
		NTAsb-249-0004-SO	3 – 4	

Table 18-1. Sample Location IDs for RVAAP-38 NACA Test Area (Continued)

Sample Location Number	Location Type	Sample ID	Sample Depth (feet bgs)	Purpose
NTAsb-250	Soil Boring	NTAsb-250-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Area 2, west of NTAcS-181M-SO1.
		NTAsb-250-0002-SO	1 – 2	
		NTAsb-250-0003-SO	2 – 3	
		NTAsb-250-0004-SO	3 – 4	
NTAsb-251	Soil Boring	NTAsb-251-0001-SO	2 – 3	Further delineate exceedance of benzo(a)pyrene below 2 feet bgs at NTAcS-207M-SO1.
		NTAsb-251-0002-SO	3 – 4	
NTAsb-252	Soil Boring	NTAsb-252-0001-SO	2 – 3	Further delineate exceedance of benzo(a)pyrene below 2 feet bgs at NTAcS-207M-SO1.
		NTAsb-252-0002-SO	3 – 4	
NTAsb-253	Soil Boring	NTAsb-253-0001-SO	2 – 3	Further delineate exceedance of benzo(a)pyrene below 2 feet bgs at NTAcS-207M-SO1.
		NTAsb-253-0002-SO	3 – 4	
NTAsb-254	Soil Boring	NTAsb-254-0001-SO	2 – 3	Further delineate exceedance of benzo(a)pyrene below 2 feet bgs at NTAcS-207M-SO1.
		NTAsb-254-0002-SO	3 – 4	

bgs = Below Ground Surface

ID = Identifier

NACA = National Advisory Committee on Aeronautics

Table 18-2. Sample Location IDs for RVAAP-42 Load Line 9

Sample Location Number	Location Type	Sample ID	Sample Depth (feet bgs)	Purpose
LL9sb-149	Soil Boring	LL9sb-149-0001-SS	0 – 1	Further delineate exceedances of lead at Area 1, west of LL9cs-139M-SO1.
		LL9sb-149-0002-SO	1 – 2	
		LL9sb-149-0003-SO	2 – 3	
		LL9sb-149-0004-SO	3 – 4	
LL9sb-150	Soil Boring	LL9sb-150-0001-SS	0 – 1	Further delineate exceedances of lead at Area 1, west of LL9cs-139M-SO1.
		LL9sb-150-0002-SO	1 – 2	
		LL9sb-150-0003-SO	2 – 3	
		LL9sb-150-0004-SO	3 – 4	
LL9sb-151	Soil Boring	LL9sb-151-0001-SS	0 – 1	Further delineate exceedances of lead at Area 1, west of LL9cs-139M-SO1.
		LL9sb-151-0002-SO	1 – 2	
		LL9sb-151-0003-SO	2 – 3	
		LL9sb-151-0004-SO	3 – 4	
LL9sb-152	Soil Boring	LL9sb-152-0001-SS	0 – 1	Further delineate exceedances of lead at Area 1, west of LL9cs-139M-SO1.
		LL9sb-152-0002-SO	1 – 2	
		LL9sb-152-0003-SO	2 – 3	
		LL9sb-152-0004-SO	3 – 4	
LL9sb-153	Soil Boring	LL9sb-153-0001-SS	0 – 1	Further delineate exceedances of lead at Area 1, west of LL9cs-139M-SO1.
		LL9sb-153-0002-SO	1 – 2	
		LL9sb-153-0003-SO	2 – 3	
		LL9sb-153-0004-SO	3 – 4	
LL9sb-154	Soil Boring	LL9sb-154-0001-SS	0 – 1	Further delineate exceedances of lead at Area 1, west of LL9cs-139M-SO1.
		LL9sb-154-0002-SO	1 – 2	
		LL9sb-154-0003-SO	2 – 3	
		LL9sb-154-0004-SO	3 – 4	
LL9sb-155	Soil Boring	LL9sb-155-0001-SS	0 – 1	Further delineate exceedances of lead at Area 1, west of LL9cs-139M-SO1.
		LL9sb-155-0002-SO	1 – 2	
		LL9sb-155-0003-SO	2 – 3	
		LL9sb-155-0004-SO	3 – 4	
LL9sb-156	Soil Boring	LL9sb-156-0001-SS	0 – 1	Further delineate exceedances of lead at Area 1, west of LL9cs-139M-SO1.
		LL9sb-156-0002-SO	1 – 2	
		LL9sb-156-0003-SO	2 – 3	
		LL9sb-156-0004-SO	3 – 4	

Table 18-2. Sample Location IDs for RVAAP-42 Load Line 9 (Continued)

Sample Location Number	Location Type	Sample ID	Sample Depth (feet bgs)	Purpose
LL9sb-157	Soil Boring	LL9sb-157-0001-SS	0 – 1	Further delineate exceedances of lead and mercury at Area 1, east of LL9cs-137M-SO1.
		LL9sb-157-0002-SO	1 – 2	
		LL9sb-157-0003-SO	2 – 3	
		LL9sb-157-0004-SO	3 – 4	
LL9sb-158	Soil Boring	LL9sb-158-0001-SS	0 – 1	Further delineate exceedances of lead and mercury at Area 1, east of LL9cs-137M-SO1.
		LL9sb-158-0002-SO	1 – 2	
		LL9sb-158-0003-SO	2 – 3	
		LL9sb-158-0004-SO	3 – 4	
LL9sb-159	Soil Boring	LL9sb-159-0001-SS	0 – 1	Further delineate exceedances of lead and mercury at Area 1, east of LL9cs-137M-SO1.
		LL9sb-159-0002-SO	1 – 2	
		LL9sb-159-0003-SO	2 – 3	
		LL9sb-159-0004-SO	3 – 4	
LL9sb-160	Soil Boring	LL9sb-160-0001-SS	0 – 1	Further delineate exceedances of lead and mercury at Area 1, east of LL9cs-137M-SO1.
		LL9sb-160-0002-SO	1 – 2	
		LL9sb-160-0003-SO	2 – 3	
		LL9sb-160-0004-SO	3 – 4	
LL9sb-161	Soil Boring	LL9sb-161-0001-SS	0 – 1	Further delineate exceedances of lead and mercury at Area 1, east of LL9cs-137M-SO1.
		LL9sb-161-0002-SO	1 – 2	
		LL9sb-161-0003-SO	2 – 3	
		LL9sb-161-0004-SO	3 – 4	
LL9sb-162	Soil Boring	LL9sb-162-0001-SS	0 – 1	Further delineate exceedances of lead and mercury at Area 1, east of LL9cs-137M-SO1.
		LL9sb-162-0002-SO	1 – 2	
		LL9sb-162-0003-SO	2 – 3	
		LL9sb-162-0004-SO	3 – 4	
LL9sb-163	Soil Boring	LL9sb-163-0001-SS	0 – 1	Further delineate exceedances of lead and mercury at Area 1, east of LL9cs-137M-SO1.
		LL9sb-163-0002-SO	1 – 2	
		LL9sb-163-0003-SO	2 – 3	
		LL9sb-163-0004-SO	3 – 4	
LL9sb-164	Soil Boring	LL9sb-164-0001-SS	0 – 1	Further delineate exceedances of lead and mercury at Area 1, east of LL9cs-137M-SO1.
		LL9sb-164-0002-SO	1 – 2	
		LL9sb-164-0003-SO	2 – 3	
		LL9sb-164-0004-SO	3 – 4	

Table 18-2. Sample Location IDs for RVAAP-42 Load Line 9 (Continued)

Sample Location Number	Location Type	Sample ID	Sample Depth (feet bgs)	Purpose
LL9sb-165	Soil Boring	LL9sb-165-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 2, south of LL9cs-144M-SO1.
		LL9sb-165-0002-SO	1 – 2	
		LL9sb-165-0003-SO	2 – 3	
		LL9sb-165-0004-SO	3 – 4	
LL9sb-166	Soil Boring	LL9sb-166-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 2, south of LL9cs-144M-SO1.
		LL9sb-166-0002-SO	1 – 2	
		LL9sb-166-0003-SO	2 – 3	
		LL9sb-166-0004-SO	3 – 4	
LL9sb-167	Soil Boring	LL9sb-167-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Area 2, south of LL9cs-144M-SO1.
		LL9sb-167-0002-SO	1 – 2	
		LL9sb-167-0003-SO	2 – 3	
		LL9sb-167-0004-SO	3 – 4	
LL9sb-168	Soil Boring	LL9sb-168-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Area 2, south of LL9cs-144M-SO1.
		LL9sb-168-0002-SO	1 – 2	
		LL9sb-168-0003-SO	2 – 3	
		LL9sb-168-0004-SO	3 – 4	
LL9sb-169	Soil Boring	LL9sb-169-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Area 2, south of LL9cs-144M-SO1.
		LL9sb-169-0002-SO	1 – 2	
		LL9sb-169-0003-SO	2 – 3	
		LL9sb-169-0004-SO	3 – 4	
LL9sb-170	Soil Boring	LL9sb-170-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Area 2, south of LL9cs-144M-SO1.
		LL9sb-170-0002-SO	1 – 2	
		LL9sb-170-0003-SO	2 – 3	
		LL9sb-170-0004-SO	3 – 4	
LL9sb-171	Soil Boring	LL9sb-171-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Area 2, south of LL9cs-144M-SO1.
		LL9sb-171-0002-SO	1 – 2	
		LL9sb-171-0003-SO	2 – 3	
		LL9sb-171-0004-SO	3 – 4	
LL9sb-172	Soil Boring	LL9sb-172-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Area 2, south of LL9cs-144M-SO1.
		LL9sb-172-0002-SO	1 – 2	
		LL9sb-172-0003-SO	2 – 3	
		LL9sb-172-0004-SO	3 – 4	

Table 18-2. Sample Location IDs for RVAAP-42 Load Line 9 (Continued)

Sample Location Number	Location Type	Sample ID	Sample Depth (feet bgs)	Purpose
LL9sb-173	Soil Boring	LL9sb-173-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, east of LL9cs-143M-SO1.
		LL9sb-173-0002-SO	1 – 2	
		LL9sb-173-0003-SO	2 – 3	
		LL9sb-173-0004-SO	3 – 4	
LL9sb-174	Soil Boring	LL9sb-174-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, east of LL9cs-143M-SO1.
		LL9sb-174-0002-SO	1 – 2	
		LL9sb-174-0003-SO	2 – 3	
		LL9sb-174-0004-SO	3 – 4	
LL9sb-175	Soil Boring	LL9sb-175-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, east of LL9cs-143M-SO1.
		LL9sb-175-0002-SO	1 – 2	
		LL9sb-175-0003-SO	2 – 3	
		LL9sb-175-0004-SO	3 – 4	
LL9sb-176	Soil Boring	LL9sb-176-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, east of LL9cs-143M-SO1.
		LL9sb-176-0002-SO	1 – 2	
		LL9sb-176-0003-SO	2 – 3	
		LL9sb-176-0004-SO	3 – 4	
LL9sb-177	Soil Boring	LL9sb-177-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, east of LL9cs-143M-SO1.
		LL9sb-177-0002-SO	1 – 2	
		LL9sb-177-0003-SO	2 – 3	
		LL9sb-177-0004-SO	3 – 4	
LL9sb-179	Soil Boring	LL9sb-179-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, east of LL9cs-143M-SO1.
		LL9sb-179-0002-SO	1 – 2	
		LL9sb-179-0003-SO	2 – 3	
		LL9sb-179-0004-SO	3 – 4	
LL9sb-180	Soil Boring	LL9sb-180-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Area 2, east of LL9cs-143M-SO1.
		LL9sb-180-0002-SO	1 – 2	
		LL9sb-180-0003-SO	2 – 3	
		LL9sb-180-0004-SO	3 – 4	

bgs = Below Ground Surface
ID = Identifier

Table 18-3. Sample Location IDs for RVAAP-45 Wet Storage Area

Sample Location Number	Location Type	Sample ID	Sample Depth (feet bgs)	Purpose
WSAsb-053	Soil Boring	WSAsb-053-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, east of WSAscs-042M-SO1.
		WSAsb-053-0002-SO	1 – 2	
		WSAsb-053-0003-SO	2 – 3	
		WSAsb-053-0004-SO	3 – 4	
WSAsb-054	Soil Boring	WSAsb-054-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, east of WSAscs-042M-SO1.
		WSAsb-054-0002-SO	1 – 2	
		WSAsb-054-0003-SO	2 – 3	
		WSAsb-054-0004-SO	3 – 4	
WSAsb-055	Soil Boring	WSAsb-055-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, east of WSAscs-042M-SO1.
		WSAsb-055-0002-SO	1 – 2	
		WSAsb-055-0003-SO	2 – 3	
		WSAsb-055-0004-SO	3 – 4	
WSAsb-056	Soil Boring	WSAsb-056-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, east of WSAscs-042M-SO1.
		WSAsb-056-0002-SO	1 – 2	
		WSAsb-056-0003-SO	2 – 3	
		WSAsb-056-0004-SO	3 – 4	
WSAsb-057	Soil Boring	WSAsb-057-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, east of WSAscs-042M-SO1.
		WSAsb-057-0002-SO	1 – 2	
		WSAsb-057-0003-SO	2 – 3	
		WSAsb-057-0004-SO	3 – 4	
WSAsb-058	Soil Boring	WSAsb-058-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, east of WSAscs-042M-SO1.
		WSAsb-058-0002-SO	1 – 2	
		WSAsb-058-0003-SO	2 – 3	
		WSAsb-058-0004-SO	3 – 4	
WSAsb-059	Soil Boring	WSAsb-059-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, east of WSAscs-042M-SO1.
		WSAsb-059-0002-SO	1 – 2	
		WSAsb-059-0003-SO	2 – 3	
		WSAsb-059-0004-SO	3 – 4	
WSAsb-060	Soil Boring	WSAsb-060-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, east of WSAscs-042M-SO1.
		WSAsb-060-0002-SO	1 – 2	
		WSAsb-060-0003-SO	2 – 3	
		WSAsb-060-0004-SO	3 – 4	

Table 18-3. Sample Location IDs for RVAAP-45 Wet Storage Area (Continued)

Sample Location Number	Location Type	Sample ID	Sample Depth (feet bgs)	Purpose
WSAsb-061	Soil Boring	WSAsb-061-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, east of WSAscs-042M-SO1.
		WSAsb-061-0002-SO	1 – 2	
		WSAsb-061-0003-SO	2 – 3	
		WSAsb-061-0004-SO	3 – 4	
WSAsb-062	Soil Boring	WSAsb-062-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, east of WSAscs-042M-SO1.
		WSAsb-062-0002-SO	1 – 2	
		WSAsb-062-0003-SO	2 – 3	
		WSAsb-062-0004-SO	3 – 4	
WSAsb-063	Soil Boring	WSAsb-063-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, east of WSAscs-042M-SO1.
		WSAsb-063-0002-SO	1 – 2	
		WSAsb-063-0003-SO	2 – 3	
		WSAsb-063-0004-SO	3 – 4	
WSAsb-064	Soil Boring	WSAsb-064-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, east of WSAscs-042M-SO1.
		WSAsb-064-0002-SO	1 – 2	
		WSAsb-064-0003-SO	2 – 3	
		WSAsb-064-0004-SO	3 – 4	
WSAsb-065	Soil Boring	WSAsb-065-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, east of WSAscs-042M-SO1.
		WSAsb-065-0002-SO	1 – 2	
		WSAsb-065-0003-SO	2 – 3	
		WSAsb-065-0004-SO	3 – 4	
WSAsb-066	Soil Boring	WSAsb-066-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, east of WSAscs-042M-SO1.
		WSAsb-066-0002-SO	1 – 2	
		WSAsb-066-0003-SO	2 – 3	
		WSAsb-066-0004-SO	3 – 4	
WSAsb-067	Soil Boring	WSAsb-067-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, east of WSAscs-042M-SO1.
		WSAsb-067-0002-SO	1 – 2	
		WSAsb-067-0003-SO	2 – 3	
		WSAsb-067-0004-SO	3 – 4	
WSAsb-068	Soil Boring	WSAsb-068-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, east of WSAscs-042M-SO1.
		WSAsb-068-0002-SO	1 – 2	
		WSAsb-068-0003-SO	2 – 3	
		WSAsb-068-0004-SO	3 – 4	

Table 18-3. Sample Location IDs for RVAAP-45 Wet Storage Area (Continued)

Sample Location Number	Location Type	Sample ID	Sample Depth (feet bgs)	Purpose
WSAsb-069	Soil Boring	WSAsb-069-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, north of WSAscs-041M-SO1.
		WSAsb-069-0002-SO	1 – 2	
		WSAsb-069-0003-SO	2 – 3	
		WSAsb-069-0004-SO	3 – 4	
WSAsb-070	Soil Boring	WSAsb-070-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, north of WSAscs-041M-SO1.
		WSAsb-070-0002-SO	1 – 2	
		WSAsb-070-0003-SO	2 – 3	
		WSAsb-070-0004-SO	3 – 4	
WSAsb-071	Soil Boring	WSAsb-071-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, north of WSAscs-041M-SO1.
		WSAsb-071-0002-SO	1 – 2	
		WSAsb-071-0003-SO	2 – 3	
		WSAsb-071-0004-SO	3 – 4	
WSAsb-072	Soil Boring	WSAsb-072-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, north of WSAscs-041M-SO1.
		WSAsb-072-0002-SO	1 – 2	
		WSAsb-072-0003-SO	2 – 3	
		WSAsb-072-0004-SO	3 – 4	
WSAsb-073	Soil Boring	WSAsb-073-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, north of WSAscs-041M-SO1.
		WSAsb-073-0002-SO	1 – 2	
		WSAsb-073-0003-SO	2 – 3	
		WSAsb-073-0004-SO	3 – 4	
WSAsb-074	Soil Boring	WSAsb-074-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, north of WSAscs-041M-SO1.
		WSAsb-074-0002-SO	1 – 2	
		WSAsb-074-0003-SO	2 – 3	
		WSAsb-074-0004-SO	3 – 4	
WSAsb-075	Soil Boring	WSAsb-075-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, north of WSAscs-041M-SO1.
		WSAsb-075-0002-SO	1 – 2	
		WSAsb-075-0003-SO	2 – 3	
		WSAsb-075-0004-SO	3 – 4	
WSAsb-076	Soil Boring	WSAsb-076-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 1, north of WSAscs-041M-SO1.
		WSAsb-076-0002-SO	1 – 2	
		WSAsb-076-0003-SO	2 – 3	
		WSAsb-076-0004-SO	3 – 4	

Table 18-3. Sample Location IDs for RVAAP-45 Wet Storage Area (Continued)

Sample Location Number	Location Type	Sample ID	Sample Depth (feet bgs)	Purpose
WSAsb-077	Soil Boring	WSAsb-077-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 2, east of WSAscs-048M-SO1.
		WSAsb-077-0002-SO	1 – 2	
		WSAsb-077-0003-SO	2 – 3	
		WSAsb-077-0004-SO	3 – 4	
WSAsb-078	Soil Boring	WSAsb-078-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 2, east of WSAscs-048M-SO1.
		WSAsb-078-0002-SO	1 – 2	
		WSAsb-078-0003-SO	2 – 3	
		WSAsb-078-0004-SO	3 – 4	
WSAsb-079	Soil Boring	WSAsb-079-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 2, east of WSAscs-048M-SO1.
		WSAsb-079-0002-SO	1 – 2	
		WSAsb-079-0003-SO	2 – 3	
		WSAsb-079-0004-SO	3 – 4	
WSAsb-080	Soil Boring	WSAsb-080-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 2, east of WSAscs-048M-SO1.
		WSAsb-080-0002-SO	1 – 2	
		WSAsb-080-0003-SO	2 – 3	
		WSAsb-080-0004-SO	3 – 4	
WSAsb-081	Soil Boring	WSAsb-081-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 2, east of WSAscs-048M-SO1.
		WSAsb-081-0002-SO	1 – 2	
		WSAsb-081-0003-SO	2 – 3	
		WSAsb-081-0004-SO	3 – 4	
WSAsb-082	Soil Boring	WSAsb-082-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 2, east of WSAscs-048M-SO1.
		WSAsb-082-0002-SO	1 – 2	
		WSAsb-082-0003-SO	2 – 3	
		WSAsb-082-0004-SO	3 – 4	
WSAsb-083	Soil Boring	WSAsb-083-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 2, east of WSAscs-048M-SO1.
		WSAsb-083-0002-SO	1 – 2	
		WSAsb-083-0003-SO	2 – 3	
		WSAsb-083-0004-SO	3 – 4	
WSAsb-084	Soil Boring	WSAsb-084-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 2, east of WSAscs-048M-SO1.
		WSAsb-084-0002-SO	1 – 2	
		WSAsb-084-0003-SO	2 – 3	
		WSAsb-084-0004-SO	3 – 4	

Table 18-3. Sample Location IDs for RVAAP-45 Wet Storage Area (Continued)

Sample Location Number	Location Type	Sample ID	Sample Depth (feet bgs)	Purpose
WSAsb-085	Soil Boring	WSAsb-085-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 2, east of WSAscs-048M-SO1.
		WSAsb-085-0002-SO	1 – 2	
		WSAsb-085-0003-SO	2 – 3	
		WSAsb-085-0004-SO	3 – 4	
WSAsb-086	Soil Boring	WSAsb-086-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 2, east of WSAscs-048M-SO1.
		WSAsb-086-0002-SO	1 – 2	
		WSAsb-086-0003-SO	2 – 3	
		WSAsb-086-0004-SO	3 – 4	
WSAsb-087	Soil Boring	WSAsb-087-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 2, east of WSAscs-048M-SO1.
		WSAsb-087-0002-SO	1 – 2	
		WSAsb-087-0003-SO	2 – 3	
		WSAsb-087-0004-SO	3 – 4	
WSAsb-088	Soil Boring	WSAsb-088-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 2, east of WSAscs-048M-SO1.
		WSAsb-088-0002-SO	1 – 2	
		WSAsb-088-0003-SO	2 – 3	
		WSAsb-088-0004-SO	3 – 4	
WSAsb-089	Soil Boring	WSAsb-089-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 2, east of WSAscs-048M-SO1.
		WSAsb-089-0002-SO	1 – 2	
		WSAsb-089-0003-SO	2 – 3	
		WSAsb-089-0004-SO	3 – 4	
WSAsb-090	Soil Boring	WSAsb-090-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 2, east of WSAscs-048M-SO1.
		WSAsb-090-0002-SO	1 – 2	
		WSAsb-090-0003-SO	2 – 3	
		WSAsb-090-0004-SO	3 – 4	
WSAsb-091	Soil Boring	WSAsb-091-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 2, east of WSAscs-048M-SO1.
		WSAsb-091-0002-SO	1 – 2	
		WSAsb-091-0003-SO	2 – 3	
		WSAsb-091-0004-SO	3 – 4	
WSAsb-092	Soil Boring	WSAsb-092-0001-SS	0 – 1	Further delineate exceedance of benzo(a)pyrene at Area 2, east of WSAscs-048M-SO1.
		WSAsb-092-0002-SO	1 – 2	
		WSAsb-092-0003-SO	2 – 3	
		WSAsb-092-0004-SO	3 – 4	

bgs = Below Ground Surface
ID = Identifier

Table 18-4. Sample Location IDs for CC RVAAP-76 Depot Area

Sample Location Number	Location Type	Sample ID	Sample Depth (feet bgs)	Purpose
076sb-127	Soil Boring	076sb-127-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, east of 076cs-111M.
		076sb-127-0002-SO	1 – 2	
		076sb-127-0003-SO	2 – 3	
		076sb-127-0004-SO	3 – 4	
076sb-128	Soil Boring	076sb-128-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, east of 076cs-111M.
		076sb-128-0002-SO	1 – 2	
		076sb-128-0003-SO	2 – 3	
		076sb-128-0004-SO	3 – 4	
076sb-129	Soil Boring	076sb-129-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, east of 076cs-111M.
		076sb-129-0002-SO	1 – 2	
		076sb-129-0003-SO	2 – 3	
		076sb-129-0004-SO	3 – 4	
076sb-130	Soil Boring	076sb-130-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, east of 076cs-111M.
		076sb-130-0002-SO	1 – 2	
		076sb-130-0003-SO	2 – 3	
		076sb-130-0004-SO	3 – 4	
076sb-131	Soil Boring	076sb-131-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, east of 076cs-111M.
		076sb-131-0002-SO	1 – 2	
		076sb-131-0003-SO	2 – 3	
		076sb-131-0004-SO	3 – 4	
076sb-132	Soil Boring	076sb-132-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, east of 076cs-111M.
		076sb-132-0002-SO	1 – 2	
		076sb-132-0003-SO	2 – 3	
		076sb-132-0004-SO	3 – 4	
076sb-133	Soil Boring	076sb-133-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, east of 076cs-111M.
		076sb-133-0002-SO	1 – 2	
		076sb-133-0003-SO	2 – 3	
		076sb-133-0004-SO	3 – 4	
076sb-134	Soil Boring	076sb-134-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, east of 076cs-111M.
		076sb-134-0002-SO	1 – 2	
		076sb-134-0003-SO	2 – 3	
		076sb-134-0004-SO	3 – 4	

Table 18-4. Sample Location IDs for CC RVAAP-76 Depot Area (Continued)

Sample Location Number	Location Type	Sample ID	Sample Depth (feet bgs)	Purpose
076sb-135	Soil Boring	076sb-135-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, east of 076cs-111M.
		076sb-135-0002-SO	1 – 2	
		076sb-135-0003-SO	2 – 3	
		076sb-135-0004-SO	3 – 4	
076sb-136	Soil Boring	076sb-136-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, east of 076cs-111M.
		076sb-136-0002-SO	1 – 2	
		076sb-136-0003-SO	2 – 3	
		076sb-136-0004-SO	3 – 4	
076sb-137	Soil Boring	076sb-137-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, east of 076cs-111M.
		076sb-137-0002-SO	1 – 2	
		076sb-137-0003-SO	2 – 3	
		076sb-137-0004-SO	3 – 4	
076sb-138	Soil Boring	076sb-138-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, east of 076cs-111M.
		076sb-138-0002-SO	1 – 2	
		076sb-138-0003-SO	2 – 3	
		076sb-138-0004-SO	3 – 4	
076sb-139	Soil Boring	076sb-139-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, north of 076cs-110M.
		076sb-139-0002-SO	1 – 2	
		076sb-139-0003-SO	2 – 3	
		076sb-139-0004-SO	3 – 4	
076sb-140	Soil Boring	076sb-140-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, north of 076cs-110M.
		076sb-140-0002-SO	1 – 2	
		076sb-140-0003-SO	2 – 3	
		076sb-140-0004-SO	3 – 4	
076sb-141	Soil Boring	076sb-141-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, north of 076cs-110M.
		076sb-141-0002-SO	1 – 2	
		076sb-141-0003-SO	2 – 3	
		076sb-141-0004-SO	3 – 4	
076sb-142	Soil Boring	076sb-142-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, north of 076cs-110M.
		076sb-142-0002-SO	1 – 2	
		076sb-142-0003-SO	2 – 3	
		076sb-142-0004-SO	3 – 4	

Table 18-4. Sample Location IDs for CC RVAAP-76 Depot Area (Continued)

Sample Location Number	Location Type	Sample ID	Sample Depth (feet bgs)	Purpose
076sb-143	Soil Boring	076sb-143-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, north of 076cs-110M.
		076sb-143-0002-SO	1 – 2	
		076sb-143-0003-SO	2 – 3	
		076sb-143-0004-SO	3 – 4	
076sb-144	Soil Boring	076sb-144-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, north of 076cs-110M.
		076sb-144-0002-SO	1 – 2	
		076sb-144-0003-SO	2 – 3	
		076sb-144-0004-SO	3 – 4	
076sb-145	Soil Boring	076sb-145-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, north of 076cs-110M.
		076sb-145-0002-SO	1 – 2	
		076sb-145-0003-SO	2 – 3	
		076sb-145-0004-SO	3 – 4	
076sb-146	Soil Boring	076sb-146-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, north of 076cs-110M.
		076sb-146-0002-SO	1 – 2	
		076sb-146-0003-SO	2 – 3	
		076sb-146-0004-SO	3 – 4	
076sb-147	Soil Boring	076sb-147-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, north of 076cs-110M.
		076sb-147-0002-SO	1 – 2	
		076sb-147-0003-SO	2 – 3	
		076sb-147-0004-SO	3 – 4	
076sb-148	Soil Boring	076sb-148-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, north of 076cs-110M.
		076sb-148-0002-SO	1 – 2	
		076sb-148-0003-SO	2 – 3	
		076sb-148-0004-SO	3 – 4	
076sb-149	Soil Boring	076sb-149-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, north of 076cs-110M.
		076sb-149-0002-SO	1 – 2	
		076sb-149-0003-SO	2 – 3	
		076sb-149-0004-SO	3 – 4	
076sb-150	Soil Boring	076sb-150-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene at Building U-4, north of 076cs-110M.
		076sb-150-0002-SO	1 – 2	
		076sb-150-0003-SO	2 – 3	
		076sb-150-0004-SO	3 – 4	

Table 18-4. Sample Location IDs for CC RVAAP-76 Depot Area (Continued)

Sample Location Number	Location Type	Sample ID	Sample Depth (feet bgs)	Purpose
076sb-151	Soil Boring	076sb-151-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene and dibenz(a,h)anthracene at Building U-5, south of 076cs-120M.
		076sb-151-0002-SO	1 – 2	
		076sb-151-0003-SO	2 – 3	
		076sb-151-0004-SO	3 – 4	
076sb-152	Soil Boring	076sb-152-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene and dibenz(a,h)anthracene at Building U-5, south of 076cs-120M.
		076sb-152-0002-SO	1 – 2	
		076sb-152-0003-SO	2 – 3	
		076sb-152-0004-SO	3 – 4	
076sb-153	Soil Boring	076sb-153-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene and dibenz(a,h)anthracene at Building U-5, south of 076cs-120M.
		076sb-153-0002-SO	1 – 2	
		076sb-153-0003-SO	2 – 3	
		076sb-153-0004-SO	3 – 4	
076sb-154	Soil Boring	076sb-154-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene and dibenz(a,h)anthracene at Building U-5, south of 076cs-120M.
		076sb-154-0002-SO	1 – 2	
		076sb-154-0003-SO	2 – 3	
		076sb-154-0004-SO	3 – 4	
076sb-155	Soil Boring	076sb-155-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene and dibenz(a,h)anthracene at Building U-5, south of 076cs-120M.
		076sb-155-0002-SO	1 – 2	
		076sb-155-0003-SO	2 – 3	
		076sb-155-0004-SO	3 – 4	
076sb-156	Soil Boring	076sb-156-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene and dibenz(a,h)anthracene at Building U-5, south of 076cs-120M.
		076sb-156-0002-SO	1 – 2	
		076sb-156-0003-SO	2 – 3	
		076sb-156-0004-SO	3 – 4	
076sb-157	Soil Boring	076sb-157-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene and dibenz(a,h)anthracene at Building U-5, south of 076cs-120M.
		076sb-157-0002-SO	1 – 2	
		076sb-157-0003-SO	2 – 3	
		076sb-157-0004-SO	3 – 4	
076sb-158	Soil Boring	076sb-158-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene and dibenz(a,h)anthracene at Building U-5, south of 076cs-120M.
		076sb-158-0002-SO	1 – 2	
		076sb-158-0003-SO	2 – 3	
		076sb-158-0004-SO	3 – 4	

Table 18-4. Sample Location IDs for CC RVAAP-76 Depot Area (Continued)

Sample Location Number	Location Type	Sample ID	Sample Depth (feet bgs)	Purpose
076sb-159	Soil Boring	076sb-159-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene and dibenz(a,h)anthracene at Building U-5, south of 076cs-120M.
		076sb-159-0002-SO	1 – 2	
		076sb-159-0003-SO	2 – 3	
		076sb-159-0004-SO	3 – 4	
076sb-160	Soil Boring	076sb-160-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene and dibenz(a,h)anthracene at Building U-5, south of 076cs-120M.
		076sb-160-0002-SO	1 – 2	
		076sb-160-0003-SO	2 – 3	
		076sb-160-0004-SO	3 – 4	
076sb-161	Soil Boring	076sb-161-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene and dibenz(a,h)anthracene at Building U-5, south of 076cs-120M.
		076sb-161-0002-SO	1 – 2	
		076sb-161-0003-SO	2 – 3	
		076sb-161-0004-SO	3 – 4	
076sb-162	Soil Boring	076sb-162-0001-SS	0 – 1	Further delineate exceedances of benzo(a)pyrene and dibenz(a,h)anthracene at Building U-5, south of 076cs-120M.
		076sb-162-0002-SO	1 – 2	
		076sb-162-0003-SO	2 – 3	
		076sb-162-0004-SO	3 – 4	
076sb-163	Soil Boring	076sb-163-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Building U-5, north of 076cs-118M.
		076sb-163-0002-SO	1 – 2	
		076sb-163-0003-SO	2 – 3	
		076sb-163-0004-SO	3 – 4	
076sb-164	Soil Boring	076sb-164-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Building U-5, north of 076cs-118M.
		076sb-164-0002-SO	1 – 2	
		076sb-164-0003-SO	2 – 3	
		076sb-164-0004-SO	3 – 4	
076sb-165	Soil Boring	076sb-165-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Building U-5, north of 076cs-118M.
		076sb-165-0002-SO	1 – 2	
		076sb-165-0003-SO	2 – 3	
		076sb-165-0004-SO	3 – 4	
076sb-166	Soil Boring	076sb-166-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Building U-5, north of 076cs-118M.
		076sb-166-0002-SO	1 – 2	
		076sb-166-0003-SO	2 – 3	
		076sb-166-0004-SO	3 – 4	

Table 18-4. Sample Location IDs for CC RVAAP-76 Depot Area (Continued)

Sample Location Number	Location Type	Sample ID	Sample Depth (feet bgs)	Purpose
076sb-167	Soil Boring	076sb-167-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Building U-5, north of 076cs-118M.
		076sb-167-0002-SO	1 – 2	
		076sb-167-0003-SO	2 – 3	
		076sb-167-0004-SO	3 – 4	
076sb-168	Soil Boring	076sb-168-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Building U-5, north of 076cs-118M.
		076sb-168-0002-SO	1 – 2	
		076sb-168-0003-SO	2 – 3	
		076sb-168-0004-SO	3 – 4	
076sb-169	Soil Boring	076sb-169-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Building U-5, north of 076cs-118M.
		076sb-169-0002-SO	1 – 2	
		076sb-169-0003-SO	2 – 3	
		076sb-169-0004-SO	3 – 4	
076sb-170	Soil Boring	076sb-170-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Building U-5, north of 076cs-118M.
		076sb-170-0002-SO	1 – 2	
		076sb-170-0003-SO	2 – 3	
		076sb-170-0004-SO	3 – 4	
076sb-171	Soil Boring	076sb-171-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Building U-5, north of 076cs-118M.
		076sb-171-0002-SO	1 – 2	
		076sb-171-0003-SO	2 – 3	
		076sb-171-0004-SO	3 – 4	
076sb-172	Soil Boring	076sb-172-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Building U-5, north of 076cs-118M.
		076sb-172-0002-SO	1 – 2	
		076sb-172-0003-SO	2 – 3	
		076sb-172-0004-SO	3 – 4	
076sb-173	Soil Boring	076sb-173-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Building U-5, north of 076cs-118M.
		076sb-173-0002-SO	1 – 2	
		076sb-173-0003-SO	2 – 3	
		076sb-173-0004-SO	3 – 4	
076sb-174	Soil Boring	076sb-174-0001-SS	0 – 1	Further delineate exceedances of benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene at Building U-5, north of 076cs-118M.
		076sb-174-0002-SO	1 – 2	
		076sb-174-0003-SO	2 – 3	
		076sb-174-0004-SO	3 – 4	

bgs = Below Ground Surface

ID = Identifier

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

Laboratory Name: WWA/ELLE

Laboratory Address: 2425 New Holland Pike Lancaster, PA 17601

Point of Contact: Vanessa Badman, Principal Project Manager/Group Leader, Environmental Client Services

Email and Telephone Number: Vanessa.Badman@ET.EurofinsUS.com (717) 556-9762

Accreditation and Expiration Date (WWA): DoD ELAP/PJLA L22-129-R1; expiration March 31, 2024

Accreditation and Expiration Date: DoD ELAP/A2LA 0.0001.01; expiration November 30, 2022

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
PAHs	Soil	SW846 8270E SIM	1, 4-oz. amber glass; Teflon [®] -lined cap	100 g	Cool 0-6°C	14 days to extraction/ 40 days post-extraction	ELLE 15 business days (Level 4 data)
Metals	Soil	SW3050B/6020B	1, 16-oz. glass; Teflon [®] -lined cap	100 g	Cool 0-6°C	180 days	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 0-6°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 0-6°C	7 days to extraction; 40 days from extraction to analysis	ELLE 15 business days (Level 2 data)
TCLP Herbicides	Aqueous IDW	SW 1311/8151A	1-L amber glass	500 mL	Cool 0-6°C	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 0-6°C	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 0-6°C	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 0-6°C	None	ELLE 15 business days (Level 2 data)
pH	Aqueous IDW	SW 9040C	250-mL plastic	100 mL	Cool 0-6°C	None	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
Total Sulfide	Aqueous IDW	SW 9034	1-L plastic	500 ml	Cool $\leq 6^{\circ}\text{C}$; ZnAc/NaOH to pH>19	17 days	ELLE 15 business days (Level 2 data)
Total Cyanide	Aqueous	SW 9012A	1-L plastic	500 ml	Cool $\leq 6^{\circ}\text{C}$; NaOH to pH>12	14 days	ELLE 15 business days (Level 2 data)
TCLP VOC	Solid IDW	SW 1311	2-oz. glass jar with septa cap	25 g	Cool, $< 6^{\circ}\text{C}$	14 days from collection to leach; 14 days from leach to analysis	ELLE 15 business days (Level 2 data)
TCLP SVOCs, Pesticides, Herbicides	Solid IDW	SW 1311/8270E SW 1311/8081B SW 1311/8151A	9-oz. glass	100 g	Cool 0-6 $^{\circ}\text{C}$	14 days from collection to leach; 7 days from leach to extraction; 40 days from extraction to analysis	ELLE 15 business days (Level 2 data)
TCLP Metals	Solid IDW	SW 1311/6010D/7470A	16- or 32-oz. glass	200 g	Cool 0-6 $^{\circ}\text{C}$	14 days from collection to leach; 28 days (Hg) from leach to analysis (180 days other metals)	ELLE 15 business days (Level 2 data)
Flashpoint	Solid IDW	SW 1010A	4-oz. glass	100 g	Cool 0-6 $^{\circ}\text{C}$	None	ELLE 15 business days (Level 2 data)
pH	Solid IDW	SW 9045D	2-oz. glass	40 g	Cool 0-6 $^{\circ}\text{C}$	None	ELLE 15 business days (Level 2 data)
Total Sulfide	Solid IDW	SW 9034	2-oz. glass/plastic	40 g	Cool 0-6 $^{\circ}\text{C}$	7 days	ELLE 15 business days (Level 2 data)
Total Cyanide	Solid IDW	SW 9012A	4-oz. amber glass/plastic	10 g	Cool 0-6 $^{\circ}\text{C}$	14 days	ELLE 15 business days (Level 2 data)
Modified Paint Filter Test	Solid IDW	SW 9095B	8-oz. plastic/glass	100 g	Cool 0-6 $^{\circ}\text{C}$	N/A	ELLE 15 business days (Level 2 data)

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

Note: All analyses will be performed by ELLE and WWA. The addresses and telephone numbers are provided below.

°C = Degrees Celsius

DoD = U.S. Department of Defense

ELAP = Environmental Laboratory Accreditation Program

ELLE = Eurofins Lancaster Laboratories Environmental, LLC

N/A = Not Applicable

Hg = Mercury

IDW = Investigation-Derived Waste

N/A = Not Applicable

NaOH = Sodium Hydroxide

PAH = Polycyclic Aromatic Hydrocarbon

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.

ZnAc = Zinc Acetate

Eurofins Lancaster Laboratories Environmental, LLC

2425 New Holland Pike

Lancaster, PA 17601

(717) 556-9762

White Water Associates, Inc.

429 River Lane, PO Box 27

Amasa, Michigan 49903

(906) 822-7889

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QAPP Worksheet #20 – Field Quality Control Summary

Sampling Breakdown

Matrix/Event	Number of Field Samples	Field Duplicate Samples	Field Blanks	Equipment Rinsate Blanks	MS/MSDs	Total Analyses
RVAAP-38 NACA Test Area (Area 1)	32	4	1	4	2/2	45
RVAAP-38 NACA Test Area (Area 2)	128	13	0	13	7/7	168
RVAAP-38 NACA Test Area (Area 3)	8	1	0	1	1/1	12
RVAAP-42 Load Line 9 (Area 1)	64	7	0	7	4/4	86
RVAAP-42 Load Line 9 (Area 2)	64	7	0	7	4/4	86
RVAAP-45 Wet Storage Area (Area 1)	96	10	0	10	5/5	126
RVAAP-45 Wet Storage Area (Area 2)	64	7	0	7	4/4	86
CC RVAAP-76 Depot Area	64	7	0	7	4/4	86

Field blanks consist of the source water used during the equipment decontamination process. The source water used for the field blank will be potable water from the site and/or laboratory-provided DI water. A new field blank will be collected and analyzed whenever the source water changes, or every 6 months, whichever occurs first. Rinsate blanks will be collected at the rate of one per 10 samples when using non-disposable equipment for sample collection.

DI = Deionized

MS = Matrix Spike

MSD = Matrix Spike Duplicate

NACA = National Advisory Committee on Aeronautics

RVAAP = Ravenna Army Ammunition Plant

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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 (Y/N)
EE FTP-1215	Field Activity Documentation, Revision 4, 12/31/20	Leidos	None	No
EE FTP-750	Field Measurement Procedures, Revision 1, 12/31/20	Leidos	PID	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-400	Equipment Decontamination, Revision 1, 12/31/20	Leidos	Varies	No
EE FTP-525	Soil Sampling, Revision 1, 12/31/20	Leidos	Varies	No
EE FTP-691	Composite Procedures, Revision 1, 12/31/20	Leidos	Varies	No
EE FTP-180	GPS Data Collection, Revision 1, 12/31/20	Leidos	Varies	No
EE FTP-1225	Field Demobilization Checklist for Investigative Derived Waste, Revision 1, 12/31/20	Leidos	Varies	No
EE FTP-1220	Documenting and Controlling Field Changes to Approved Work Plans, Revision 1, 12/31/20	Leidos	Varies	No
EHS 33.0	Subsurface Asset and Hazard Avoidance, 2/17	Leidos	Varies	No

EE = Energy and Environmental
 EHS = Environmental Health and Safety
 FTP = Field Technical Procedure
 GPS = Global Positioning System
 PID = Photoionization Detector

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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
PID	Screening during drilling and soil 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
Drilling equipment emergency stop	Testing functionality of emergency shut off switches	N/A	Leidos Field Manager	Daily	Emergency stop functions correctly	Place equipment out of service until repaired

EE = Energy and Environment
 FTP = Field Technical Procedure
 N/A = Not Applicable
 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?
WI10928	Microwave Extraction by Method 3546 for Semivolatiles, Version 14, effective 04/15/2022	N/A	Solvent extraction	N/A	ELLE	No
WI9252	Parent and Alkyl Substituted PAHs and Geochemical Biomarkers by 8270C/D/E SIM by GC/MS, Version 9, effective 11/16/2020	Definitive	Solid PAHs	GC/MS	ELLE	No
WI18636	Sample Prep of Sediments, Sludges, Soils, and Tissues by SW846 3050B for ICP and ICP/MS. Version 27, effective 7/1/2022	N/A	Acid digestion	N/A	ELLE	No
WI11933	Metals by ICP/MS by Methods SW-846 6020/6020A/6020B (waters, solid, tissue) and USEPA 200.8 (waters), Version 13, effective 07/27/2022	Definitive	Solid metals	ICP/MS	ELLE	No

ELLE = Eurofins Lancaster Laboratories Environmental, LLC

GC/MS = Gas Chromatography/Mass Spectrometry

ICP = Inductively Coupled Plasma

ICP/MS = Inductively Coupled Plasma/Mass Spectrometry

N/A = Not Applicable

PAH = Polycyclic Aromatic Hydrocarbon

QSM = Quality Systems Manual

SIM = Selected Ion Monitoring

SOP = Standard Operating Procedure

USEPA = U.S. Environmental Protection Agency

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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	SOP Reference
GC/MS	Tune check of mass spectral ion intensities using DFTPP	Prior to ICAL and at the beginning of each 12-hour period.	Refer to method/SOP for specific ion criteria.	Retune instrument and verify.	ELLE analyst	SW-846 8270C/D/E SIM/ WI9252
	Performance check SVOC only	At the beginning of each 12-hour period, prior to sample analysis.	Degradation $\leq 20\%$ for DDT. Benzidine and pentachlorophenol present at their normal responses and tailing factor for each < 2 .	Correct problem (inspect/change liner, clip front end of column, or other maintenance as indicated), then repeat the performance check.	ELLE analyst	SW-846 8270C/D/E SIM/ WI9252
	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 $\leq 15\%$ Option 2: Linear least squares regression for each analyte: $r^2 \geq 0.99$ Option 3: Non-linear least squares regression (quadratic) for each analyte: $r^2 \geq 0.99$. 6 levels required.	Verify standard solutions still valid, perform instrument maintenance as needed, then repeat the ICAL.	ELLE analyst	SW-846 8270C/D/E SIM/ WI9252
	Second source ICV	Second source standard once after each ICAL, prior to sample analysis.	All reported analytes within $\pm 20\%$ of true value.	Correct problem and verify second source standard. Rerun verification. If still fails, repeat initial calibration.	ELLE analyst	SW-846 8270C/D/E SIM/ WI9252
	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	ELLE analyst	SW-846 8270C/D/E SIM/ WI9252

QAPP Worksheet #24 – Analytical Instrument Calibration (Continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
	CCV	Daily, prior to sample analysis, after every 12 hours of analysis time, and at the end of the analytical batch.	Opening CCV: All reported analytes and surrogates within $\pm 20\%$ of true value. Closing CCV: All reported analytes and surrogates within $\pm 50\%$ of true value.	Evaluate failure and impact on samples. If samples non-detect for analytes that have a high bias, report non-detect results with case narrative comment. For closing CCVs, if chemicals are not identified as critical COCs, report results with qualifiers. For closing CCVs, if the chemicals are identified as COCs, then recalibrate and reanalyze all affected samples since the last in control CCV. <i>or</i> Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s), recalibrate, and then reanalyze all affected samples since the last in control CCV.	ELLE analyst	SW-846 8270C/D/E SIM/ WI9252
	IS	Every standard, blank, field sample, and QC sample.	Retention time within ± 30 seconds from retention time of the midpoint standard in the ICAL. EICP area within -50 to +100% of ICAL midpoint standard.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.	ELLE analyst	SW-846 8270C/D/E SIM/ WI9252

QAPP Worksheet #24 – Analytical Instrument Calibration (Continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
ICP/MS	Tuning	Prior to ICAL.	Mass calibration < 0.1 amu from the true value. Resolution <0.9 amu full width at 10% peak height. %RSD <5 for masses used for tuning.	Retune instrument and verify. No samples will be analyzed without a valid tune.	ELLE analyst	WI11933 and/or WI21590
ICP/MS	ICAL Minimum of one high standard and a calibration blank	Daily, prior to sample analysis.	Passing ICV and ICB.	Recalibrate, perform instrument maintenance if calibration cannot conform to criteria, recalibrate.	ELLE analyst	WI11933 and/or WI21590
ICP/MS	ICV	Second source standard immediately following ICAL.	All reported analytes $\pm 10\%$ of expected value.	Correct any problems and rerun ICV. If that fails, correct problem and repeat ICAL. No samples will be analyzed until the second-source calibration verification is successful.	ELLE analyst	WI11933 and/or WI21590
ICP/MS	LLC check standard	At the beginning of each run.	All reported analytes must be within $\pm 20\%$ of expected value.	Correct any problems, then reanalyze or repeat ICAL. Results cannot be reported without a valid LLC check standard.	ELLE analyst	WI11933 and/or WI21590
ICP/MS	ICS	At the beginning of each run immediately following the LLC.	ICS-A: Absolute value of concentration for all non-spiked project analytes < $\frac{1}{2}$ LOQ (unless they are a verified trace impurity from one of the spiked analytes). ICS-AB: Within +20% of true value.	Terminate analysis; locate and correct problem; reanalyze ICS, reanalyze all samples.	ELLE analyst	WI11933 and/or WI21590

QAPP Worksheet #24 – Analytical Instrument Calibration (Continued)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
ICP/MS	CCV	After every 10 field samples and at the end of the sequence.	All reported analytes $\pm 10\%$ of expected value.	Evaluate failure and impact on samples. If samples non-detect for analytes that have a high bias, report non-detect results with case narrative comment with written approval from the client. <i>or</i> 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.	ELLE analyst	WI11933 and/or WI21590
ICP/MS	ICB and CCB	Before analyzing samples, after every 10 field samples, and at the end of the analysis sequence.	No analytes detected $> \frac{1}{2}$ LOQ or $\frac{1}{10}$ the amount measured in any sample or $\frac{1}{10}$ the regulatory limit, whichever is greater.	Correct any problems and repeat ICAL. All samples following the last in control calibration blank must be reanalyzed. CCB failures due to carryover may not require an ICAL.	ELLE analyst	WI11933 and/or WI21590

amu = Atomic Mass Unit
 CCB = Continuing Calibration Blank
 CCV = Continuing Calibration Verification
 COC = Chemical of Concern
 DFTTP = Decafluorotriphenylphosphine
 DDT = Dichlorodiphenyltrichloroethane
 EICP = Extracted Ion Current Profile
 ELLE = Eurofins Lancaster Laboratories Environmental, LLC
 GC = Gas Chromatograph

GC/MS = Gas Chromatography/Mass Spectrometry
 ICAL = Initial Calibration
 ICB = Initial Calibration Blank
 ICP/MS = Inductively Coupled Plasma Mass Spectrometry
 ICV = Initial Calibration Verification
 ICS = Interference Check Standard
 IS = Internal Standard
 LLC = Low-Level Calibration

LOQ = Level of Quantitation
 N/A = Not Applicable
 QC = Quality Control
 r^2 = Coefficient of Determination
 RSD = Relative Standard Deviation
 SIM = Selected Ion Monitoring
 SOP = Standard Operating Procedure
 SVOC = Semivolatile Organic Compound

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 (Semivolatiles)	Replace sleeve, septum, split-less disc, and syringe; clip guard column; clean sources; maintain vacuum pumps	CCV and DFTPP per 12-hour tune period	Instrument performance and sensitivity	Daily routine maintenance (injection port); as needed for other components	Initial calibration or continuing calibration verification passes method criteria	Re-inspect injector port, cut additional column, reanalyze CCV, recalibrate instrument	Analyst	WI9598
ICP/MS (Metals)	Replace disposables, clean/change nebulizer, torch, and cones	Tuning	Instrument performance and sensitivity	As needed	Tune and CCV pass criteria	Recalibrate	Analyst	WI11933, WI21590

CCV = Continuing Calibration Verification

GC/MS = Gas Chromatograph/Mass Spectrophotometer

ICP/MS = Inductively Coupled Plasma/Mass Spectrometry

SOP = Standard Operating Procedure

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

Sampling Organization: Leidos

Laboratories: ELLE

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	Standard Operating Procedure 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

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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 B (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 date and time of receipt will be completed in the appropriate spaces on the CoC record. This will complete the sample transfer.

LABORATORY SAMPLE CUSTODY PROCEDURES (RECEIPT OF SAMPLES, ARCHIVING, AND DISPOSAL)

When the samples are delivered to the laboratory, signatures of the laboratory personnel receiving the samples and the courier personnel relinquishing them will be completed in the appropriate spaces on the CoC record, unless the courier is a commercial carrier. 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 (UFP-QAPP 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 (Appendix B).

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

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

Matrix: Solid

Analytical Group: Low-Level PAHs

Concentration Level: Low to High

Analytical Method/Standard Operating Procedure Reference: Parent and Alkyl Substituted PAHs and Geochemical Biomarkers by 8270C/D/E SIM by GC/MS/WI9252

Analytical Organization: ELLE

QC Sample	Frequency/Number	QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Field Duplicate	One per 10 samples.	See Worksheet #12	No corrective action is taken on field duplicate data alone. Assess data and determine if resampling is required.	Leidos QA Officer	See Worksheet #12
Method Blank	One per prep batch of 20 or fewer samples of similar matrix.	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 10 samples.	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
IS	Each calibration standard, sample, and QC sample.	See Worksheet #12	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning in accordance with DoD QSM requirements. If field samples still outside criteria, qualify data and explain in case narrative.	Analyst/Section Supervisor	RT ± 30 seconds and EICP area within -50% to +100% of ICAL midpoint standard
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, re-extract and reanalyze.	Analyst/Section 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
MS/MSD	One per prep batch of 20 or fewer samples of similar matrix.	See Worksheet #12	No corrective action based on MS data alone; contact Leidos QA Officer for instruction.	Analyst/Supervisor	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. If LCS has high bias and samples are non-detect, report with case narrative comment. If LCS has low bias or if critical COCs are detected, evaluate and reprep and reanalyze the LCS and all samples in the associated prep batch for failed analytes, if sufficient sample material is available.	Analyst/Supervisor	See Worksheet #12

COC = Chemical of Concern

DI = Deionized

DoD = U.S. Department of Defense

ELLE = Eurofins Lancaster Laboratories Environmental, LLC

EICP = Extracted Ion Current Profile

GC = Gas Chromatograph

GC/MS = Gas Chromatography/Mass Spectrometry

ICAL = Internal Calibration

IS = Internal Standard

LCS = Laboratory Control Sample

MS = Matrix Spike

MSD = Matrix Spike Duplicate

PAH = Polycyclic Aromatic Hydrocarbon

QA = Quality Assurance

QC = Quality Control

QSM = Quality Systems Manual

RT = Retention Time

SIM = Selected Ion Monitoring

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, APP)	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 Reports/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.

APP = Accident Prevention Plan

DUA = Data Usability Assessment

EDD = Electronic Data Deliverable

QA = Quality Assurance

QC = Quality Control

REIMS = Ravenna Environmental Information Management System

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	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 Log 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	Field 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	Field 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

FPPRR = Field Project Planning Readiness Review

H&S = Health and Safety

QA = Quality Assurance

SSHO = Site Safety and 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 Work Plan Addendum	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	
Other			
29	Laboratory QA surveillance findings (if applicable)	X	X

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

Note: Leidos SOPs and ELLE SOPs are provided in Appendix B.

*Leidos will evaluate the laboratory data using criteria taken from the DoD Validation Guidelines Modules 1 and 5 (DoD 2020, DoD 2022).

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; see Worksheets #26 and #27	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 – ELLE Project Manager or designee Upon receipt of Laboratory Sample Receipt Confirmation – Leidos Data Validation Staff
Laboratory data package	UFP-QAPP ELLE 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: <ul style="list-style-type: none"> • 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) • Post spike sample results (if applicable) • LCS/LCSD summaries, as applicable • Instrument • Initial and continuing calibration summaries, including ISC • 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)	ELLE Quality Manual Leidos SOPs: Control of Nonconforming Items; EE A15.1; Revision 1; December 31, 2020. Nonconformance and Corrective Action; EE 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 ELLE Project Manager or designee

Note: Leidos SOPs and ELLE SOPs are provided in Appendix B.

CoC = Chain-of-Custody

EE = Energy and Environmental

ELLE = Eurofins Lancaster Laboratories Environmental, LLC

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	PAH – SW846 8270E SIM Metals – SW6020B
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% will undergo Stage 2B validation, and 10% will undergo Stage 4 validation by a third-party contractor.
Percent of raw data reviewed	10%.
Percent of results to be recalculated	10% 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

LOD = Limit of Detection

LOQ = Limit of Quantitation

PAH = Polycyclic Aromatic Hydrocarbon

PDF = Portable Document File

QA = Quality Assurance

QC = Quality Control

QSM = Quality Systems Manual

RI = Remedial Investigation

SIM = Selected Ion Monitoring

UFP-QAPP = Uniform Federal Policy-Quality Assurance Project Plan

USEPA = U.S. Environmental Protection Agency

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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 DLs, LODs, LOQs, and CUGs 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 evaluated 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 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.

CUG = Cleanup Goal
DL = Detection Limit
DUA = Data Usability Assessment
LCS = Laboratory Control Sample
LCSD = Laboratory Control Sample Duplicate
LOD = Limit of Detection
LOQ = Limit of Quantitation
MS = Matrix Spike
MSD = Matrix Spike Duplicate
QC = Quality Control
RPD = Relative Percent Difference
UFP-QAPP = Uniform Federal Policy-Quality Assurance Project Plan

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APPENDIX A

UTILITY CLEARANCE PROCEDURES

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A. Utility Clearance Procedures

Prior to all subsurface activities, contractors must notify and coordinate a utility clearance with the Ohio Army National Guard (OHARNG) Environmental Specialist. While most active Camp James A. Garfield (CJAG) utilities are outside Comprehensive Environmental Response, Compensation, and Liability Act areas of concern, utility clearances are required to ensure that subsurface activities will not damage or otherwise affect operational facility utilities or personnel safety. A request for utility clearance will be submitted to the OHARNG Environmental Specialist 10 business days prior to subsurface activities onsite. The request must describe and illustrate sample locations and activities to be performed so utilities can be adequately marked or cleared. OHARNG will provide the utility clearance as the Ohio Utility Protection Service one-call system is not currently active onsite. In addition, contractors are required to have a third party complete a utility clearance for the designated work areas. If a utility (known or unknown) is discovered (damaged or undamaged) during field activities, work will be stopped immediately and the OHARNG Environmental Specialist, U.S. Army Corps of Engineer (USACE) Contracting Officer's Representative (COR), and Army National Guard (ARNG) Restoration Program Manager will be notified. The OHARNG Environmental Specialist is responsible for coordinating further clearance of the discovered utility. Work will not recommence until the status of the utility (i.e., live, abandoned) has been determined.

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APPENDIX B

STANDARD OPERATING PROCEDURES

- B.1 – Leidos SOPs
- B.2 – Laboratory SOPs

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B.1 – Leidos SOPs

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ENERGY & ENVIRONMENTAL DIVISION

STANDARD OPERATING PROCEDURE

GPS Data Collection

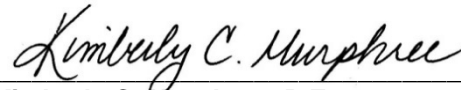
E&E FTP-180, Revision 1

Effective 31 Dec 2020

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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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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/ga> 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

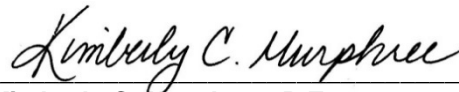
Equipment Decontamination E&E FTP-400, Revision 1

Effective 31 Dec 2020

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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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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	<ul style="list-style-type: none"> • 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.).	<ul style="list-style-type: none"> • Ambient air thermometers • Emergency equipment • Field support equipment

Category	Definition	Type of Decon	Example(s)
2	<ul style="list-style-type: none"> 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.	<ul style="list-style-type: none"> Flow meter used in conjunction with surface water sampling
3	<ul style="list-style-type: none"> 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.	<ul style="list-style-type: none"> 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.

ENERGY & ENVIRONMENTAL DIVISION

STANDARD OPERATING PROCEDURE

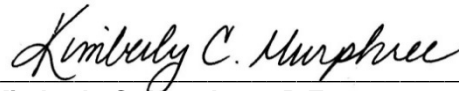
Soil Sampling E&E FTP-525, Revision 1

Effective 31 Dec 2020

A handwritten signature in blue ink, appearing to read "M.D. Simms".

Approved By: _____

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

A handwritten signature in black ink, appearing to read "Kimberly C. Murphree".

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

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1. PURPOSE

This Standard Operating Procedure (SOP) establishes methods for obtaining soil, or sediment samples for chemical and/or physical analysis to evaluate surface and subsurface conditions.

1.1 Scope and Limitations

This procedure applies to samples collected from soil or similar matrices using a spade, scoop, or hand auger by Leidos Energy & Environmental (E&E) Division personnel or subcontractors. Techniques are also included that cover collection of samples from areas with standing water.

The methods described in this procedure provide a disturbed sample and apply to a wide variety of soil and sediment types ranging from gravel and sands to silts and clays. This procedure also provides general guidance on the use of other sample tools that may be employed to collect both soil and sediment samples.

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.

- ASTM D1452 / D1452M-16, *Standard Practice for Soil Exploration and Sampling by Auger Borings*
- ASTM D6282 / D6282M-14, *Standard Guide for Direct Push Soil Sampling for Environmental Site Characterizations*

1.3 Definitions / Acronyms

Depth Interval – The defined zone from which a sample is collected. The depth interval must have a starting value, an ending value and be recorded with units. For example, 2.0 to 4.0 feet below ground surface.

Hand-Operated Auger – A small, lightweight, metal auger. Diameters typically range between 1 and 4 inches. Augers are normally used in conjunction with 2 to 4 foot long metal shafts (extensions) and T-handles.

Homogenization – The mixing or blending of a soil or sediment sample to provide uniform distribution of contaminants. Proper homogenization ensures that portions of the containerized samples are equal or identical in composition and representative of the total soil sample collected.

Motor-Operated Auger – A metal auger attached to a shaft and powered by an internal combustion or electric motor. Augers for sample collection purposes will generally be less than 8 inches in diameter.

Photoionization Detector (PID) – a portable field instrument used for screening soil and atmosphere for volatile organic contamination.

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 one of the other site activity plans.

Sample – The representative portion of a targeted population. This may be an entire drill core that is described for logging purposes or a portion of a core that is collected and submitted for physical and chemical analyses.

Scoop – A shovel-like utensil, usually having a deep curved dish and a short handle.

Spade – A sturdy digging tool having a thick handle and a heavy blade that can be pressed into the ground with the foot.

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).

Site Safety and Health Officer

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

Field Manager (FM)

- Verifying that personnel perform their assigned duties in accordance with this procedure when it is applicable.
- Verifying conformance with the SAP during fieldwork.
- Managing fieldwork.

Field Staff

- Collecting samples in accordance with this procedure.
- Communicating issues encountered with the FM / PM.

3. HEALTH AND SAFETY

Proper personal protective equipment shall be worn at all times when performing field work. Appropriate safety precautions shall be observed when collecting soil samples. 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

- Sampling Equipment
 - Augers (see ASTM D1452 / D1452M-16 for more information about available augers). Examples include:
 - Hand-operated
 - Spiral-type
 - Ship-type
 - Open tubular
 - Orchard-barrel
 - Open spiral
 - Closed spiral
 - Post hole
 - Clam shell
 - Iwan
 - Machine-operated
 - Spade
 - Scoop
 - PVC pipe (schedule 40 minimum thickness)
 - Disposable or Teflon[®] bailers
 - Rope, as applicable
- Sample Containers (new sample containers, appropriate for the matrix and analytical test)
- Field Logbooks/Forms (see E&E FTP-1215 “Field Activity Documentation”)
- Chain of Custody Forms (see E&E FTP-625 “Sample Chain of Custody”)
- Writing utensils (indelible ink, black preferred)
- Decontamination Supplies (see E&E FTP-400 “Equipment Decontamination”)
- Personal Protective Equipment (Refer to the site- or project-specific Health and Safety Plan for relevant requirements.)

5. PROCEDURE

5.1 Overview

A variety of techniques and tools exist for collecting surface and subsurface samples of solid matrices like soils and sediments. These include using scoops, spades or other digging tools to collect surface samples and using augers or other tools to bore into the subsurface to expose the desired sampling interval. The following sections detail procedures to be used for this type of sampling. 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. These procedures may be superseded by more stringent project specific requirements as described in the SAP or other project-specific document.

Sampling tools and equipment must be decontaminated and protected from sources of contamination prior to and between sampling, as specified in E&E FTP-400 "Equipment Decontamination".

Auger coatings such as chrome, paint, or other materials, with the exception of Teflon[®], must be removed prior to use to prevent sample contamination. Stainless steel is preferred.

Spades or scoops must be either stainless steel or Teflon[®]-coated. Spades with chrome or other materials shall not be used as these materials may contaminate the sample. As an exception, disposable scoops may be used, if appropriate, for specified media and analytical parameters, in accordance with the SAP.

Care must be employed to avoid cross-contamination between sampling intervals and locations. Sample collection activities must be planned so they progress from areas suspected of the least contamination to areas of the highest suspected contamination. Background or uncontaminated samples must be collected, handled, and stored separately from samples that appear to be highly contaminated. Decontaminated or new disposable sampling equipment and new, disposable gloves shall be used for each sample taken. New gloves must be donned just prior to sample collection.

5.1.1 Collection of Material for Volatile Organics Analysis

Samples to be analyzed for volatile organics must be collected in a manner that minimizes disturbance to the sample. Samples for volatile organic analysis must not be homogenized. The appropriate aliquot (sample interval) specified in the SAP must be identified immediately after removing the sample from the ground and collected directly from the sample tool if possible. The subsample should be collected using an appropriate SW-846 Method 5035 compatible technique. The method should be consulted for additional details. Appropriate sample collection techniques include the use of a coring device (e.g., a Terra Core[®] transfer tool or a cut-off syringe) and direct transfer to a suitably preserved VOA vial where applicable (sodium bisulfate solution or methanol); or the use of an EnCore[®] sampling/storage tool or another technique as specified in the SAP.

5.1.2 Sample Homogenization

Samples collected for the analysis of parameters other than volatile organics must be homogenized before being separated into the various sample containers so that a subsample representative of the desired interval is provided. Samples shall be manually homogenized using a decontaminated stainless steel spoon or scoop and a stainless steel bucket or bowl. A disposable scoop and pan may also be used. Care must be taken to ensure that the soil is mixed or blended thoroughly to ensure the sample has a uniform distribution of contaminants.

5.2 Sample Collection

The following steps are applicable to all sampling techniques:

1. Don new gloves and use a stainless steel spade, or other approved utensil to remove surface vegetation and debris from the immediate area around the sampling point

2. Place plastic sheeting around the work area, as necessary, to prevent equipment from coming in contact with potentially contaminated surfaces and to prevent the transfer of contaminated materials to uncontaminated areas.
3. Record the appropriate information and observations about the sample location in the field logbook. See E&E FTP-1215 "Field Activity Documentation" for details.
4. Select the appropriate soil sampling technique from the following sections and collect representative sample material.
5. Preserve, label and prepare the sample for shipment in accordance with E&E FTP-650 "Labeling, Packaging and Shipping Environmental Field Samples". This step includes completing the field logbook entries and COC forms. Details are included in E&E FTP-625 "Sample Chain of Custody".
6. After drilling and sampling activities have been completed, boreholes shall be abandoned according to procedures described in the SAP. Borehole abandonment shall be compliant with applicable state regulations. Excavated materials must be handled in accordance with the waste management plan.

5.2.1 Soil Sampling Using a Spade or Scoop

1. Don new gloves and use a decontaminated stainless steel spade to remove soil down to the required sample interval.
2. Use a separate decontaminated scoop to remove a thin layer, if necessary, of soil that may have been in contact with the spade used in step 1 and discard this material.
3. Use a separate decontaminated scoop to obtain the appropriate volume of sample and place it on new aluminum foil or in a decontaminated stainless steel bowl on a polyethylene sheet or other appropriate material to help control the sample material and prevent potential sources of cross-contamination.
4. If volatile organic compound analysis is required, immediately transfer required portions to the appropriate sample container, avoiding large rock or other organic materials (i.e., roots, twigs, insects, worms, etc.), unless otherwise specified in the SAP. The portion suspected of the highest volatile organic contamination should be selected.
5. Use the spade or scoop to remove and discard large rocks or other organic materials (i.e., roots, twigs, insects, worms, etc.) from the remaining sample material and homogenize thoroughly, in accordance with the SAP, to provide samples representative of the entire interval.
6. Fill additional sample containers as required using appropriate, decontaminated equipment.

5.2.2 Soil Sampling Using an Auger

The use of a hand auger is typically limited to depths of 6 feet below ground surface; it is also used to clear down to 6 feet prior to subsurface drilling. The use of a hand auger can be restricted in dense clay or rocky soils.

1. Don clean gloves and assemble a decontaminated auger, extension, and T-handle, as required.
2. Advance the auger into the soil until the auger bucket is full.
3. Withdraw the auger carefully from the boring.
4. If a sample is not desired from the first interval, remove the soil from the auger bucket, discard and repeat steps 2 – 4, as required, to reach the desired sample interval. If a sample is to be taken in the next interval, replace the auger bucket with a decontaminated one prior to advancing into the sample interval. A decontaminated auger bucket must be used for each sample interval required.
5. After filling the auger bucket from the desired sample interval, use a decontaminated stainless steel scoop or other approved utensil to remove soil from the bucket. Place the sample on new aluminum foil or in a decontaminated stainless steel bowl on a polyethylene sheet (or other appropriate material) to control the sample material and prevent potential sources of cross-contamination. Remove material starting approximately two to three inches below the top of the auger bucket. Discard the material above this point. Additionally, the outside layer of the sample core should be removed using a stainless steel knife to further eliminate possible sources of contamination.
6. If volatile organic compound analysis is required, immediately transfer required portions to the appropriate sample container, avoiding large rocks or other organic materials (i.e., roots, twigs, insects, worms, etc.), unless otherwise specified in the SAP. The sample interval suspected of the highest VOC contamination should be selected (as indicated via a PID detector or other field screening tool, or visual observation of staining, oily material, etc.)
7. Use the spade or scoop to remove and discard large rocks or other organic materials (i.e., roots, twigs, insects, worms, etc.) from the remaining sample material unless otherwise specified in the SAP and homogenize thoroughly, in accordance with the SAP, to provide samples representative of the entire interval.
8. Fill additional sample containers as required using appropriate, decontaminated equipment.

5.2.3 Soil/Sediment Sampling in Standing Water

The details below are intended for use when the collection of a soil or sediment sample while limiting contact with overlying surface water is required. The methods described herein may not fully prevent contact with surface water in all soil conditions (such as gravelly or rocky soil).

The methods described can be used for standing water depths ranging from several inches to 20+ feet. These methods can be conducted from a boat or other floating platform subject to appropriate risk approval and health & safety requirements.

1. Once the sample location is determined, install a section of decontaminated PVC pipe by hammering the upright pipe into the soil while keeping the pipe as close to vertical as possible. The PVC pipe should be of sufficient length so that the top of

the pipe will remain above the level of the standing water after installation and should be of sufficient diameter to allow for the insertion and free movement of the auger to be used for sampling. A block of untreated wood may be used between the top of the pipe and the hammer to prevent damage to the pipe. A length of rope may be attached to the mid-section of the PVC pipe to ease removal when sampling is completed.

2. The pipe should be advanced to a depth sufficient to allow the pipe to form a seal with the surrounding soil in order to minimize the infiltration of standing water.
3. Standing water remaining inside the PVC pipe should be removed prior to augering by using a new or decontaminated bailer. If water continues to infiltrate into the PVC pipe during bailing, reposition the pipe or advance it deeper until an appropriate seal is achieved.
4. Follow the steps detailed in Section 5.2.2 to collect the necessary sample. Care must be taken not to disturb the PVC pipe and the surrounding soil.
5. Remove the PVC pipe and abandon the borehole per Section 5.2, step 6 above.

5.2.4 Subsurface Soil Sampling

When soil samples are to be collected from depths greater than 6 feet below ground surface, soil samplers should be advanced using drilling equipment. For subsurface soil samples to be collected using direct push sampling, a licensed, qualified driller must be used. Direct push soil sampling consists of advancing a sampling device into subsurface soils by applying static pressure, impact, vibration, or any combination thereof, to the above ground portion of the sampler extensions until the sampling device has been advanced to the desired depth. The sampling device is recovered from the borehole and the sample extracted. The sampling device is cleaned and the procedure is repeated for the next desired interval. Sampling can be continuous for full depth borehole logging or incremental for specific interval sampling. Once the sample interval of interest is obtained, the sample is homogenized (after the collection of an aliquot for VOCs, if required) and placed into appropriate sample containers.

5.2.5 Composite Samples

Compositing is the process of physically combining and homogenizing two or more spatially discrete samples. The composite is treated as a single sample to provide for an average concentration over multiple sampling points. Composite sampling is typically conducted at the beginning of field activities to locate the general areas of contamination without having to analyze a large number of samples. Review E&E FTP-691 "Composite Procedures" for details.

6. QUALITY ASSURANCE / QUALITY CONTROL

Field sampling quality control generally includes the collection of field duplicate samples and equipment rinsate blanks at a frequency specified in the SAP. Refer to the SAP for project-specific details and requirements.

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 Samples
- E&E FTP-691, Composite Procedures
- 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 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 1.1 – 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

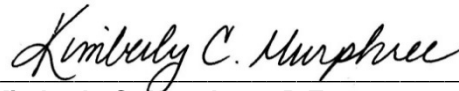
Sample Chain of Custody E&E FTP-625, Revision 1.1

Effective 31 Dec 2020

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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)

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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/ga> 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.

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ENERGY & ENVIRONMENTAL DIVISION

STANDARD OPERATING PROCEDURE

Labeling, Packaging, and Shipping Environmental Samples

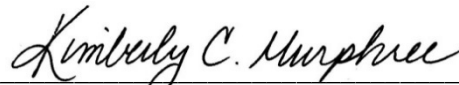
E&E FTP-650, Revision 1

Effective 31 Dec 2020

A handwritten signature in blue ink, appearing to read "M.D. Simms".

Approved By: _____

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

A handwritten signature in blue ink, appearing to read "Kimberly C. Murphree".

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

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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

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

DOT – Department of Transportation

Environmental Sample – A sample of material that is collected from an environmental source.

Hazardous Material – 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.

IATA – International Air Transport Association

Limited Quantity (Radionuclides) – 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 repellent, 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.

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ENERGY & ENVIRONMENTAL DIVISION

STANDARD OPERATING PROCEDURE

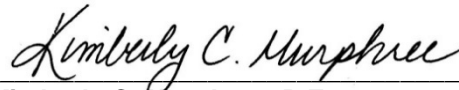
Composite Procedures E&E FTP-691, Revision 1

Effective 31 Dec 2020

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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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1. PURPOSE

This Standard Operating Procedure (SOP) establishes the methods that may be used for field compositing of samples.

1.1 Scope and Limitations

This procedure applies to field compositing, according to sample matrix, performed or directed by the Leidos Energy & Environmental (E&E) Division.

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

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

Aliquot – A portion of the whole.

Composite – A sample composed of two or more discrete aliquots. A composite sample is prepared by combining two or more samples having the same specific relationship and processed to achieve homogeneity.

Homogenize – To blend or combine like materials into a uniform mixture.

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 one of the other site activity plans.

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

- 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.
- Authorizing and documenting deviations from specified requirements.

Field Manager

- Verifying that field personnel perform assigned duties in accordance with this procedure when applicable.
- Verifying compliance with the Sampling and Analysis Plan (SAP).
- Overall management of field activities.

- Determining which method will be used for composite sampling if not specified in the SAP or other project-specific plan.
- Verifying that samples are compatible before compositing occurs (i.e., mixing will not produce effects which are harmful to human health or the environment) and are collected uniformly.

Site Safety and Health Officer

- Providing guidance on and answering questions about health and safety requirements.

Field Staff

- Conducting applicable work in accordance with this procedure and applicable site-specific documents.

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. Health and safety questions shall be directed to the Site Safety and Health Officer and/or the Field Manager.

4. EQUIPMENT AND SUPPLIES

This list includes typical equipment and supplies necessary for sampling and compositing activities. Refer to the site- or project-specific SAP for specific details regarding required equipment and supplies.

- Chain of Custody forms (See E&E FTP-625 “Sample Chain of Custody”)
- Decontamination equipment (see E&E FTP-400 “Equipment Decontamination”)
- Field Logbook/Field Forms (see E&E FTP-1215 “Field Activity Documentation”)
- Labels
- Paper towels
- Personal Protective Equipment, including but not limited to, safety glasses, gloves, and safety shoes. Refer to the site- or project-specific Health and Safety Plan for specific requirements.
- Plastic sheeting
- Sample collection devices (e.g., auger, grab sampler, core sleeve)
- Stainless steel or glass bowl(s)
- Stainless steel spoon(s) (Teflon[®]-coated if needed)
- Sample containers (appropriate for the media sampled)
- Tape
- Waste container(s)
- Writing Utensil (indelible ink, black preferred)

5. PROCEDURE

5.1 Overview

Compositing is the process of physically combining and homogenizing individual aliquots of discreet samples into a single composite sample. Compositing provides for an average concentration of contaminants over a certain number of sample points, which reduces both the number of required laboratory analyses and the sample variability. Composite sampling is typically conducted at the beginning of field activities to locate the general areas of contamination without having to analyze a large number of samples. Composite sampling also has the advantage for some applications (e.g., flow-based systems) due to the ability to take into account changes in flow and other characteristics of the system over time. The rationale for obtaining composite samples, as well as the method used to ensure data comparability, should be fully documented in the project SAP or other appropriate governing document. Chain of custody forms and logbooks should accurately reflect information regarding composited samples.

There are limitations to compositing samples.

- The potential for hotspots to remain undiscovered is a particular limitation to compositing soil samples. In addition, the analysis of composite samples impacts sensitivity based on the dilution impact of combining two or more discreet samples. Therefore, composite soil sampling is not typically used for site-specific health and ecological risk assessments or for quantitative assessments of site contamination.
- Composite soil sampling is not typically used for assessing volatile or semi-volatile compounds due to the nature of the compositing techniques and its potential effect on analytical results. Care should be taken to ensure the integrity of the target analytes of any sample matrix are not compromised during the homogenization and compositing process.
- Time-weighted composite samples are not suitable when parameters with short holding times are required.
- Some samples are difficult to homogenize and will require extra caution and technique (e.g., discrete samples of soil with high clay content).

During a sampling event, anomalous or suspected highly contaminated samples must be brought to the attention of the Field Manager prior to compositing samples. These samples may require special treatment or notation.

Care must be taken to verify that materials to be composited are compatible. Many hazardous wastes, when mixed with other wastes or materials, can produce effects that are harmful to human health and the environment (e.g., heat or pressure, fire or explosion, violent reaction, toxic dusts, fumes or gases).

Specific compositing and homogenization techniques to be used on a project shall be defined in the SAP or other project-specific document. Refer to the site- or project-specific SAP for relevant requirements. Deviations from specified field requirements will be justified to and authorized by the Project Manager and/or the relevant Program Manager.

Deviations from requirements will be sufficiently documented to allow recreation of the modified process, if necessary.

Sampling tools, instruments, and equipment must be protected from sources of contamination prior to use and decontaminated after use as specified in E&E FTP-400 "Equipment Decontamination."

Composite samples must be packaged, labeled, and prepared for shipment in accordance with E&E FTP-650 "Labeling, Packaging, and Shipping Environmental Samples."

Field logbook and chain-of-custody forms must be completed in accordance with procedures E&E FTP-1215 "Field Documentation" and E&E FTP-625 "Sample Chain of Custody."

5.2 Compositing Discharge Water

Discharge water composite samples may be a time-proportional composite or a flow-proportional composite.

Time-Proportional Composite

- Interval time and sample volume are constant.
- Time-proportional samples are typically obtained via continuous or automatic sampling devices, but may be grab collected as long as interval time and sample volume are constant.

Flow-Proportional Composite

- Interval time or sample volume may vary.
 - Collect a constant sample volume with the time intervals between samples proportional to the flow rate; or,
 - Collect samples with an equal time interval between samples with the sample volume proportional to the flow rate.
- Samples may be continuous or grab collected and long as appropriate sampling parameters (volume and time) are maintained proportional to the flow rate.

Detailed information regarding the compositing method used, including the flow rates, times, and volumes of samples obtained must be recorded in the field logbook.

5.3 Compositing Solid Material

Solid aliquots must be homogenized and of equal proportion before compositing. The solid material must be composited in a stainless steel or glass bowl with a stainless steel spoon. Teflon®-coated spoons or scoops may be required for samples collected for trace metals analyses. Mixing must be thorough to ensure the composite sample is homogenized prior to transfer into the appropriate sample container.

- Soil aliquots obtained for compositing should be collected from the same soil horizon and depth interval and should be of similar characteristics (e.g., particle size and soil type).

- Waste materials must be determined to be compatible before compositing is performed. Care should be taken to avoid mixing hazardous waste with non-hazardous waste.

Detailed information regarding the original location of solid aliquots used to create a composite sample must be recorded in the field logbook.

6. QUALITY ASSURANCE / QUALITY CONTROL

Care must be taken at all times to ensure proper preservation requirements are maintained for composite samples and that hold times are monitored.

The compositing technique used must be recorded in the field logbook as well as detailed information on the discreet samples that were composited.

7. RECORDS

Documentation generated as a result of this procedure must be 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-400, Equipment Decontamination
- 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-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_manualpdf.

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.

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ENERGY & ENVIRONMENTAL DIVISION

STANDARD OPERATING PROCEDURE

Field Measurement Procedures

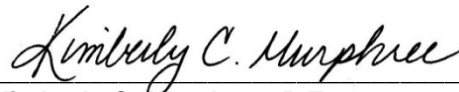
E&E FTP-750, Revision 1

Effective 31 Dec 2020

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Approved By: _____

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

A handwritten signature in blue ink, appearing to read "Kimberly C. Murphree".

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

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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 drying 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 defensible 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/ga> 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

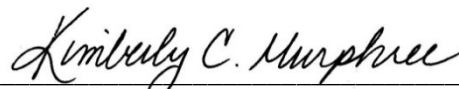
Field Activity Documentation E&E FTP-1215, Revision 2

Effective 31 Dec 2020

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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)

ATTACHMENT 1 - Applicable Logbook Entries..... 7

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.

ENERGY & ENVIRONMENTAL DIVISION

STANDARD OPERATING PROCEDURE

Documenting and Controlling Field Changes to Approved Work Plans

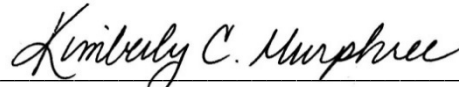
E&E FTP-1220, Revision 1

Effective 31 Dec 2020

A handwritten signature in blue ink, appearing to read "M.D. Simms".

Approved By: _____

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

A handwritten signature in blue ink, appearing to read "Kimberly C. Murphree".

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

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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/ga> 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:	<input type="checkbox"/> Cost <input type="checkbox"/> Scope <input type="checkbox"/> Milestone <input type="checkbox"/> 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:	<input type="checkbox"/> Yes <input type="checkbox"/> 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	Status¹	Document Affected²	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.



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ENERGY & ENVIRONMENTAL DIVISION

STANDARD OPERATING PROCEDURE

Field Demobilization Checklist for Investigative Derived Waste

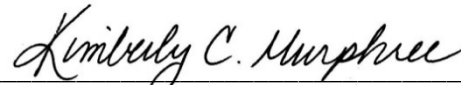
E&E FTP-1225, Revision 1

Effective 31 Dec 2020

A handwritten signature in blue ink, appearing to read "M.D. Simms".

Approved By: _____

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

A handwritten signature in black ink, appearing to read "Kimberly C. Murphree".

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

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ATTACHMENT(S)

**ATTACHMENT 1 - Field Demobilization Checklist for Investigative Derived
Waste (Example) 5**

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/ga> 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? <i>Note: If no, skip to Section B. If yes, continue with Section A.</i>						
2. Have known regulated wastes been transferred to the client (with transfer documented) or properly disposed offsite? <i>Note: Regulated waste must be transferred to the client's custody within three days of collection.</i>						
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? <i>Note: If no, skip to Section C. If yes, continue with Section B.</i>						
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: <i>General rule of thumb for waste water is the headspace should be approximately 10% of the container volume.</i>						
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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B.2 – Laboratory SOPs

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Mercury in Aqueous, Solid and Tissue Samples by EPA 7471A, 7471B, 7470A, and 245.1 rev 3 by Cold Vapor AA

Document number:
T-MET-WI7965
 Old Reference:
1-P-QM-WI-9015067
 Version:
20
 Approved by: **X6TJ**
 Effective Date: **27-APR-2022**

Document users:
6_EUUSLA_Metals_Hg Analysis, 6_EUUSLA_Metals_Hg Analysis Verifiers, 6_EUUSLA_Metals_Management

Work Instruction

Organisation level:

5-Sub-BU

Responsible:

5_EUUSLA_Metals_Manager

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Revision Log

Revision	20	Effective Date: This Version
Section	Justification	Changes
Revision Log	Formatting requirement	Removed revision logs up to the previous version
Header	Clarification	Update to reflect current company name
	Clarification	Updated to reflect current process
Procedure B.2.c.		
Sample Analysis B. 4. and 6.	Current Process	Updated to reflect current process

Revision	19	Effective Date: Nov 24, 2020
Section	Justification	Changes
Revision Log	Formatting requirement	Removed revision logs up to the previous version
Throughout Document	Current Practice	Updated QC IDs
LIMS ID	New procedure	Added new LIMS method IDs
Cross Reference	Update	Added Do Not Use Form and verification SOP
Basic Principals	Current Process	Updated to reflect current process
Sample Collection, Preservation, and Handling	Method Required	Added information regarding preservation hold time
Apparatus and Equipment	Addition	Added products used for analysis
Reagents and Standards	Clarification	Added note about deviation from method
Calibration	Update	Criteria has been moved to new SOP and removed wording of old LIMS
Procedure	Update/Enhancement	Added direction for new LIMS and feature in Envoy
Sample Analysis	Update	Updated to current practice
Calculations	Enhancement	Add units to water sample
Quality Assurance/Quality Control 2	Update	change to reference Verification SOP
Data Review	Update	Updated to reflect current practice
Instrument Repair and Maintenance	Enhancement	Added Q-EQA-FRM6871

Reference

1. Test Methods for Evaluating Solid Wastes, SW-846 Method 7470A, September 1994
2. Test Methods for Evaluating Solid Wastes, SW-846 Method 7471B, February 2007.
3. Test Methods for Evaluating Solid Wastes, SW-846 Method 7471A, September 1994
4. Method 245.1 (rev. 3), Determination of Mercury in Water by Cold Vapor Atomic Absorption Spectroscopy, USEPA 600/R-94/111 May 1994.
5. *Chemical Hygiene Plan*, current version.

Cross Reference

Document	Document Title
T-MET-WI11948	Preparation of Solids by EPA 7471A or B for Mercury Analysis
T-MET-WI11924	Digestion of Aqueous Samples by SW-846 Method 7470A
T-MET-WI26740	Digestion of Aqueous Samples for Mercury by EPA 245.1
T-MET-WI9084	Preparation of Mercury Solutions and Standards
QA-SOP11178	Demonstrations of Capability
QA-SOP11901	Instrument Maintenance and Calibration
QA-SOP11892	Determining Method Detection Limits and Limits of Quantitation
QA-SOP11896	Establishing Control Limits
QA-SOP11886	Processing Regulatory Compliance (i.e. SDWA, NPDES) Samples
QA-FRM6871	Do Not Use - Environmental
T-MET-WI35797	Metals Data Verification Process

Scope

This method is used for determination of mercury in aqueous and solid samples. The optimum concentration range for this method is 0.2 to 5.0 ppb.

Matrices - EPA 7470A and EPA 245.1 are applicable to water analysis. EPA 7471A and EPA 7471B are applicable to soil and tissue analysis. EPA 245.1 is applicable to drinking water analysis.

Method Detection Limits (MDLs) are based on annual statistical evaluation of laboratory data and are subject to change. The current MDLs and RLs are maintained in the LIMS, and are subject to change without notification.

Basic Principles

The Leeman Labs Mercury Analyzer utilizes continuous flow technology with drying of the sample vapor for the analysis of mercury by automated vapor generation. The reaction for the mercury analysis is a simple reduction reaction. The mercury is reduced with stannous chloride to liberate mercury metal and Tin (IV) chloride. An inert gas is used to sweep the volatile mercury into the absorption cell in the optical path of the atomic absorption spectrophotometer. The dry vapor enters one path of the optical cell, which has been optimized for fast response (small diameter), and sensitivity (long length).

Mercury is measured using a solid state detector with a wide dynamic range and a mercury source that delivers a stable source of emission at 254 nm. The signal is referenced to the simultaneous absorbance of air through direct view of the lamp. The system adds Stannous chloride to the samples via a "Y" connection in the pump tubing. The peristaltic pump then carries the sample/stannous mix to the liquid gas separator. Argon gas is bubbled through the liquid and used to transport the volatile mercury into the detector. The mercury is reduced with stannous chloride to liberate mercury metal and Tin (IV) chloride.

Definitions

1. CRA - Low Level Check Standard
2. MSA – Method of Standard Additions
3. SPLP - Synthetic Precipitation Leaching Procedure
4. TCLP – Toxicity Characteristic Leaching Procedure
5. QC Type Designators:
 - a. BKG – unspiked background sample
 - b. DUP – Sample Duplicate
 - c. MS – sample spike
 - d. MSD – Sample spike duplicate
 - e. MB –Preparation Blank (Water/ Solid). Equivalent to a Method Blank (MB)
 - f. LCS/LCSD - Laboratory Control Sample/Laboratory Control Sample Duplicate

Interferences

Potassium permanganate is added to samples to eliminate possible interference from sulfide. Concentrations as high as 20 mg/L of sulfide as sodium sulfide do not interfere with the recovery of added inorganic mercury from reagent water.

Samples high in chlorides require additional permanganate (as much as 25 mL) because, during the oxidation step, chlorides are converted to free chlorine, which also absorbs radiation of 253.7 nm. Take care to ensure that free chlorine is absent before the mercury is reduced and swept into the cell by using an excess of hydroxylamine sulfate (or chloride) reagent.

Copper has been reported to interfere; however, copper concentrations as high as 10 mg/kg had no effect on recovery of mercury from spiked samples.

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.

Preparing samples for inorganic analysis involves working with concentrated acids and other chemicals which are dangerous if not handled carefully:

Nitric acid (HNO₃) – This acid can cause skin burns. Add nitric acid to samples in a hood to avoid exposure to toxic fumes.

Sulfuric acid (H₂SO₄) – This acid is a strong oxidizing agent and can cause severe burns. Sulfuric acid spills are extremely slippery, adding to the danger. Always use in a fume hood. Never mix with concentrated HCl or concentrated KMNO₄ to avoid a violent reaction (explosive splattering and extreme heat).

Hydrochloric acid (HCl) – This acid can cause skin burns. Never mix HCl with concentrated H₂SO₄ to avoid a violent reaction. Always use in a fume hood.

When diluting strong acids, never add water to acid; always add acid to water.

Store concentrated acids in the prep room acid lockers. Only acids are to be stored in these lockers. (Store solvents in the flammable liquid storage cabinet.) Some concentrated acids are kept in the acid reagent bottles on prep room counters. Fill reagent bottles in an operating fume hood using caution to avoid spills.

Perform acid digestions in hoods that are turned on and have active alarms. Notify a supervisor immediately if the hood is malfunctioning or the alarm sounds. Samples that contain dust may be hazardous. Open in a fume hood.

Samples that may contain cyanide require special precautions to avoid exposure to hydrogen cyanide gas. Contact your supervisor prior to adding acid. Always open these samples and add the acid in a hood.

Use spill pillows to absorb large acid spills (small spills are cleaned with wet paper towels.) Use SPILL-X-A powder or equivalent to neutralize any remaining acid and then rinse the area thoroughly with water.

Dispose of acid waste properly. Collect all acid digestions, waste solutions, and expired reagent solutions in waste containers. When the acid waste containers are full, a designated acid waste handler transfers the waste to the acid neutralization tank.

Personnel Training and Qualifications

All personnel performing this procedure must have documentation of reading, understanding, and agreeing to follow the current version of this SOP and an annual documented Demonstration of Capability (DOC) which is maintained in the analyst's training records.

Initially, each analyst performing the instrumental analysis must work with an experienced analyst for a period of time until they can independently calibrate the instrument, use the system to set up sequences, perform the calculations, interpret raw data, and enter data into the LIMS. Proficiency is measured through documented audits of the tasks listed and over checking of data as well as an Initial Demonstration of Capability (IDOC).

The IDOC consists of four laboratory control samples that are carried through all steps of the analysis and meet the defined acceptance criteria. The criteria include the calculation of mean accuracy and standard deviation. Various options are available for a DOC and can include four laboratory control samples or one blind sample. Refer to [QA-SOP11178](#) for more guidance on these options.

Sample Collection, Preservation, and Handling

Aqueous samples are collected in plastic or glass containers, preserved to a pH of <2 with nitric acid. Samples must be analyzed within 28 days of collection.

NOTE: Regulatory Drinking Water samples (EW) are collected in 1-L plastic or glass containers and must be analyzed by EPA 245.1. Drinking water samples are not analyzed for dissolved mercury.

Solid samples are collected in glass containers and stored at 0° to 6°C not frozen. Samples must be analyzed within 28 days of collection.

Dissolved Mercury: Samples to be analyzed for soluble mercury requiring filtration at the lab must be submitted unpreserved. The sample is run through a 0.45 micron filter within 5 days of receipt and are collected in plastic containers and preserved to a pH of <2 with HNO₃.

Samples must be held for 16 hours following preservation and checked again prior to processing.

Store sample digestates in plastic bottles at room temperature. Store standards and digestates separately.

Apparatus and Equipment

1. Hydra II Mercury Analyzer
2. Leeman Labs Envoy software – a windows based program to help navigate the software.
3. 15-mL graduated polypropylene screw cap tubes (certified ± 1%)
4. 10-mL sterile disposable syringes
5. 25-mm syringe filters, PTFE, 0.45-µm
6. 40-mL clear glass VOA vials and lids
7. 50-mL polypropylene containers and covers (digestion vessels for block digestion) - certified clean and Class A equivalent

Reagents and Standards

A. Store all standards and reagents in polyethylene or glass containers at room temperature. Label the container with the solution name, lot number, date prepared, the expiration date, the initials of the person preparing the solution, and the storage conditions.

NOTE: Standard/ spiking concentration and reagent vendors are subject to change without notification.

B. Reagents use the following or equivalent:

1. Nitric acid, 70.0% to 71.0% HNO₃, Fisher Trace Metal Grade reagent, 1.428 g/mL; Store in glass container at room temperature. Follow manufacturer's expiration date.
2. Sodium chloride, NaCl, J.T. Baker, Certified ACS. Store in plastic container at room temperature. Follow manufacturer's expiration date.
3. Hydroxylamine hydrochloride, NH₂OH·HCl, J.T. Baker, Certified ACS. Store in plastic container at room temperature. Follow manufacturer's expiration date.
4. Reagent Water
5. Stannous chloride solution, 10% SnCl, Baker Analyzed reagent, ACS. Store in plastic container at room temperature. Follow manufacturer's expiration date.

6. Hydrochloric acid, HCl, 36.5% to 38.0%, Fisher Trace Metal Grade reagent, 1.194 g/mL or equivalent. Store in glass container at room temperature. Follow manufacturer's expiration date.

C. For the preparation of calibration blanks, ICBs, CCBs, calibration standards, ICVs, CCVs, CRAs, Method Blanks, LCSs and Matrix Spikes solutions, see Form [T-MET-WI9084](#).

D. General solutions - See Form [T-MET-WI9084](#).

NOTE: Method states to use Sulfuric acid when making Stannous Chloride, however, manufacture requires HCl. The lab practices this deviation in order to maintain instrument performance.

Calibration

Leeman Labs Hydra II Mercury Analyzer

1. The software program has been developed to check the correlation coefficient of the curve, run appropriate ICV and CCVs at proper intervals, and check the percent recoveries of the ICV and CCVs.
2. Due to the instrument software limitations, the calibration blank is included in the correlation coefficient calculation.
3. A recalibration and reread of any associated samples is required for any checks that fall outside the windows.
4. For the frequency, acceptance criteria and corrective action see SOP [T-MET-WI35797](#)
5. For the preparation of calibration standards, see [T-MET-WI9084](#).
6. The calibration is part of each run shown in the LIMs system

Procedure

A. Sample Digestion

1. Aqueous samples are digested by EPA 7471A/B according to SOP [T-MET-WI11924](#).
2. Aqueous samples are digested by EPA 245.1 according to SOP [T-MET-WI26740](#).
3. Solid samples are digested according to SOP [T-MET-WI11948](#).

B. Leeman Labs Hydra II Mercury Analyzer Operation

1. Instrument Setup

- a. Turn ON the power to the instrument (switch in the back) and computer.
- b. Ensure that Argon supply is set to 15 psi.
- c. Double click the Envoy icon on the desktop to initialize the instrument software.
- d. Put on the peristaltic pump cassettes. Do not over tighten. At the end of shift, remove them from the pump.
- e. Place levers in the 1 o'clock position to avoid stalling the pump. Do not fully tighten at this point.
- f. Check that the rinse bottle is full and Luer connections are tight. Only a 'light' finger tightening is required. Refill the rinse tank with a 2.0% Hydrochloric Acid (HCl) solution. For preparation of 2.0% HCl solution, see [T-MET-WI9084](#).
- g. Check that the 10% stannous chloride bottle is full and Luer connections are tight. Only a 'light' finger tightening is required. For preparation of 10% stannous chloride, see [T-MET-WI9084](#).
- h. Click the start icon on the Tool Bar to turn on the peristaltic pump and press the green play button.
- i. Check to see that the lamp, pump and gas turn on. If necessary, open the Method/Instrument Control Panel and turn them on and set appropriate parameters.
- j. When the pump is turning, tighten the cassettes by lowering the levers to a horizontal position. Allow 20 minutes for lamp and pump equilibration.
 - a) There is an option to use Chart Recorder which displays when the instrument is optimized. To utilize this feature follow these steps
 - i. Observe Instrument
 - ii. Stabilization Tools
 - iii. Chart Recorder : resize window to ~1200 seconds or 10mins.
- k. Inspect all system connections for leaks.
- l. The system is now ready to be optimized for automated analysis.

2. Autosampler and Run Setup

- a. Clear previous analyses
 - i. Analysis Tab
 - ii. Tools
 - iii. Database Manger
 - iv. Create Archive
- b. Scan the samples from their label that is on the sample itself into the Envoy program under the Sequence Tab
 - i. Select Sequence
 - ii. New
 - iii. Select correct rack size
 - iv. Scan samples in order
- c. Check QC
 - i. Method Tab
 - ii. QC control checks tab
 - iii. Modify QC as needed to set pass/fail flags
- d. Press Run Sequence (Test tube rack icon): The calibration and sequence will run automatically with CCV and CCB every 10 analyses.

Sample Analysis

1. Filtering Samples

- Samples that are cloudy or have particulate suspended in solution must be filtered prior to analysis.
- Difficult matrix samples or samples with limited volume may be filtered using a 10-mL sterile disposable syringe fitted with a 0.45 µm PTFE syringe filter.
- If any samples are filtered, the MB and the LCS on the batch must be filtered.
- Document all filtrations on the run cover sheet.

2. Dilutions

- Dilute samples with appropriate matrix matching solution when necessary to yield a response that falls within the calibration range.
- Stop run if sample is above 4.5ppb. Rinse system and dilute sample immediately. Reanalyze. If the subsequent sample analyzed after an over range sample has a detection, reanalyze the subsequent sample as well.
- Report the results for the least dilute sample where the concentration measured is within the acceptable calibration range.

3. Data Export: follow the below step by step instructions

On the instrument

- Analysis Tab
- Report Tab
- Select Statistics
- Select Load
- Select TALS Export
- Select OK
- Check all data on this run
- Select Report
- Select CSV File
 - Name CSV file (2034301M07)
- Select Save
- Open IDAT sequence shortcut on desktop
- Highlight and copy run file
- Open TALS import file on desktop and paste run

4. Attach raw data to run: follow the step by step instructions

On the instrument

- Analysis Tab
- Report Tab
- Select Detailed
- Select Load
- Select Detailed TALS
- Select OK
- Check all data on this run
- Select report
- Select CSV file
 - Name CSV file (2034301M07)
- Select Save

NOTE: Do not paste this report into the TALS import file.

5. See Data Review section for when data is in LIMS system. See SOP [T-MET-WI35797](#) for final data review.

6. Shutdown

- Place Stannous Chloride and rinse tubing into 2% HCl for minimum of 5 minutes.
- Place tubing into reagent water for a minimum of 5 minutes
- Remove tubing from reagent water to allow the aspirating of air for a minimum of 5 minutes.

Never leave bottle of Stannous Chloride and rinse connected to the instrument if the pump clamps are released because siphoning can occur and cause damage to the instrument.

NOTE: Do not turn off power switch to instrument on a daily basis.

Calculations

1. Final Result

- Water sample (ug/L)

$$\frac{\text{Instrument Reading}}{\text{Reading}} \times \frac{\text{Dilution Volume}}{\text{Aliquot Volume}} \times \frac{\text{Final Volume}}{\text{Sample Volume}}$$

- Solid sample (mg/kg)

$$\text{Instrument Reading} \times \frac{\text{Dilution Volume}}{\text{Aliquot Volume}} \times \frac{\text{Final Volume}}{\text{Sample Weight (grams)}}$$

2. Relative percent different (RPD)

$$\text{RPD} = \frac{S - D}{(S + D)/2} \times 100$$

Where:

S = first sample value

D = duplicate sample value

3. Spike recovery

$$\% \text{ Recovery} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

Where:

SSR = spiked sample result

SR = sample result

SA = spike added

4. Correlation Coefficient

$$r = \frac{\sum XY - \frac{\sum X \sum Y}{N}}{\sqrt{(\sum X^2 - \frac{(\sum X)^2}{N})(\sum Y^2 - \frac{(\sum Y)^2}{N})}}$$

Where :

X = the known concentration

Y = the instrument response

N = the total number of data points

5. Serial Dilution

$$\% \text{ Difference} = \frac{(5 \times \text{SDR}) - \text{SR}}{\text{SR}} \times 100$$

Where:

SDR = serial dilution result

SR = sample result

6. Methods of standard additions (MSA)

Take 4 identical aliquots of the same sample. Leave one unspiked. Spike the other 3 aliquots with different levels of a standard solution. Add blank solution to sample aliquots so that the final volume is the same for all. Use small volumes of spiking solution to avoid diluting the sample more than 10%. Analyze the 4 aliquots and record the instrument readings in absorbance. Use the readings and spike values to find the slope and x- and y- intercepts. The x- intercept is the result.

$$\text{Slope} = m = \frac{\sum x_i y_i - (\sum x_i \sum y_i) / n}{\sum x_i^2 - (\sum x_i)^2 / n}$$

$$\text{Y-Intercept} = b = \bar{y} - m\bar{x}$$

$$\text{Result} = -\frac{b}{m}$$

$$\text{Correlation Coefficient} = r = \frac{\sum \{(x_i - \bar{x})(y_i - \bar{y})\}}{\sqrt{[\sum (x_i - \bar{x})^2][\sum (y_i - \bar{y})^2]}}$$

The correlation coefficient (r) for the least squares fit must be ≥ 0.995 . If the r value is < 0.995 , the MSA must be repeated at the same dilution. If the r value is again low, the result with the higher r value is verified and both are flagged with a "+" in the data package. If the r value is < 0.990 , the sample is run at an interference dilution to overcome matrix effects. This usually requires a raised limit of quantitation. If a client requests a particular limit of quantitation that prohibits further dilution, then the sample is repeated at the same dilution and the best of the two results is verified.

Statistical Information/Method Performance

Generate MDLs and LOQs according to [QA-SOP11892](#). The department supervisor maintains annual study data.

QC limits for MS/MSD, and LCS/LCSD are established through statistical analysis of historical data. The limits are maintained in the LIMS for the relevant analysis numbers.

The department supervisor requests that a Quality Assurance Specialist update to the LIMS as needed. Update the department database via a download from the LIMS.

Quality Assurance/Quality Control

Batch Quality Control

1. For the preparation and concentrations of Batch Quality Control see [T-MET-WI9084](#).
2. For the frequency, acceptance criteria and corrective action see [T-MET-WI35797](#).
3. For EPA 7470A, 7471A, and 7471B, a digestion batch is up to 20 samples. Each batch must contain a MB, LCS, BKG, DUP, MS and MSD (an LCSD is used if there is insufficient sample for an MSD).
4. For EPA 245.1 Rev 3, a digestion batch is up to 10 samples. Each batch must contain a MB, LCS, BKG, DUP, and MS (an LCSD is used if there is insufficient sample for an MSD).

Data Review

1. To view imported analytical batch in the LIMS, follow these steps:
 - a. Go to Analyst
 - b. Choose Analyst Desktop II
 - c. Select the instrument where the data is pulled from on the left hand side by expanding the Instrument option
 - d. Data will be listed with a designated analytical batch number given by the LIMS system under the instrument where it was analyzed.
 - e. Record this designated analytical batch number on prep batch paperwork.
2. How to complete 1st level review of analytical batch
 - a. Once analytical batch is located from following steps in #1 double click to open the batch
 - b. Choose Edit button
 - c. When asked if data should be processed choose No
 - d. Edit Standards/Batch QC
 - i. Scan calibration standards from prep batch sheet
 - e. If PDS is on analytical run enter PDS data
 - i. Go to the Reagents tab at the bottom
 - ii. Scan lot number of spike used in PDS
 - iii. Enter volume of spike used for PDS. Normally this would be 0.1mL to a final volume of 10mL
 - iv. Go to Worksheet Tab and enter a final volume for the PDS. Normally, this would be 10mL
 - f. Calculate Results
 - i. Go to Samples Results Tab
 - ii. Highlight all samples by using Ctrl + L
 - iii. Right click and choose Identify
 - iv. Once samples are and calibration and all identified it is always a good practice to recalculate by hitting F6
 - g. Evaluate the Results
 - i. Go to the Sample List tab
 - ii. Either look at each line individually to ensure calibration and data are valid or filter by job number and evaluate data
 - iii. Look for recoveries in the spiked calibration as well as the batch QC
 - iv. Look for contamination in blanks
 - v. Look for E flags for samples that need to be diluted. If they were diluted check that the dilution makes sense.
 - h. Enter Batch Information
 - i. Prior to saving batch right click and chose View Batch Information or press Ctrl + 1
 - a. If you try to save batch without going to this screen the program will prompt you

- ii. Enter analyst
 - iii. Enter Stannous Chloride ID lot #
 - iv. Enter tube lot #'s if dilutions were made, filtering of samples occurred, or PDS was used
 - v. Enter lot number of filters used
 - vi. Hit Ok to save
- i. Attach Raw Data
 - i. Go to IDAT Sequence folder \\ldata\Env\IDAT-Sequences
 - ii. Find the analytical run by searching the unique run number given to it by the analyst.
 - iii. Double Click on file once located
 - iv. Once file is open, Save As pdf file and name the file the analytical run number give to the data by the LIMs system.
 - v. Open Sharefile in Google Chrome
 - vi. Go into the Personal Folder and choose Browse Files
 - vii. Find File and select Upload
 - viii. Once uploaded into Sharefiles go into the analytical batch in the LIMs system and choose Docs button at top
 - ix. Right click and select Add New Document
 - x. Select the document in the Personal Folder in Sharefiles and hit Select
 - xi. Hit OK and now the raw data file is attached into the analytical batch
 - j. 1st level data
 - i. Once data has been confirmed by analyst to be valid and the raw data is attached go to Sample List tab
 - ii. Highlight calibration and samples that are valid (if all samples Ctrl +L to highlight)
 - iii. Either do Ctrl + Shift + 1 to turn status to 1st Level or right click, Review Sample, Choose 1st Level Review

Instrument Maintenance and Repair

A. Routine Maintenance

1. Replace the pump tubing as needed under normal daily usage.
 - a. Inspect tygon supply lines for discoloration and cloudiness
 - b. Check peri-pump lines for flattening
2. As needed for foamy samples, replace liquid/gas separator
 - a. Remove and rinse the clear front panel
 - b. For severe foam replace entire gas box module
3. If liquid has entered the optical cell, check the optical cell and windows, and if needed, clean the optical cell.
 - a. Wipe the optical cell with a soapy solution (one drop of liquid Ivory soap to 500 mL reagent water) and warm tap water.
 - b. Rinse with reagent water and dry. To speed the drying of the optical cell, connect the heater plug to the optical cell with the windows off for several minutes.
 - c. Clean the quartz windows with methanol and a piece of lens paper.
4. Document any maintenance in the Mercury maintenance logbook located next to the instrument.

NOTE: Detailed instructions for the maintenance and troubleshooting of the Leeman Labs Mercury Analyzer can be found in the Leeman Labs Hydra II Mercury Analyzer Manual.

B. Taking an instrument/analysis out of service/returning an instrument/analysis to service.

NOTE: In the event of an equipment failure, perform the steps in SOP [QA-SOP11901](#):


1. Document the nature of the failure in the maintenance logbook.
2. Document how and when the defect was discovered.
3. Notify a supervisor or experienced analyst to determine a person who can decide on appropriate action to take.
4. The instrument must be clearly tagged as Out of Service. The tag must be printed from Q-EQA-FRM6871 contain the following information:
 - a. Date taken out of service.
 - b. Employee who took the instrument out of service.
 - c. Reason for tagout.
5. The date taken out of service and the date returned to service must be documented in the logbook.
6. Document any corrective action that was taken and the result of that corrective action (i.e., system calibration within specifications, etc.) to bring the equipment back into service.
7. Supervisory personnel must perform a documented evaluation and review of instrumentation/equipment where a major or uncommon failure has occurred to assess the potential impact the failure could have on the calibration and/or qualification of the instrument.
8. After a repair, document whether the function has been fixed. Calibration or verification activities are to be performed before the instrumentation is put back into service.

[11178 Demonstrations of Capability](#)
[11886 Processing Regulatory Compliance \(i.e. SDWA, NPDES\) Samples](#)
[11892 Determining Method Detection Limits and Limits of Quantitation](#)
[11896 Establishing Control Limits](#)
[11901 Instrument Maintenance and Calibration](#)
[11924 Digestion of Aqueous Samples by SW-846 Method 7470A](#)
[11948 Preparation of Solids by EPA 7471A or B for Mercury Analysis](#)
[26740 Digestion of Aqueous Samples for Mercury by EPA 245.1](#)
[35797 Metals Data Verification Process](#)
[6871 Do Not Use - Environmental](#)
[9084 Preparation of Mercury Solutions and Standards](#)

End of document

Version history

Version	Approval	Revision information	
18	29.JUL.2019		
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	Metals by ICPMS by Methods SW-846 6020/6020A/6020B(waters, solid, tissue) and EPA 200.8 (waters)	Work Instruction
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Revision Log

Revision: 13	Effective Date:	This version
Section	Justification	Changes
Revision Log	Formatting requirement	Removed revision logs up to the previous version
Throughout	Combined SOPs	Removed cross references to T-MET-WI11939.
Procedure E.2.	Enhancement	Added note to reference Internal Standard Attachment.
QAQC 11.	Enhancement	Added note to reference Internal Standard Attachment. Added reference to Verification SOP.

Revision: 13	Effective Date:	This version
Section	Justification	Changes
Attachment	Enhancement	Attachment references internal standards used for analysis

Revision: 12	Effective Date:	This version
Section	Justification	Changes
Revision Log	Formatting requirement	Removed revision logs up to the previous version
Throughout	Update to current LIMS	Updated method references to current LIMS
Throughout	Combined SOPs	Combined with T-MET-WI18027 and T-MET-215089
Cross Reference	Updated document list	Updated document list to reference combined 7700 and 7900 maintenance procedures into T-MET-21590, and combined operations procedures into this procedure
Cross Reference	Formatting requirement per G-DC-FRM7674	Added prep procedure cross references associated with this analysis and removed higher level references that are not required.
Scope	Added Clarification	Added RL is same as LOQ
Sample Collection, Preservation, and Handling	Reflects current protocol	Updated to reference water digestion and prep SOPs, and updated temperature for stored aqueous samples.

Reference

1. Method 200.8 (rev 5.4), Determination of Metals and Trace Metals in Water and Wastes by Inductively Coupled Plasma-Mass Spectrometry, USEPA 600/R-94/111 May 1994.
2. Test Methods for Evaluating Solid Wastes, SW-846 Method 6020, September 1994.
3. Test Methods for Evaluating Solid Wastes, SW-846 Method 6020A, February 2007.
4. Test Methods for Evaluating Solid Wastes, SW-846 Method 6020B, Rev. 2, July 2014.
5. ESI SC Manual.
6. Agilent 7700 and 7900 Series ICP-MS MassHunter Workstation Guide and Hardware Maintenance Manual.
7. *Chemical Hygiene Plan*, current version.

Cross Reference

Document	Document Title
T-MET-WI12065	Working Instructions for Preparation of ICP-MS Solutions and Standards

Document	Document Title
<i>S-SS-WI10695</i>	Liquid Sample Preservation, Sample Splitting, and Turbidity for metals by EPA Methods 200.7 and 200.8
<i>T-MET-WI21590</i>	Instrument Maintenance for Agilent 7700 and 7900
<i>T-MET-WI35797</i>	Metals Data Verification Process
<i>T-MET-WI11925</i>	Client Specific - 3030 C. Treatment for Acid-Extractable Metals for North Carolina Groundwater Samples
<i>T-MET-WI11938</i>	Digestion of Waters by EPA 200.7/200.8 for the Analysis of Metals in Water by ICP or ICPMS
<i>T-MET-WI11941</i>	Sample Preparation of Wastewater and Leachates for Analysis of Total Metals by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP) and Inductively Coupled Plasma Mass Spectrometer (ICP-MS)
<i>T-MET-WI8636</i>	Sample Prep of Sediments, Sludges, Soils, and Tissues by SW846 3050B for ICP and ICP-MS
<i>T-MET-WI8639</i>	Sample Preparation of Waters for Analysis of Total Recoverable Metals by ICP-OES and ICP-MS
<i>T-MET-WI8732</i>	Lab and Field Filtered Waters and <1NTU Drinking Water Preparation for ICP (EPA 200.7, 6010B/C/D) or ICP-MS (EPA 200.8, 6020/A/B)

Scope

This procedure applies to analyses performed at Eurofins Lancaster Laboratories Environmental (ELLE) using ICP-MS for identification and quantitation of metallic constituents.

Aqueous undigested samples and digestates (aqueous and solid matrices) are analyzed via this SOP.

Limits of Quantitation (LOQs/RLs), Method Detection Limits (MDLs) and linear ranges are maintained in the LIMS. These are subject to change without notification.

This procedure is used for analysis and instrument operation for the Agilent 7700 and 7900 series ICPMS instruments.

Routine Methods

Analyte	Mass
Be	9
B	11
Na	23
Mg	24
Al	27
K	39
Ca	44
Ti	47
V	51
Cr	52
Mn	55
Fe	57
Co	59
Ni	60
Cu	63
Zn	66
As	75
Se*	78
Se**	82
Sr	88
Mo	98

Ag	107
Cd	111
Sn	120
Sb	121
Ba	137
Tl	203
Pb 206	206
Pb 207	207
Pb 208***	208
U	238
*Se 78 is the mass reported from collision cell ICPMS only	
**Se 82 is the mass reported from non-collision cell ICPMS only	
***For Pb masses 206, 207 and 208 are summed for calibration and analysis	

Basic Principles

ICP-MS is an analytical instrument that uses the energy of inductively coupled plasma to generate ions to be analyzed in the mass spectrometer.

The instruments use a discrete sampling system that first loads the sample into a Teflon sample loop. The sample is then pushed by a carrier solution using a computer controlled peristaltic pump that delivers the sample from the loop into the nebulizer attached to a cooled Scott double pass spray chamber.

The Agilent 7700 (E05) and 7900 (E07/E08/E09) can analyze samples in 3 different modes of operation, although typically analysis is done in 3 mode or No Gas mode only:

1. Mode 1 – no gas. This mode does not use a collision or reaction gas. Elements with a low atomic mass or that have no interferences can be analyzed using the “no gas” mode.
2. Mode 2 – Hydrogen (H₂) mode. This mode uses H₂ as a reaction gas, since it reacts quickly and efficiently with the Argon-based interfering species, but reacts slowly or not at all with the analyte(s) of interest. In this mode, interferences can be reduced to the level of baseline noise, allowing lower detection limits to be achieved for some difficult elements.
3. Mode 3 – Helium (He) mode. This mode uses He as a collision gas for reliable, predictable removal of unknown matrix interferences. No new interferences are formed in the cell, and no analytes are lost by a reaction.

Interferences

ICP-MS interferences include isobaric elemental interferences and polyatomic ion interferences derived from the plasma gas, reagents, and/or sample matrix. The Agilent 7900 utilize helium as an inert collision gas to reduce or eliminate many types of polyatomic ion interferences.

Physical interferences caused by the change in sample matrix affecting sample transport and/or nebulization must be compensated for using internal standardization.

Memory interference is the contribution of analyte signal from a previous sample onto the next sample analysis. Adequate rinse time with an appropriate rinse solution of the sample introduction system overcomes any memory interference.

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 the *Chemical Hygiene Plan* for general information regarding employee safety, waste management, and pollution prevention.

Preparing samples for inorganic analysis involves working with concentrated acids and other chemicals which are dangerous if not handled carefully:

Hydrochloric acid (HCl) – This acid can cause skin burns. Only mix with approved solutions. Always use this chemical in a fume hood.

Hydrofluoric acid (HF) – This acid is very toxic and absorbs through the skin without pain. This acid is found at trace levels in standard solutions.

Hydrogen Peroxide 30% (H₂O₂) - This oxidizer can cause skin burns. Always use in a fume hood.

Nitric acid (HNO₃) – This acid can cause skin burns and burning of the respiratory tract. Add nitric acid to samples in a fume hood to avoid exposure to toxic fumes.

When diluting strong acids, never add water to acid; always add acid to water.

Store concentrated acids in the prep room acid cabinets. Only acids are to be stored in these cabinets. Flammable solvents are stored in flammable liquid storage cabinets. Some concentrated acids are kept in the acid reagent bottles on prep room counters. Fill reagent bottles in an operating fume hood using caution to avoid spills.

Large spills are cleaned by HSE. For large spills of concentrated acid, immediately evacuate the area and dial 1-1-1. HSE will use spill pillows to absorb large acid spills (small spills are cleaned with wet paper towels.)

Dispose of acid waste properly. Collect all acid digestions, waste solutions, and expired reagent solutions in waste containers. When the acid waste containers are full, a designated acid waste handler transfers the waste to the acid neutralization tank.

Personnel Training and Qualifications

All personnel performing this procedure must have documentation of reading, understanding, and agreeing to follow the current version of this SOP and an annual documented Demonstration of Capability (DOC) which is maintained in the analyst's training records.

Initially, each analyst performing the instrumental analysis must work with an experienced analyst for a period of time until they can independently calibrate the instrument, use the sequence editor to set up the run, perform calculations, interpret raw data, and enter/transfer data into the LIMS. Proficiency is measured through documented audits of the tasks listed, and checking of data as well as an IDOC (Initial Demonstration of Capability) and continued DOCs (Demonstration of Capability) as defined in [QA-SOP11178](#).

The IDOC consists of four laboratory control samples (LCS) that are carried through all steps of the prep and analysis and meet the defined acceptance criteria. The criteria include the calculation of mean accuracy and standard deviation.

Sample Collection, Preservation, and Handling

Aqueous undigested samples, aqueous digestates, and solid digestates are analyzed via this SOP. Samples must be analyzed within 6 months of collection for all methods in this SOP.

Aqueous samples are collected in plastic or glass containers. Drinking Water samples are collected in 1-L plastic or glass containers. Aqueous samples are preserved with nitric acid with a pH of < 2 and stored at 0° to 6°C, not frozen, or at room temperature.

Aqueous digestates are digested per the method in [T-MET-WI11938](#) (aqueous samples 200.8), [T-MET-WI8639](#) (aqueous samples 3005A). Aqueous non-digested samples are prepared per the method in SOP [T-MET-WI8732](#) (lab and field filtered waters and <1NTU Drinking water). Aqueous samples are stored in 50 ml plastic vials at room temperature.

Solid samples are collected in glass containers and stored at 0° to 6°C, not frozen. Digestates are digested per the method in SOP [T-MET-WI8636](#). Solid samples are stored in 100 ml plastic vials at room temperature.

Store standards and digestates separately.

The general practice in the metals group is to discard the digestions after all the required metals from a batch of samples have been analyzed and lab completed in the LIMS. Samples which require the digestate to be held for long term storage are periodically evaluated for discard.

Apparatus and Equipment

A. The following is a list of the hardware used in the Agilent 7700 and 7900 ICP-MS systems.

1. Inductively Coupled Plasma Mass Spectrometers (ICP-MS)

a. The Agilent 7700 and 7900 - The sample introduction system consists of an ESI FAST discrete sampling system, Teflon nebulizer and cooled spray chamber attached to a concentric quartz tube plasma torch.

2. Autosampler

a. The Agilent 7700 and 7900 (E08) systems use an ESI SC-8 FAST autosampler. The Agilent 7900 (E07 & E09) systems use an ESI SC-14 FAST autosampler. The autosampler parameters for each automated run are entered into the Sample List in MassHunter software.

3. Coolflow

a. The Agilent 7700 and 7900 G3292A Recirculating Chillers are set up to deliver cooling liquid to the ICP-MS at a regulated pressure of ~40 psi.

4. Computer

a. The Agilent 7700 and 7900 are controlled by a Windows-based IBM compatible PC with MassHunter software installed.

5. Vacuum Pumps

a. The Agilent 7700 and 7900 both have a 2-stage vacuum system. A rotary pump evacuates the interface chamber; a turbo molecular pump evacuates the ion lens chamber and the analyzer chamber.

B. The following is a list of the apparatus necessary for the setup of an ICP-MS run for analysis:

1. ICP-MS prep batch sheets.

2. Test tube racks

3. Graduated 15-mL polypropylene tubes and caps

4. 50-mL polypropylene screw cap tubes

5. FilterMate 2 µm filters and plungers

6. 10-mL sterile disposable syringes

7. 25-mm syringe filters, PTFE, 0.45µm

8. 30-mL polypropylene medicine cups

9. Fixed volume hand-held pipettes (25 – 2000 µL) - Eppendorf or equivalent.

NOTE: For routine operation, calibration, and maintenance of fixed-volume, hand-held pipettes, see [QA-SOP11880](#).

Reagents and Standards

Refer to Form [T-MET-WI12065](#) for reagent and standard information and the preparation of the following standards and solutions

1. ICP-MS Calibration Standards and ICP-MS LOQ Check Standard Solution (CRI)

2. ICP-MS Initial and Continuing Calibration Verification Standards

3. Interference Check Solutions
4. Rinse/Carrier, Tuning, and Calibration Solutions
5. Internal Standard Solution
6. PDS Solutions
7. General Acids and Chemicals

Calibration

Before calibration is performed, allow the instrument to warm up for the recommended time, usually at least 15 minutes, if the plasma has been off for 15 minutes or less, or at least 30 minutes if the plasma has been off for more than 15 minutes. Daily tuning requirements must be performed prior to calibration of the instrument and after warm up occurs. Full Tuning and Optimization is done as needed, or when required by the Group Leader or Manager.

Calibration is performed daily. Calibrations consist of a blank and one to three standards, followed by analysis of an ICV, ICB, CCV, CRI, ICSA/ICSAB, LRC, CCV, and CCB.

A single point calibration, consisting of a blank and one standard, is used for all analysis, except Non-TNI samples requiring a multi-point calibration (either MA MCP or CT RCP protocol or a lab note indicating a multi-point calibration is needed). For samples requiring a multi-point calibration the calibration consists of a blank, "S1", "S2", and "S3" standards. The concentrations of the calibration standards are defined in [T-MET-WI12065](#).

For data review, acceptance criteria, and corrective action, see [T-MET-WI35797](#).

Procedure

A. Instrument Start Up

This procedure is the same for the Agilent 7700 (E05) and the 7900 (E07/E08/E09) instruments.

1. Power on the ESI autosampler and start the ESI software.
2. Make sure the instrument is powered on before starting the ICP-MS software – the light on the front of the instrument will be red (shutdown mode), orange (standby mode) or green (analysis mode).
3. If the instrument is powered down: flip the main power switch on the back of the instrument to the on position, and then make sure the Foreline Pump (red switch) is also in the on position.
4. Make sure the recirculating chiller power switch is in the on position. If the orange light on the front of the chiller is on, you will need to turn off the chiller and add coolant before turning the chiller back on.
5. Verify that the program is in Online mode – the Hardware tab will have a green check mark if it is online.
6. If the Hardware tab has a red x instead of the green check, click on the arrow down in the Hardware tab and select Communication. Select Online and click OK.
7. Check the Instrument Status pane. The instrument should be in one of three modes: Shutdown (plasma and vacuum off, red light on the front of instrument); Standby (plasma off but vacuum on, orange light on the front of instrument); Analysis (plasma and vacuum on, green light on the front of instrument).
8. If in Shutdown mode click on the Hardware tab arrow down and select Vacuum On – the Foreline pump will start and the instrument will transition to Standby mode.
9. Once Standby mode has been reached select Plasma On from the Plasma tab arrow down.
10. When asked if you want to "Run 'Startup' after plasma ignition?", select No.
11. The plasma will ignite and the instrument will transition to Analysis mode.

12. Once Analysis mode is achieved you must allow the instrument to warm up for at least 20 minutes before running the EPA Daily Tune check sample.

B. Running the Daily Tune Check

1. To run the EPA Daily Tune check place both probes into the EPA Tune Solution and allow sufficient time for the solution to flush through both lines.
2. Make sure the FAST valve is in the LOAD position.
3. Once the EPA Tune Solution is aspirating into the spray chamber take the following steps to start the EPA Daily Tune check.
4. Click on the arrow down for the Batch tab.
5. Open the batch "~ICPMS.b" by clicking on the file in the drop down menu or the pop up menu if necessary.
6. In the Batch pane select the Acq Method tab then the Tune tab.
7. Right click in the Signal Monitor grid and select Report, then Generate Tune Report.
8. In the window that appears verify that the Report Template selected is as follows:
C:\Agilent\ICPMH\Report Templates\en\Letter\Tune Report\TuneCheckReport.xltx
9. Click Generate. The software will acquire the tune check data from the instrument and a report will be printed.
10. If the EPA Daily Tune fails any of the criteria rerun the tune a second time. If it fails a second time take corrective action before running the EPA Daily Tune check again (maintenance or optimization of tuning parameters).

C. Sample analysis

1. Once the EPA Daily Tune passes all criteria, place the internal standard probe in the internal standard solution and place the carrier probe into the carrier solution.
2. Once the carrier and internal standard solution have flushed through the tubing and are aspirating into the spray chamber, sample analysis can begin.
3. In MassHunter open the method batch file used for analysis. Use ~ICPMS.b for non-potable waters and solids analyses, and ~ICPMS_nogas.b for drinking water analysis.

4. Save the batch with a new name:

YYMDDR## where:

YY is the two digit year

M is the letter of the alphabet corresponding to the month (A for January, B for February, etc.)

DD is the two digit day of the month

R is the letter of the alphabet that changes for each attempted run sequence

Example: For the first run started on March 19 in the year 2012 the batch folder would be named 12C19A01.b

5. Enter the calibration standards and lot numbers in the order of:

ICV/ICB/CRI/ICSA/ICSAB/LRC(s)/Rinse(s)/CCV/CCB

6. Scan all samples into the sample list and add PDS/SD and/or dilutions as needed.

7. Add a CCV/CCB block after every 10 samples (or ending the run) as well as an ending CRI/ICSA/ICSAB as needed per method or project note.

8. Enter the locations of the samples to match the rack in which they will be loaded onto the auto-sampler. Ensure that the order of the samples on the batch paperwork/re-read sheet match the order in which they are loaded.

9. Right click on the sample list and print a copy.

10. Use the print out to confirm the sample ID(s) and locations of the samples on the auto-sampler.

11. Load the auto-sampler based off of the printed out sample list. Sign off on the sample list with your initials, employee number and the date.

12. Keep the sample list with the batch(es) paperwork until the batch is imported into the LIMS. Note the analytical and prep batch(es) numbers on the sample list and give to the Group Leader.

D. Pouring an ICP-MS run (Waters only in 50 mL digestion tubes):

It is important to minimize any chance of contamination, to both yourself and the samples. Keep your hands and the work area clean at all times. Wear appropriate PPE at all times to prevent exposure to chemicals and samples including lab coat, gloves, and safety glasses, and additional PPE as required by project or health and safety.

NOTE: See Form [T-MET-WI 12065](#) for standards and solutions used during the analytical run.

1. Choose the appropriate prep batch sheet.

NOTE: When retrieving the batch from the shelf for the first time, record the batch location on the cap of the prep blank in black sharpie. This saves time when returning the batch to the proper location after analysis and shows that the batch has been poured before and verified to be in the correct order. To prevent more than one batch from being assigned to the same location, the digestion trays all have the location written on the foam holder.

2. Verify that each digestion tube is in the correct order according to the prep sheet. If anything is missing, correct the prep sheet and notify PREP or the Group Leader to correct the LIMS and put the sample back in for digestion. If the order is incorrect, reorder the sample digestion tubes to match the paperwork.

3. For batches prepared in hot blocks in 50-mL digestion tubes or prepared by the MTL_ND method:

a. The only tubes that typically need to be poured for the initial run are the post digestion spike (PDS) and serial dilution (SD) samples. These are prepared using the background sample (BKG) or the duplicate background sample (DUP) when limited sample volume is available.

b. All other samples remain in the 50-mL digestion tubes for analysis.

4. Samples that need to be poured into test tubes:

a. Obtain the appropriate number of tubes.

b. Write the last four digits of the sample number and the dilution factor if greater than 1 on each tube. If the MB or LCS must be in tubes, write MB/LCS and the prep batch number/location on the tubes.

c. Place tubes in test tube racks in the same order as the samples on the prep batch cover sheet and/or re-read.

d. The analyst must ensure that tubes are labeled correctly, that dilutions are performed accurately, and that the dilutions are recorded on the prep cover sheet and/or re-read.

5. Post-digest spike (PDS):

a. A PDS is required for each batch (sample volume permitting).

b. A PDS is prepared by pipetting 0.2 mL of the appropriate PDS solution into a 15-mL graduated test tube, and bringing it to a volume of 10 mL with the background sample, "BKG". If the PDS must be diluted, pipette 0.2 mL of the PDS solution into a 14 mL graduated test tube, add the appropriate amount of background sample, "BKG", and dilute to 10 mL using matrix rinse. If there is limited

volume for the background sample, "BKG", then the "DUP" may be used for dilutions of the PDS or SD. If the duplicate is used for PDS or SD, make an internal NCM on the analytical batch after analysis.

c. Record the lot number of the PDS solution used on the prep batch cover sheet and/or re-read.

6. Serial dilution (SD)

a. Prepare the SD by diluting the background sample at a dilution that is equal to 5× the dilution factor of the PDS sample (i.e. if PDS= DF1, SD must = DF5; if PDS=DF5, SD must=DF25).

7. Filtering samples

a. Samples that are cloudy or have particulate suspended in solution must be filtered prior to analysis to prevent clogging of the sample introduction system, which causes run failures and instrument down time to correct the problem.

b. Samples that are in the 50-mL digestion tubes may be filtered using the FilterMate filtration devices and plunger or a syringe and syringe filter.

c. Attach a filtration device to the plunger and very carefully insert the filter into the digestion tube until the filter reaches the bottom of the digestion tube.

d. Remove and discard the plunger.

e. An alternative for samples in any type of vessel is to filter using a 10-mL sterile disposable syringe fitted with a 0.45µm PTFE syringe filter.

f. If any samples are filtered, the MB and LCS must also be filtered. If any QC sample is filtered (BKG, DUP, MS, or MSD), then all QC including the MB and LCS must be filtered.

g. Document all filtrations on the prep batch cover sheet.

NOTE: It is not necessary to filter all samples (in 50 mL digestion tubes only) that contain particulate, as long as all of the particulate is settled to the bottom of the tube below the 5-mL mark in 50-mL digestion vessels. The sampling depth of the autosampler probe is set such that the tip of the probe is approximately 100 mm above the bottom of the digestion tube. It is necessary to filter all solid samples and to dilute to DF2 prior to analysis.

8. Verify that all samples in the hotblock tray are in the correct position and/or pour each sample (or sample filtrate) into the appropriate tube. Usually, the order of the batch QC is MB, LCS, (LCSD), Bkg, PDS, DUP, MS, (MSD), and SD. Most importantly, the actual positions of the samples in the tray must match the autosampler table used for analysis.

NOTE: Immediately prior to beginning analysis, the analyst must visually verify that each sample is in the position indicated in the autosampler table used for the run.

9. If not being analyzed immediately, cap any poured tubes to prevent contamination of the samples (digestion tubes and dilutions prepared in graduated test tubes must be capped tightly except during pouring and/or analysis).

10. Return samples to sample storage, being sure to place the batch back into the location recorded on the prep batch sheet.

11. Record the following on the prep batch cover sheet: initials, employee number, and the date, and lot numbers for PDS, filters, test tubes, as used).

12. NOTES:

a. A PDS and a SD are performed on one sample in each digestion batch. Typically, the background sample is chosen. If the batch QC is split between two samples, the PDS is performed on the background sample accompanied by a matrix spike; the SD is performed on the background sample accompanied by a matrix duplicate. If sample volume is limited, it is acceptable to use the duplicate for the PDS and SD.

b. Batches with only field blanks or equipment blanks do not need a PDS or a SD.

c. Air filter batches need only a SD on one sample in the batch (a PDS is not required).

d. "As Received" samples are analyzed with a blank and LCS, LCSD (prepared by the analyst).

e. Documentation is of utmost importance. Verify all entries.

E. Data analysis and Import

1. Once the sample run is complete you will switch to or open the Offline ICP-MS Data Analysis program to make any changes to internal standard selection and generate the file for import into LIMS. Note, the Attachment Internal Standard Reference includes the appropriate internal standards to reference for each metal.

2. Once in the Offline ICP-MS Data Analysis program open the batch that contains the run data you are going to process by clicking Open Analysis File (open folder icon or from the File drop down menu).

3. Evaluate appropriate internal standard selection based on the Quality Control section of this SOP and method requirements for the samples analyzed.

4. If it is appropriate to change internal standard selection from the defaults in the method used click the DA Method Editor button (skip to step e. if alternate internal standard selection is not needed).

select a. Under Method Development Tasks (in the left pane of the DA Method Editor window) "FullQuant" under item number 4 (Set up Analysis Parameters).

will b. Under the analyte list that appears in the right hand pane of the DA Method Editor you see a list of the analytes.

both c. Change internal standards for any analytes where alternate internal standard selection is necessary and appropriate.

d. Then click "Return to Batch-at-a-Glance" in the left hand pane.

e. When prompted to "Update Analysis Method?" select "Yes".

f. Click the "Process Batch" button to recalculate all concentration values in the batch folder using the internal standard selections you made while in the DA Method Editor.

5. To generate the file for import into LIMS you must first select all the data rows needed for your run, starting with the ICIS down to the last row in your run. If you restarted the run only select the most recent ICIS and all samples below it.

6. Once the appropriate rows of data are selected click on Tools and select "Upload to TALs" to run the script that compiles the file for import.

7. A pop up will appear once the script is complete stating that the file was created successfully. While the batch is still highlighted click on the Report tab. Generate the raw data PDF's and save them into the respective run's folder.

8. Open the ITUNE app and select the .rep file that was generated along with the tune file for that day. This will generate a new .rep file that will then be copied to the import folder. This will put the run into the LIMs system.

Calculations

1. Final Result

a. Water sample

$$\text{Instrument Reading} \times \frac{\text{Dilution Volume}}{\text{Aliquot Volume}} \times \frac{\text{Final Volume}}{\text{Sample Volume}}$$

b. Solid sample (mg/kg)

$$\text{Instrument Reading} \times \frac{\text{Dilution Volume}}{\text{Aliquot Volume}} \times \frac{\text{Final Volume}}{\text{Sample Weight (grams)}}$$

2. Relative percent different (RPD)

$$\text{RPD} = \frac{S - D}{(S + D)/2} \times 100$$

Where:

S = first sample value

D = duplicate sample value

3. Spike recovery

$$\% \text{ Recovery} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

Where:

SSR = spiked sample result

SR = sample result

SA = spike added

4. Correlation Coefficient

$$r = \frac{\sum XY - \frac{\sum X \sum Y}{N}}{\sqrt{(\sum X^2 - \frac{(\sum X)^2}{N})(\sum Y^2 - \frac{(\sum Y)^2}{N})}}$$

Where :

X = the known concentration

Y = the instrument response

N = the total number of data points

5. Serial Dilution

$$\% \text{ Difference} = \frac{(5 \times \text{SDR}) - \text{SR}}{\text{SR}} \times 100$$

Where:

SDR = serial dilution result

SR = sample result

6. Methods of standard additions (MSA)

Take either 4 identical aliquots (for 3 point MSA) or 2 identical aliquots (for one point MSA) of the same sample. Leave one unspiked. Spike the other 3 aliquots with different levels of a standard solution (for 3 point MSA) and spike the other aliquot at approximately the indigenous concentration of the sample (for one point MSA). Add blank solution to sample aliquots so that the final volume is the same for all. Use small volumes of spiking solution to avoid diluting the sample more than 10%. Analyze the 4 aliquots or 2 aliquots and record the instrument readings in absorbance. Use the readings and spike values to find the slope and x- and y- intercepts. The x- intercept is the result.

$$\text{Slope} = m = \frac{\sum x_i y_i - (\sum x_i \sum y_i) / n}{\sum x_i^2 - (\sum x_i)^2 / n}$$

$$\text{Y-Intercept} = b = \bar{y} - m\bar{x}$$

$$\text{Result} = -\frac{b}{m}$$

$$\text{Correlation Coefficient} = r = \frac{\sum \{(x_i - \bar{x})(y_i - \bar{y})\}}{\sqrt{[\sum (x_i - \bar{x})^2][\sum (y_i - \bar{y})^2]}}$$

The correlation coefficient (r) for the least squares fit must be ≥ 0.995 . If the r value is < 0.995 , the MSA must be repeated at the same dilution. If the r value is again low, the result with the higher r value is verified and both are flagged with a "+" in the data package. If the r value is < 0.990 , the sample is run at an interference dilution to overcome matrix effects. This usually requires a raised limit of quantitation. If a client requests a particular limit of quantitation that prohibits further dilution, then the sample is repeated at the same dilution and the best of the two results is verified.

7. Average, Standard Deviation and Relative Standard Deviation

The average result, \bar{x} , is calculated by summing the individual results and dividing this sum by the number (n) of individual values:

$$\bar{x} = \frac{X_1 + X_2 + X_3 + X_4 + \dots + X_n}{n}$$

Standard deviation is a measure of how precise the average is or how well the individual numbers agree with each other.

$$\text{Standard deviation, } S = \sqrt{\frac{(x_1 - \bar{x})^2 + (x_2 - \bar{x})^2 + (x_3 - \bar{x})^2 + \dots + (x_n - \bar{x})^2}{n - 1}}$$

Relative standard deviation (RSD) is expressed in percent and is obtained by multiplying the standard deviation by 100 and dividing this product by the average.

$$\text{Relative standard deviation, RSD} = \frac{100 \times S}{\bar{x}}$$

Statistical Information/Method Performance

Generate MDLs and LOQs according to [QA-SOP11892](#).

The department principal scientist and manager maintain annual study data. The department principal scientist, manager, and/or group leader requests that a Quality Assurance Specialist update to the LIMS as needed by department email.

Refer to [QA-SOP11896](#) for statistical information.

Quality Assurance/Quality Control

A. For 6020, 6020A and 6020B, each digestion batch (up to 20 samples) must contain a method blank, LCS, and either an BKG, DUP, MS, MSD or an LCS/LCSD (limited volume or approved by manager and QA only).

B. For 200.8, each digestion batch (up to 10 samples) must contain a method blank, LCS, and either an BKG, DUP, MS or an LCS/LCSD (limited volume or approved by manager and QA only). An additional BKG and MS are added for batches over 10 samples up to 20 samples.

C. QC limits for MS/MSD, and LCS/LCSD are established through statistical analysis of historical data.

1. The limits are maintained in the LIMS in Method Limit Groups.
2. The limits are evaluated every 6 months and updated as needed.
3. The limits are subject to change without notification.

D. Batch Quality Control

1. For the preparation and concentrations of Quality Control samples see [T-MET-WI12065](#).
2. For the frequency, acceptance criteria and corrective action see [T-MET-WI35797](#).

E. Raw data quality checks

1. Make sure that the run is correctly labeled, and dated and that the corresponding prep sheet is attached to the run.
2. Verify that the appropriate Tuning Report is with the run.

3. For run and batch QC/Calibration frequency, acceptance criteria and corrective action, see [T-MET-WI35797](#) tables.

4. Spike levels of batch QC are available in the LIMS and on T-MET-WI9082.

5. LOQs (RLs), MDLs, and IDLs are available to analysts in the LIMS in Method Limit Groups and Equipment Limit Groups.

6. Check to make sure that all results are not > 90% of the Linear Range, according to LIMS Equipment Limit Groups. If a sample reading is above 90% of the linear range, then reread the sample at a dilution sufficient to bring the sample concentration to approximately the middle of the calibration range.

7. Check that the **absolute** value of all non-detected analytes is less than the RL. A technical decision must be made as to whether a reread is warranted for readings $< |RL|$.

8. Check for carryover between samples. Sample RSD >20%, with a concentration > the LOQ decreasing progressively over time (i.e., Reading $3 < 2 < 1$). Flag any suspect samples for reread.

NOTE: Whenever a sample is encountered that exceeds the calibration range, the following sample must be checked for carryover for the over range analyte (s) and any suspect results must be deselected and reanalyzed. During reanalysis the sample order must be modified as needed to avoid carryover from any over range sample(s).

9. For all EW (samples from public drinking water sources), highlighted mint green in the LIMS, check the results against the MCL (maximum contaminant level) by reviewing the limits tab in analyst desktop II. If an analyte **exceeds** the MCL, is a certified analyte for the SDWA method, and is associated with a mint green compliance drinking water sample, notify the verification group at once by NCM or email. An automated email is sent to the Client Service Representative and the state for the analytes listed below with the exception of Pb and Cu which follow the 90th percentile rule (the CSR tracks the lead and copper and notifies the supplier when necessary). Suppliers must be notified within the required time limit as stated in QA-SOP11886.

10. To avoid the risks associated with polyatomic interferences in wastewater and soil matrices all analytes must be analyzed on the collision cell ICP-MS instruments which include Agilent 7900, Equipment E07 - 27813, Equipment E08 - 30647, Equipment E09 - 30921).

a. Because EPA 200.8 rev. 5.4 does not currently allow the analysis of drinking water samples using collision cell ICP-MS all drinking water samples must be analyzed using a method with no gas mode for all analytes on the Agilent 7700, which includes Equipment E05 - 19204.

11. Check the internal standard level for the entire run. Reference the Internal Standard Reference attachment in this SOP for the appropriate internal standards to use for each metal. If the internal standard reading for any sample is out of the acceptance range of the S0 reading, evaluate whether this is a result of the sample matrix or drift from other samples in the run. Only reread the sample at a dilution if the internal standard appears to be out of range due to the sample matrix. For samples where an internal standard is above the acceptance range it is acceptable to reprocess the data using an alternate internal standard. This is the preferred approach in order to avoid raised reporting limits. The acceptance criteria differ based on the method being used. Refer to [T-MET-WI35797](#) for the method acceptance criteria.

NOTE: The internal standard is added in equal concentration to all of the samples and standards via a dedicated line on the peristaltic pump. The analytical lines referenced to an internal standard report a corrected concentration value based on the ratio of analyte to internal standard intensities. All the calculations for determining concentration are based on Intensity Ratio (IR). The IR is defined as the background corrected intensity signal of the

analyte line (Ia) divided by the internal standard value (Iis). $IR = Ia/Iis$.

12. For TCLP and SPLP samples, an MSA (method of standard additions) is required if:
- The sample concentration falls between 80% and 100% of the regulatory limit.
 - If the TCLP or SPLP matrix spike (QA) recovers <20%, all samples in the leachate batch must be reanalyzed using the method of standard additions for that analyte.
13. When items 1 – 12 are complete, check the following:
- All samples requiring reread/redigestion are listed on the reread paperwork, and redigestions are communicated to the verification group by email.
 - The data are uploaded to LIMS via data transfer to TALS.

Figure I - Daily Performance Acceptance Criteria and Tuning Solution Concentrations

Be (9)	10 or 100 PPB
Mg (24)	10 or 100 PPB
Co (59)	10 or 100 PPB
In (115)	10 or 100 PPB
Pb (208)	10 or 100 PPB
CeO/Ce	<3%
Ce++/Ce	<3%
Background	<30 cps @ Mass 220
RSD	<5%
Peak Width at 10% Peak Height	<0.9 AMU
Res/Axis	< +/- 0.1 AMU from unit mass

Attachment:
Internal Standard Reference (.pdf)

10695 Liquid Sample Preservation, Sample Splitting, and Turbidity for metals by EPA Methods 200.7 and 200.8
11178 Demonstrations of Capability
11880 Laboratory Equipment Verifications - Balance, Syringe, Pipette, Weights, and Other Equipment
11892 Determining Method Detection Limits and Limits of Quantitation
11896 Establishing Control Limits
11901 Instrument Maintenance and Calibration
11925 Client Specific - 3030 C. Treatment for Acid-Extractable Metals for North Carolina Groundwater Samples
11938 Digestion of Waters by EPA 200.7/200.8 for Analysis of Metals by ICP/ICPMS
11941 Sample Preparation of Wastewater and Leachates for Analysis of Total Metals by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP) and Inductively Coupled Plasma Mass Spectrometer (ICP-MS)
12065 Working Instructions for Preparation of ICP-MS Solutions and Standards
21590 Instrument Maintenance for Agilent 7900
35797 Metals Data Verification Process
6869 Nonconformance Form
8636 Sample Prep of Sediments, Sludges, Soils, and Tissues by SW846 3050B for ICP and ICP-MS
8639 Sample Preparation of Waters for Analysis of Total Recoverable Metals by ICP-OES and ICP-MS
8732 Lab and Field Filtered Waters and <1NTU Drinking Water Preparation for ICP (EPA 200.7,



End of document

Version history

Version	Approval	Revision information	
11	12.NOV.2020		
12	15.APR.2022		
13	27.JUL.2022		

Mass - Element	Possible ISTD	Internal Standard Elements				
		Sc - 45	Ge - 72	In - 115	Tb - 159	Bi - 209
9 - Be	Sc	DEFAULT INTERNAL STANDARD	Possible Use As Internal Standard	X	X	X
11 - B	Sc					
23 - Na	Sc + Ge					
24 - Mg	Sc + Ge					
27 - Al	Sc + Ge					
39 - K	Sc + Ge					
44 - Ca	Sc + Ge					
47 - Ti	Sc + Ge					
51 - V	Sc + Ge					
52 - Cr	Sc + Ge					
55 - Mn	Sc + Ge					
57 - Fe	Sc + Ge + In					
59 - Co	Sc + Ge + In					
60 - Ni	Sc + Ge + In					
63 - Cu	Sc + Ge + In					
66 - Zn	Sc + Ge + In					
75 - As	Sc + Ge + In					
78 - Se	Sc + Ge + In					
88 - Sr	Ge + In	X	X	X	X	
98 - Mo	Ge + In					
107 - Ag	Ge + In + Tb					
111 - Cd	Ge + In + Tb					
120 - Sn	Ge + In + Tb					
121 - Sb	Ge + In + Tb					
137 - Ba	In + Tb					
203 - Tl	Tb + Bi	X	X	X	DEFAULT INTERNAL STANDARD	
208 - Pb	Tb + Bi					
238 - U	Tb + Bi					

ISTD Elements
Sc - 45
Ge - 72
In - 115
Tb - 159
Bi - 209

	Always check on-line for validity.	Level: 
	Metals by ICPMS by Methods SW-846 6020/6020A/6020B(waters, solid, tissue) and EPA 200.8 (waters)	Work Instruction
Document number: T-MET-WI11933		
Old Reference: 1-P-QM-WI-9018443		
Version: 13		Organisation level: 5-Sub-BU
Approved by: X6TJ Effective Date: 27-JUL-2022	Document users: 6_EUUSLA_Metals_ICP-MS Analysis, 6_EUUSLA_Metals_ICP-MS Analysis Verifiers, 6_EUUSLA_Metals_Management	Responsible: 5_EUUSLA_Metals_Manager

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Revision Log

Revision: 13	Effective Date:	This version
Section	Justification	Changes
Revision Log	Formatting requirement	Removed revision logs up to the previous version
Throughout	Combined SOPs	Removed cross references to T-MET-WI11939.
Procedure E.2.	Enhancement	Added note to reference Internal Standard Attachment.
QAQC 11.	Enhancement	Added note to reference Internal Standard Attachment. Added reference to Verification SOP.

Revision: 13	Effective Date:	This version
Section	Justification	Changes
Attachment	Enhancement	Attachment references internal standards used for analysis

Revision: 12	Effective Date:	This version
Section	Justification	Changes
Revision Log	Formatting requirement	Removed revision logs up to the previous version
Throughout	Update to current LIMS	Updated method references to current LIMS
Throughout	Combined SOPs	Combined with T-MET-WI18027 and T-MET-215089
Cross Reference	Updated document list	Updated document list to reference combined 7700 and 7900 maintenance procedures into T-MET-21590, and combined operations procedures into this procedure
Cross Reference	Formatting requirement per G-DC-FRM7674	Added prep procedure cross references associated with this analysis and removed higher level references that are not required.
Scope	Added Clarification	Added RL is same as LOQ
Sample Collection, Preservation, and Handling	Reflects current protocol	Updated to reference water digestion and prep SOPs, and updated temperature for stored aqueous samples.

Reference

1. Method 200.8 (rev 5.4), Determination of Metals and Trace Metals in Water and Wastes by Inductively Coupled Plasma-Mass Spectrometry, USEPA 600/R-94/111 May 1994.
2. Test Methods for Evaluating Solid Wastes, SW-846 Method 6020, September 1994.
3. Test Methods for Evaluating Solid Wastes, SW-846 Method 6020A, February 2007.
4. Test Methods for Evaluating Solid Wastes, SW-846 Method 6020B, Rev. 2, July 2014.
5. ESI SC Manual.
6. Agilent 7700 and 7900 Series ICP-MS MassHunter Workstation Guide and Hardware Maintenance Manual.
7. *Chemical Hygiene Plan*, current version.

Cross Reference

Document	Document Title
T-MET-WI12065	Working Instructions for Preparation of ICP-MS Solutions and Standards

Document	Document Title
<i>S-SS-WI10695</i>	Liquid Sample Preservation, Sample Splitting, and Turbidity for metals by EPA Methods 200.7 and 200.8
<i>T-MET-WI21590</i>	Instrument Maintenance for Agilent 7700 and 7900
<i>T-MET-WI35797</i>	Metals Data Verification Process
<i>T-MET-WI11925</i>	Client Specific - 3030 C. Treatment for Acid-Extractable Metals for North Carolina Groundwater Samples
<i>T-MET-WI11938</i>	Digestion of Waters by EPA 200.7/200.8 for the Analysis of Metals in Water by ICP or ICPMS
<i>T-MET-WI11941</i>	Sample Preparation of Wastewater and Leachates for Analysis of Total Metals by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP) and Inductively Coupled Plasma Mass Spectrometer (ICP-MS)
<i>T-MET-WI8636</i>	Sample Prep of Sediments, Sludges, Soils, and Tissues by SW846 3050B for ICP and ICP-MS
<i>T-MET-WI8639</i>	Sample Preparation of Waters for Analysis of Total Recoverable Metals by ICP-OES and ICP-MS
<i>T-MET-WI8732</i>	Lab and Field Filtered Waters and <1NTU Drinking Water Preparation for ICP (EPA 200.7, 6010B/C/D) or ICP-MS (EPA 200.8, 6020/A/B)

Scope

This procedure applies to analyses performed at Eurofins Lancaster Laboratories Environmental (ELLE) using ICP-MS for identification and quantitation of metallic constituents.

Aqueous undigested samples and digestates (aqueous and solid matrices) are analyzed via this SOP.

Limits of Quantitation (LOQs/RLs), Method Detection Limits (MDLs) and linear ranges are maintained in the LIMS. These are subject to change without notification.

This procedure is used for analysis and instrument operation for the Agilent 7700 and 7900 series ICPMS instruments.

Routine Methods

Analyte	Mass
Be	9
B	11
Na	23
Mg	24
Al	27
K	39
Ca	44
Ti	47
V	51
Cr	52
Mn	55
Fe	57
Co	59
Ni	60
Cu	63
Zn	66
As	75
Se*	78
Se**	82
Sr	88
Mo	98

Ag	107
Cd	111
Sn	120
Sb	121
Ba	137
Tl	203
Pb 206	206
Pb 207	207
Pb 208***	208
U	238
*Se 78 is the mass reported from collision cell ICPMS only	
**Se 82 is the mass reported from non-collision cell ICPMS only	
***For Pb masses 206, 207 and 208 are summed for calibration and analysis	

Basic Principles

ICP-MS is an analytical instrument that uses the energy of inductively coupled plasma to generate ions to be analyzed in the mass spectrometer.

The instruments use a discrete sampling system that first loads the sample into a Teflon sample loop. The sample is then pushed by a carrier solution using a computer controlled peristaltic pump that delivers the sample from the loop into the nebulizer attached to a cooled Scott double pass spray chamber.

The Agilent 7700 (E05) and 7900 (E07/E08/E09) can analyze samples in 3 different modes of operation, although typically analysis is done in 3 mode or No Gas mode only:

1. Mode 1 – no gas. This mode does not use a collision or reaction gas. Elements with a low atomic mass or that have no interferences can be analyzed using the “no gas” mode.
2. Mode 2 – Hydrogen (H₂) mode. This mode uses H₂ as a reaction gas, since it reacts quickly and efficiently with the Argon-based interfering species, but reacts slowly or not at all with the analyte(s) of interest. In this mode, interferences can be reduced to the level of baseline noise, allowing lower detection limits to be achieved for some difficult elements.
3. Mode 3 – Helium (He) mode. This mode uses He as a collision gas for reliable, predictable removal of unknown matrix interferences. No new interferences are formed in the cell, and no analytes are lost by a reaction.

Interferences

ICP-MS interferences include isobaric elemental interferences and polyatomic ion interferences derived from the plasma gas, reagents, and/or sample matrix. The Agilent 7900 utilize helium as an inert collision gas to reduce or eliminate many types of polyatomic ion interferences.

Physical interferences caused by the change in sample matrix affecting sample transport and/or nebulization must be compensated for using internal standardization.

Memory interference is the contribution of analyte signal from a previous sample onto the next sample analysis. Adequate rinse time with an appropriate rinse solution of the sample introduction system overcomes any memory interference.

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 the *Chemical Hygiene Plan* for general information regarding employee safety, waste management, and pollution prevention.

Preparing samples for inorganic analysis involves working with concentrated acids and other chemicals which are dangerous if not handled carefully:

Hydrochloric acid (HCl) – This acid can cause skin burns. Only mix with approved solutions. Always use this chemical in a fume hood.

Hydrofluoric acid (HF) – This acid is very toxic and absorbs through the skin without pain. This acid is found at trace levels in standard solutions.

Hydrogen Peroxide 30% (H₂O₂) - This oxidizer can cause skin burns. Always use in a fume hood.

Nitric acid (HNO₃) – This acid can cause skin burns and burning of the respiratory tract. Add nitric acid to samples in a fume hood to avoid exposure to toxic fumes.

When diluting strong acids, never add water to acid; always add acid to water.

Store concentrated acids in the prep room acid cabinets. Only acids are to be stored in these cabinets. Flammable solvents are stored in flammable liquid storage cabinets. Some concentrated acids are kept in the acid reagent bottles on prep room counters. Fill reagent bottles in an operating fume hood using caution to avoid spills.

Large spills are cleaned by HSE. For large spills of concentrated acid, immediately evacuate the area and dial 1-1-1. HSE will use spill pillows to absorb large acid spills (small spills are cleaned with wet paper towels.)

Dispose of acid waste properly. Collect all acid digestions, waste solutions, and expired reagent solutions in waste containers. When the acid waste containers are full, a designated acid waste handler transfers the waste to the acid neutralization tank.

Personnel Training and Qualifications

All personnel performing this procedure must have documentation of reading, understanding, and agreeing to follow the current version of this SOP and an annual documented Demonstration of Capability (DOC) which is maintained in the analyst's training records.

Initially, each analyst performing the instrumental analysis must work with an experienced analyst for a period of time until they can independently calibrate the instrument, use the sequence editor to set up the run, perform calculations, interpret raw data, and enter/transfer data into the LIMS. Proficiency is measured through documented audits of the tasks listed, and checking of data as well as an IDOC (Initial Demonstration of Capability) and continued DOCs (Demonstration of Capability) as defined in [QA-SOP11178](#).

The IDOC consists of four laboratory control samples (LCS) that are carried through all steps of the prep and analysis and meet the defined acceptance criteria. The criteria include the calculation of mean accuracy and standard deviation.

Sample Collection, Preservation, and Handling

Aqueous undigested samples, aqueous digestates, and solid digestates are analyzed via this SOP. Samples must be analyzed within 6 months of collection for all methods in this SOP.

Aqueous samples are collected in plastic or glass containers. Drinking Water samples are collected in 1-L plastic or glass containers. Aqueous samples are preserved with nitric acid with a pH of < 2 and stored at 0° to 6°C, not frozen, or at room temperature.

Aqueous digestates are digested per the method in [T-MET-WI11938](#) (aqueous samples 200.8), [T-MET-WI8639](#) (aqueous samples 3005A). Aqueous non-digested samples are prepared per the method in SOP [T-MET-WI8732](#) (lab and field filtered waters and <1NTU Drinking water). Aqueous samples are stored in 50 ml plastic vials at room temperature.

Solid samples are collected in glass containers and stored at 0° to 6°C, not frozen. Digestates are digested per the method in SOP [T-MET-WI8636](#). Solid samples are stored in 100 ml plastic vials at room temperature.

Store standards and digestates separately.

The general practice in the metals group is to discard the digestions after all the required metals from a batch of samples have been analyzed and lab completed in the LIMS. Samples which require the digestate to be held for long term storage are periodically evaluated for discard.

Apparatus and Equipment

A. The following is a list of the hardware used in the Agilent 7700 and 7900 ICP-MS systems.

1. Inductively Coupled Plasma Mass Spectrometers (ICP-MS)

a. The Agilent 7700 and 7900 - The sample introduction system consists of an ESI FAST discrete sampling system, Teflon nebulizer and cooled spray chamber attached to a concentric quartz tube plasma torch.

2. Autosampler

a. The Agilent 7700 and 7900 (E08) systems use an ESI SC-8 FAST autosampler. The Agilent 7900 (E07 & E09) systems use an ESI SC-14 FAST autosampler. The autosampler parameters for each automated run are entered into the Sample List in MassHunter software.

3. Coolflow

a. The Agilent 7700 and 7900 G3292A Recirculating Chillers are set up to deliver cooling liquid to the ICP-MS at a regulated pressure of ~40 psi.

4. Computer

a. The Agilent 7700 and 7900 are controlled by a Windows-based IBM compatible PC with MassHunter software installed.

5. Vacuum Pumps

a. The Agilent 7700 and 7900 both have a 2-stage vacuum system. A rotary pump evacuates the interface chamber; a turbo molecular pump evacuates the ion lens chamber and the analyzer chamber.

B. The following is a list of the apparatus necessary for the setup of an ICP-MS run for analysis:

1. ICP-MS prep batch sheets.

2. Test tube racks

3. Graduated 15-mL polypropylene tubes and caps

4. 50-mL polypropylene screw cap tubes

5. FilterMate 2 µm filters and plungers

6. 10-mL sterile disposable syringes

7. 25-mm syringe filters, PTFE, 0.45µm

8. 30-mL polypropylene medicine cups

9. Fixed volume hand-held pipettes (25 – 2000 µL) - Eppendorf or equivalent.

NOTE: For routine operation, calibration, and maintenance of fixed-volume, hand-held pipettes, see [QA-SOP11880](#).

Reagents and Standards

Refer to Form [T-MET-WI12065](#) for reagent and standard information and the preparation of the following standards and solutions

1. ICP-MS Calibration Standards and ICP-MS LOQ Check Standard Solution (CRI)

2. ICP-MS Initial and Continuing Calibration Verification Standards

3. Interference Check Solutions
4. Rinse/Carrier, Tuning, and Calibration Solutions
5. Internal Standard Solution
6. PDS Solutions
7. General Acids and Chemicals

Calibration

Before calibration is performed, allow the instrument to warm up for the recommended time, usually at least 15 minutes, if the plasma has been off for 15 minutes or less, or at least 30 minutes if the plasma has been off for more than 15 minutes. Daily tuning requirements must be performed prior to calibration of the instrument and after warm up occurs. Full Tuning and Optimization is done as needed, or when required by the Group Leader or Manager.

Calibration is performed daily. Calibrations consist of a blank and one to three standards, followed by analysis of an ICV, ICB, CCV, CRI, ICSA/ICSAB, LRC, CCV, and CCB.

A single point calibration, consisting of a blank and one standard, is used for all analysis, except Non-TNI samples requiring a multi-point calibration (either MA MCP or CT RCP protocol or a lab note indicating a multi-point calibration is needed). For samples requiring a multi-point calibration the calibration consists of a blank, "S1", "S2", and "S3" standards. The concentrations of the calibration standards are defined in [T-MET-WI12065](#).

For data review, acceptance criteria, and corrective action, see [T-MET-WI35797](#).

Procedure

A. Instrument Start Up

This procedure is the same for the Agilent 7700 (E05) and the 7900 (E07/E08/E09) instruments.

1. Power on the ESI autosampler and start the ESI software.
2. Make sure the instrument is powered on before starting the ICP-MS software – the light on the front of the instrument will be red (shutdown mode), orange (standby mode) or green (analysis mode).
3. If the instrument is powered down: flip the main power switch on the back of the instrument to the on position, and then make sure the Foreline Pump (red switch) is also in the on position.
4. Make sure the recirculating chiller power switch is in the on position. If the orange light on the front of the chiller is on, you will need to turn off the chiller and add coolant before turning the chiller back on.
5. Verify that the program is in Online mode – the Hardware tab will have a green check mark if it is online.
6. If the Hardware tab has a red x instead of the green check, click on the arrow down in the Hardware tab and select Communication. Select Online and click OK.
7. Check the Instrument Status pane. The instrument should be in one of three modes: Shutdown (plasma and vacuum off, red light on the front of instrument); Standby (plasma off but vacuum on, orange light on the front of instrument); Analysis (plasma and vacuum on, green light on the front of instrument).
8. If in Shutdown mode click on the Hardware tab arrow down and select Vacuum On – the Foreline pump will start and the instrument will transition to Standby mode.
9. Once Standby mode has been reached select Plasma On from the Plasma tab arrow down.
10. When asked if you want to "Run 'Startup' after plasma ignition?", select No.
11. The plasma will ignite and the instrument will transition to Analysis mode.

12. Once Analysis mode is achieved you must allow the instrument to warm up for at least 20 minutes before running the EPA Daily Tune check sample.

B. Running the Daily Tune Check

1. To run the EPA Daily Tune check place both probes into the EPA Tune Solution and allow sufficient time for the solution to flush through both lines.
2. Make sure the FAST valve is in the LOAD position.
3. Once the EPA Tune Solution is aspirating into the spray chamber take the following steps to start the EPA Daily Tune check.
4. Click on the arrow down for the Batch tab.
5. Open the batch "~ICPMS.b" by clicking on the file in the drop down menu or the pop up menu if necessary.
6. In the Batch pane select the Acq Method tab then the Tune tab.
7. Right click in the Signal Monitor grid and select Report, then Generate Tune Report.
8. In the window that appears verify that the Report Template selected is as follows:
C:\Agilent\ICPMH\Report Templates\en\Letter\Tune Report\TuneCheckReport.xltx
9. Click Generate. The software will acquire the tune check data from the instrument and a report will be printed.
10. If the EPA Daily Tune fails any of the criteria rerun the tune a second time. If it fails a second time take corrective action before running the EPA Daily Tune check again (maintenance or optimization of tuning parameters).

C. Sample analysis

1. Once the EPA Daily Tune passes all criteria, place the internal standard probe in the internal standard solution and place the carrier probe into the carrier solution.
2. Once the carrier and internal standard solution have flushed through the tubing and are aspirating into the spray chamber, sample analysis can begin.
3. In MassHunter open the method batch file used for analysis. Use ~ICPMS.b for non-potable waters and solids analyses, and ~ICPMS_nogas.b for drinking water analysis.

4. Save the batch with a new name:

YYMDDR## where:

YY is the two digit year

M is the letter of the alphabet corresponding to the month (A for January, B for February, etc.)

DD is the two digit day of the month

R is the letter of the alphabet that changes for each attempted run sequence

Example: For the first run started on March 19 in the year 2012 the batch folder would be named 12C19A01.b

5. Enter the calibration standards and lot numbers in the order of:

ICV/ICB/CRI/ICSA/ICSAB/LRC(s)/Rinse(s)/CCV/CCB

6. Scan all samples into the sample list and add PDS/SD and/or dilutions as needed.

7. Add a CCV/CCB block after every 10 samples (or ending the run) as well as an ending CRI/ICSA/ICSAB as needed per method or project note.

8. Enter the locations of the samples to match the rack in which they will be loaded onto the auto-sampler. Ensure that the order of the samples on the batch paperwork/re-read sheet match the order in which they are loaded.

9. Right click on the sample list and print a copy.

10. Use the print out to confirm the sample ID(s) and locations of the samples on the auto-sampler.

11. Load the auto-sampler based off of the printed out sample list. Sign off on the sample list with your initials, employee number and the date.

12. Keep the sample list with the batch(es) paperwork until the batch is imported into the LIMS. Note the analytical and prep batch(es) numbers on the sample list and give to the Group Leader.

D. Pouring an ICP-MS run (Waters only in 50 mL digestion tubes):

It is important to minimize any chance of contamination, to both yourself and the samples. Keep your hands and the work area clean at all times. Wear appropriate PPE at all times to prevent exposure to chemicals and samples including lab coat, gloves, and safety glasses, and additional PPE as required by project or health and safety.

NOTE: See Form [T-MET-WI 12065](#) for standards and solutions used during the analytical run.

1. Choose the appropriate prep batch sheet.

NOTE: When retrieving the batch from the shelf for the first time, record the batch location on the cap of the prep blank in black sharpie. This saves time when returning the batch to the proper location after analysis and shows that the batch has been poured before and verified to be in the correct order. To prevent more than one batch from being assigned to the same location, the digestion trays all have the location written on the foam holder.

2. Verify that each digestion tube is in the correct order according to the prep sheet. If anything is missing, correct the prep sheet and notify PREP or the Group Leader to correct the LIMS and put the sample back in for digestion. If the order is incorrect, reorder the sample digestion tubes to match the paperwork.

3. For batches prepared in hot blocks in 50-mL digestion tubes or prepared by the MTL_ND method:

a. The only tubes that typically need to be poured for the initial run are the post digestion spike (PDS) and serial dilution (SD) samples. These are prepared using the background sample (BKG) or the duplicate background sample (DUP) when limited sample volume is available.

b. All other samples remain in the 50-mL digestion tubes for analysis.

4. Samples that need to be poured into test tubes:

a. Obtain the appropriate number of tubes.

b. Write the last four digits of the sample number and the dilution factor if greater than 1 on each tube. If the MB or LCS must be in tubes, write MB/LCS and the prep batch number/location on the tubes.

c. Place tubes in test tube racks in the same order as the samples on the prep batch cover sheet and/or re-read.

d. The analyst must ensure that tubes are labeled correctly, that dilutions are performed accurately, and that the dilutions are recorded on the prep cover sheet and/or re-read.

5. Post-digest spike (PDS):

a. A PDS is required for each batch (sample volume permitting).

b. A PDS is prepared by pipetting 0.2 mL of the appropriate PDS solution into a 15-mL graduated test tube, and bringing it to a volume of 10 mL with the background sample, "BKG". If the PDS must be diluted, pipette 0.2 mL of the PDS solution into a 14 mL graduated test tube, add the appropriate amount of background sample, "BKG", and dilute to 10 mL using matrix rinse. If there is limited

volume for the background sample, "BKG", then the "DUP" may be used for dilutions of the PDS or SD. If the duplicate is used for PDS or SD, make an internal NCM on the analytical batch after analysis.

c. Record the lot number of the PDS solution used on the prep batch cover sheet and/or re-read.

6. Serial dilution (SD)

a. Prepare the SD by diluting the background sample at a dilution that is equal to 5× the dilution factor of the PDS sample (i.e. if PDS= DF1, SD must = DF5; if PDS=DF5, SD must=DF25).

7. Filtering samples

a. Samples that are cloudy or have particulate suspended in solution must be filtered prior to analysis to prevent clogging of the sample introduction system, which causes run failures and instrument down time to correct the problem.

b. Samples that are in the 50-mL digestion tubes may be filtered using the FilterMate filtration devices and plunger or a syringe and syringe filter.

c. Attach a filtration device to the plunger and very carefully insert the filter into the digestion tube until the filter reaches the bottom of the digestion tube.

d. Remove and discard the plunger.

e. An alternative for samples in any type of vessel is to filter using a 10-mL sterile disposable syringe fitted with a 0.45µm PTFE syringe filter.

f. If any samples are filtered, the MB and LCS must also be filtered. If any QC sample is filtered (BKG, DUP, MS, or MSD), then all QC including the MB and LCS must be filtered.

g. Document all filtrations on the prep batch cover sheet.

NOTE: It is not necessary to filter all samples (in 50 mL digestion tubes only) that contain particulate, as long as all of the particulate is settled to the bottom of the tube below the 5-mL mark in 50-mL digestion vessels. The sampling depth of the autosampler probe is set such that the tip of the probe is approximately 100 mm above the bottom of the digestion tube. It is necessary to filter all solid samples and to dilute to DF2 prior to analysis.

8. Verify that all samples in the hotblock tray are in the correct position and/or pour each sample (or sample filtrate) into the appropriate tube. Usually, the order of the batch QC is MB, LCS, (LCSD), Bkg, PDS, DUP, MS, (MSD), and SD. Most importantly, the actual positions of the samples in the tray must match the autosampler table used for analysis.

NOTE: Immediately prior to beginning analysis, the analyst must visually verify that each sample is in the position indicated in the autosampler table used for the run.

9. If not being analyzed immediately, cap any poured tubes to prevent contamination of the samples (digestion tubes and dilutions prepared in graduated test tubes must be capped tightly except during pouring and/or analysis).

10. Return samples to sample storage, being sure to place the batch back into the location recorded on the prep batch sheet.

11. Record the following on the prep batch cover sheet: initials, employee number, and the date, and lot numbers for PDS, filters, test tubes, as used).

12. NOTES:

a. A PDS and a SD are performed on one sample in each digestion batch. Typically, the background sample is chosen. If the batch QC is split between two samples, the PDS is performed on the background sample accompanied by a matrix spike; the SD is performed on the background sample accompanied by a matrix duplicate. If sample volume is limited, it is acceptable to use the duplicate for the PDS and SD.

b. Batches with only field blanks or equipment blanks do not need a PDS or a SD.

c. Air filter batches need only a SD on one sample in the batch (a PDS is not required).

d. "As Received" samples are analyzed with a blank and LCS, LCSD (prepared by the analyst).

e. Documentation is of utmost importance. Verify all entries.

E. Data analysis and Import

1. Once the sample run is complete you will switch to or open the Offline ICP-MS Data Analysis program to make any changes to internal standard selection and generate the file for import into LIMS. Note, the Attachment Internal Standard Reference includes the appropriate internal standards to reference for each metal.

2. Once in the Offline ICP-MS Data Analysis program open the batch that contains the run data you are going to process by clicking Open Analysis File (open folder icon or from the File drop down menu).

3. Evaluate appropriate internal standard selection based on the Quality Control section of this SOP and method requirements for the samples analyzed.

4. If it is appropriate to change internal standard selection from the defaults in the method used click the DA Method Editor button (skip to step e. if alternate internal standard selection is not needed).

select a. Under Method Development Tasks (in the left pane of the DA Method Editor window) "FullQuant" under item number 4 (Set up Analysis Parameters).

will b. Under the analyte list that appears in the right hand pane of the DA Method Editor you see a list of the analytes.

both c. Change internal standards for any analytes where alternate internal standard selection is necessary and appropriate.

d. Then click "Return to Batch-at-a-Glance" in the left hand pane.

e. When prompted to "Update Analysis Method?" select "Yes".

f. Click the "Process Batch" button to recalculate all concentration values in the batch folder using the internal standard selections you made while in the DA Method Editor.

5. To generate the file for import into LIMS you must first select all the data rows needed for your run, starting with the ICIS down to the last row in your run. If you restarted the run only select the most recent ICIS and all samples below it.

6. Once the appropriate rows of data are selected click on Tools and select "Upload to TALs" to run the script that compiles the file for import.

7. A pop up will appear once the script is complete stating that the file was created successfully. While the batch is still highlighted click on the Report tab. Generate the raw data PDF's and save them into the respective run's folder.

8. Open the ITUNE app and select the .rep file that was generated along with the tune file for that day. This will generate a new .rep file that will then be copied to the import folder. This will put the run into the LIMs system.

Calculations

1. Final Result

a. Water sample

$$\text{Instrument Reading} \times \frac{\text{Dilution Volume}}{\text{Aliquot Volume}} \times \frac{\text{Final Volume}}{\text{Sample Volume}}$$

b. Solid sample (mg/kg)

$$\text{Instrument Reading} \times \frac{\text{Dilution Volume}}{\text{Aliquot Volume}} \times \frac{\text{Final Volume}}{\text{Sample Weight (grams)}}$$

2. Relative percent different (RPD)

$$\text{RPD} = \frac{S - D}{(S + D)/2} \times 100$$

Where:

S = first sample value

D = duplicate sample value

3. Spike recovery

$$\% \text{ Recovery} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

Where:

SSR = spiked sample result

SR = sample result

SA = spike added

4. Correlation Coefficient

$$r = \frac{\sum XY - \frac{\sum X \sum Y}{N}}{\sqrt{(\sum X^2 - \frac{(\sum X)^2}{N})(\sum Y^2 - \frac{(\sum Y)^2}{N})}}$$

Where :

X = the known concentration

Y = the instrument response

N = the total number of data points

5. Serial Dilution

$$\% \text{ Difference} = \frac{(5 \times \text{SDR}) - \text{SR}}{\text{SR}} \times 100$$

Where:

SDR = serial dilution result

SR = sample result

6. Methods of standard additions (MSA)

Take either 4 identical aliquots (for 3 point MSA) or 2 identical aliquots (for one point MSA) of the same sample. Leave one unspiked. Spike the other 3 aliquots with different levels of a standard solution (for 3 point MSA) and spike the other aliquot at approximately the indigenous concentration of the sample (for one point MSA). Add blank solution to sample aliquots so that the final volume is the same for all. Use small volumes of spiking solution to avoid diluting the sample more than 10%. Analyze the 4 aliquots or 2 aliquots and record the instrument readings in absorbance. Use the readings and spike values to find the slope and x- and y- intercepts. The x- intercept is the result.

$$\text{Slope} = m = \frac{\sum x_i y_i - (\sum x_i \sum y_i) / n}{\sum x_i^2 - (\sum x_i)^2 / n}$$

$$\text{Y-Intercept} = b = \bar{y} - m\bar{x}$$

$$\text{Result} = -\frac{b}{m}$$

$$\text{Correlation Coefficient} = r = \frac{\sum \{(x_i - \bar{x})(y_i - \bar{y})\}}{\sqrt{[\sum (x_i - \bar{x})^2][\sum (y_i - \bar{y})^2]}}$$

The correlation coefficient (r) for the least squares fit must be ≥ 0.995 . If the r value is < 0.995 , the MSA must be repeated at the same dilution. If the r value is again low, the result with the higher r value is verified and both are flagged with a "+" in the data package. If the r value is < 0.990 , the sample is run at an interference dilution to overcome matrix effects. This usually requires a raised limit of quantitation. If a client requests a particular limit of quantitation that prohibits further dilution, then the sample is repeated at the same dilution and the best of the two results is verified.

7. Average, Standard Deviation and Relative Standard Deviation

The average result, \bar{x} , is calculated by summing the individual results and dividing this sum by the number (n) of individual values:

$$\bar{x} = \frac{X_1 + X_2 + X_3 + X_4 + \dots + X_n}{n}$$

Standard deviation is a measure of how precise the average is or how well the individual numbers agree with each other.

$$\text{Standard deviation, } S = \sqrt{\frac{(x_1 - \bar{x})^2 + (x_2 - \bar{x})^2 + (x_3 - \bar{x})^2 + \dots + (x_n - \bar{x})^2}{n - 1}}$$

Relative standard deviation (RSD) is expressed in percent and is obtained by multiplying the standard deviation by 100 and dividing this product by the average.

$$\text{Relative standard deviation, RSD} = \frac{100 \times S}{\bar{x}}$$

Statistical Information/Method Performance

Generate MDLs and LOQs according to [QA-SOP11892](#).

The department principal scientist and manager maintain annual study data. The department principal scientist, manager, and/or group leader requests that a Quality Assurance Specialist update to the LIMS as needed by department email.

Refer to [QA-SOP11896](#) for statistical information.

Quality Assurance/Quality Control

A. For 6020, 6020A and 6020B, each digestion batch (up to 20 samples) must contain a method blank, LCS, and either an BKG, DUP, MS, MSD or an LCS/LCSD (limited volume or approved by manager and QA only).

B. For 200.8, each digestion batch (up to 10 samples) must contain a method blank, LCS, and either an BKG, DUP, MS or an LCS/LCSD (limited volume or approved by manager and QA only). An additional BKG and MS are added for batches over 10 samples up to 20 samples.

C. QC limits for MS/MSD, and LCS/LCSD are established through statistical analysis of historical data.

1. The limits are maintained in the LIMS in Method Limit Groups.
2. The limits are evaluated every 6 months and updated as needed.
3. The limits are subject to change without notification.

D. Batch Quality Control

1. For the preparation and concentrations of Quality Control samples see [T-MET-WI12065](#).
2. For the frequency, acceptance criteria and corrective action see [T-MET-WI35797](#).

E. Raw data quality checks

1. Make sure that the run is correctly labeled, and dated and that the corresponding prep sheet is attached to the run.
2. Verify that the appropriate Tuning Report is with the run.

3. For run and batch QC/Calibration frequency, acceptance criteria and corrective action, see [T-MET-WI35797](#) tables.

4. Spike levels of batch QC are available in the LIMS and on T-MET-WI9082.

5. LOQs (RLs), MDLs, and IDLs are available to analysts in the LIMS in Method Limit Groups and Equipment Limit Groups.

6. Check to make sure that all results are not > 90% of the Linear Range, according to LIMS Equipment Limit Groups. If a sample reading is above 90% of the linear range, then reread the sample at a dilution sufficient to bring the sample concentration to approximately the middle of the calibration range.

7. Check that the **absolute** value of all non-detected analytes is less than the RL. A technical decision must be made as to whether a reread is warranted for readings $< |RL|$.

8. Check for carryover between samples. Sample RSD >20%, with a concentration > the LOQ decreasing progressively over time (i.e., Reading $3 < 2 < 1$). Flag any suspect samples for reread.

NOTE: Whenever a sample is encountered that exceeds the calibration range, the following sample must be checked for carryover for the over range analyte (s) and any suspect results must be deselected and reanalyzed. During reanalysis the sample order must be modified as needed to avoid carryover from any over range sample(s).

9. For all EW (samples from public drinking water sources), highlighted mint green in the LIMS, check the results against the MCL (maximum contaminant level) by reviewing the limits tab in analyst desktop II. If an analyte **exceeds** the MCL, is a certified analyte for the SDWA method, and is associated with a mint green compliance drinking water sample, notify the verification group at once by NCM or email. An automated email is sent to the Client Service Representative and the state for the analytes listed below with the exception of Pb and Cu which follow the 90th percentile rule (the CSR tracks the lead and copper and notifies the supplier when necessary). Suppliers must be notified within the required time limit as stated in QA-SOP11886.

10. To avoid the risks associated with polyatomic interferences in wastewater and soil matrices all analytes must be analyzed on the collision cell ICP-MS instruments which include Agilent 7900, Equipment E07 - 27813, Equipment E08 - 30647, Equipment E09 - 30921).

a. Because EPA 200.8 rev. 5.4 does not currently allow the analysis of drinking water samples using collision cell ICP-MS all drinking water samples must be analyzed using a method with no gas mode for all analytes on the Agilent 7700, which includes Equipment E05 - 19204.

11. Check the internal standard level for the entire run. Reference the Internal Standard Reference attachment in this SOP for the appropriate internal standards to use for each metal. If the internal standard reading for any sample is out of the acceptance range of the S0 reading, evaluate whether this is a result of the sample matrix or drift from other samples in the run. Only reread the sample at a dilution if the internal standard appears to be out of range due to the sample matrix. For samples where an internal standard is above the acceptance range it is acceptable to reprocess the data using an alternate internal standard. This is the preferred approach in order to avoid raised reporting limits. The acceptance criteria differ based on the method being used. Refer to [T-MET-WI35797](#) for the method acceptance criteria.

NOTE: The internal standard is added in equal concentration to all of the samples and standards via a dedicated line on the peristaltic pump. The analytical lines referenced to an internal standard report a corrected concentration value based on the ratio of analyte to internal standard intensities. All the calculations for determining concentration are based on Intensity Ratio (IR). The IR is defined as the background corrected intensity signal of the

analyte line (Ia) divided by the internal standard value (Iis). IR= Ia/Iis.

12. For TCLP and SPLP samples, an MSA (method of standard additions) is required if:
- The sample concentration falls between 80% and 100% of the regulatory limit.
 - If the TCLP or SPLP matrix spike (QA) recovers <20%, all samples in the leachate batch must be reanalyzed using the method of standard additions for that analyte.
13. When items 1 – 12 are complete, check the following:
- All samples requiring reread/redigestion are listed on the reread paperwork, and redigestions are communicated to the verification group by email.
 - The data are uploaded to LIMS via data transfer to TALS.

Figure I - Daily Performance Acceptance Criteria and Tuning Solution Concentrations

Be (9)	10 or 100 PPB
Mg (24)	10 or 100 PPB
Co (59)	10 or 100 PPB
In (115)	10 or 100 PPB
Pb (208)	10 or 100 PPB
CeO/Ce	<3%
Ce++/Ce	<3%
Background	<30 cps @ Mass 220
RSD	<5%
Peak Width at 10% Peak Height	<0.9 AMU
Res/Axis	< +/- 0.1 AMU from unit mass

Attachment:
Internal Standard Reference (.pdf)

10695 Liquid Sample Preservation, Sample Splitting, and Turbidity for metals by EPA Methods 200.7 and 200.8
11178 Demonstrations of Capability
11880 Laboratory Equipment Verifications - Balance, Syringe, Pipette, Weights, and Other Equipment
11892 Determining Method Detection Limits and Limits of Quantitation
11896 Establishing Control Limits
11901 Instrument Maintenance and Calibration
11925 Client Specific - 3030 C. Treatment for Acid-Extractable Metals for North Carolina Groundwater Samples
11938 Digestion of Waters by EPA 200.7/200.8 for Analysis of Metals by ICP/ICPMS
11941 Sample Preparation of Wastewater and Leachates for Analysis of Total Metals by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP) and Inductively Coupled Plasma Mass Spectrometer (ICP-MS)
12065 Working Instructions for Preparation of ICP-MS Solutions and Standards
21590 Instrument Maintenance for Agilent 7900
35797 Metals Data Verification Process
6869 Nonconformance Form
8636 Sample Prep of Sediments, Sludges, Soils, and Tissues by SW846 3050B for ICP and ICP-MS
8639 Sample Preparation of Waters for Analysis of Total Recoverable Metals by ICP-OES and ICP-MS
8732 Lab and Field Filtered Waters and <1NTU Drinking Water Preparation for ICP (EPA 200.7,



End of document

Version history

Version	Approval	Revision information	
11	12.NOV.2020		
12	15.APR.2022		
13	27.JUL.2022		

Mass - Element	Possible ISTD	Internal Standard Elements				
		Sc - 45	Ge - 72	In - 115	Tb - 159	Bi - 209
9 - Be	Sc	DEFAULT INTERNAL STANDARD	Possible Use As Internal Standard	X	X	X
11 - B	Sc					
23 - Na	Sc + Ge					
24 - Mg	Sc + Ge					
27 - Al	Sc + Ge					
39 - K	Sc + Ge					
44 - Ca	Sc + Ge					
47 - Ti	Sc + Ge					
51 - V	Sc + Ge					
52 - Cr	Sc + Ge					
55 - Mn	Sc + Ge					
57 - Fe	Sc + Ge + In					
59 - Co	Sc + Ge + In					
60 - Ni	Sc + Ge + In					
63 - Cu	Sc + Ge + In					
66 - Zn	Sc + Ge + In					
75 - As	Sc + Ge + In					
78 - Se	Sc + Ge + In					
88 - Sr	Ge + In	X	X	X	X	
98 - Mo	Ge + In					
107 - Ag	Ge + In + Tb					
111 - Cd	Ge + In + Tb					
120 - Sn	Ge + In + Tb					
121 - Sb	Ge + In + Tb					
137 - Ba	In + Tb					
203 - Tl	Tb + Bi	X	X	X	DEFAULT INTERNAL STANDARD	
208 - Pb	Tb + Bi					
238 - U	Tb + Bi					

ISTD Elements
Sc - 45
Ge - 72
In - 115
Tb - 159
Bi - 209

	Always check on-line for validity.	Level: 
	Parent and Alkyl Substituted PAHs and Geochemical Biomarkers by 8270C/D/E SIM by GC/MS	
Document number: T-SVOA-WI9252		Work Instruction
Old Reference: 1-P-QM-WI-9012766		
Version: 9		Organisation level: 5-Sub-BU
Approved by: XL3S Effective Date: 16-NOV-2020	Document users: 5_EUUSLA_GC/MS Semivolatiles_All	Responsible: 5_EUUSLA_GC/MS Semivolatiles_Manager

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Revision Log

Revision: 09	Effective Date:	This version
Section	Justification	Changes
Revision Log	Formatting requirement	Removed revision logs up to the previous version
Throughout Document	New method update	Added references to 8270E
LIMS ID	Reflects current LIMS IDs	Replaced eLIMS analysis numbers with TALS method names
Reference	Reflects current practice	Updated 8000D method reference date
Cross Reference	Reflects current practice	Updated 3510C extraction reference, removed Nonconformance Form, and added Calculations reference
Basic Principles	Enhancement	Added statement about SIM analysis
Personnel Training and Qualifications	Enhancement	Added IDOC spiking and acceptance criteria
Apparatus and Equipment	Reflects current LIMS	Replaced Target with TALS Chrom

Revision: 09	Effective Date:	This version
Section	Justification	Changes
Reagents and Standards	Reflects current documentation	Removed most standard prep information as this information is now contained in T-SVOA-W/11998
Calibration	Update to current TNI standard	Added discussion about when it is okay to drop points from a calibration. Replaced two consecutive CCV failure protocol with new protocol
Procedure	Reflects current practice	Added exception to DFTPP criteria – TF and BD must pass if analyzing work for certain clients or agencies
Calculations	Reflects current documentation	Removed calculations and referred to T-SVOA-FRM9602
Statistical Information/Method Performance	Clarification/Enhancement	Reworded entire section
Quality Assurance/Quality Control	Clarification/Enhancement	Reworded entire section
Table I	Reflects current practice	Updated to use ion abundance criteria found in method 8270D

Revision: 08	Effective Date:	16-OCT-2019
Section	Justification	Changes
Revision Log	Formatting requirement	Removed revision logs up to the previous version
Title	Enhancement	Added methods for analysis and shortened title by using initials
LIMS ID	Reflects current practice	Removed deactivated scans
Reference	Reflects current practice	Updated references to most recent versions; added 8270D method reference
Personnel Training and Qualifications	Reflects current practice	Updated to reflect current DOC/IDOC guidelines
Sample Collection, Preservation, and Handling	Reflects current practice	Updated storage condition of extracts and added sample container types
Apparatus and Equipment	Enhancement	Added column and amber GC vials with crimp caps; removed volumetric flasks
Reagents and Standards	Reflects current practice	Added statement regarding storage conditions and equivalencies; updated stocks to reference what is currently used; moved standard prep information to this section
Calibration	Reflects current practice	Changed ICV %D from 25 to 30%
Procedure	Enhancement	Added information about DFTPP
Calculations	Flow	Moved all calculations to this section and added missing calculations
Statistical Information/Method Performance	Enhancement	Added statement that if more stringent criteria are needed, we will use that rather than statistically derived limits
Quality Assurance/Quality Control	Enhancement Reflects current practice	Added that an extraction batch consists of = 20 samples Updated acceptance criteria and corrective actions.

Revision: 08	Effective Date:	16-OCT-2019
Section	Justification	Changes
Table II/Table III	Reflects current practice	Removed alkanes and a couple PAHs from the table as the pieces were deactivated
Throughout document	Reflects current practice	Removed reference to DPnB and alkanes as they're no longer offered

Reference

1. Test Methods for Evaluating Solid Wastes, SW-846 Method 8270C, Rev. 3, December 1996.
2. Test Methods for Evaluating Solid Wastes, SW-846 Method 8000D, Revision 5, July 2018.
3. SW-846 Test Method 8270D: Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry, Rev. 5, February 2015.
4. Hazardous Waste Test Method, SW-846 Test Method 8270E, June 2018.
5. LSU-RCAT SOP#001-08
6. Method 5-B3, USGS
7. Chemical Hygiene Plan, current version.

Cross Reference

Document	Document Title
T-OE-SVOA-WI10880	Microwave Extractions for the Determination of Semivolatiles in a Solid Matrix
T-OE-SVOA-WI10928	Microwave Extraction by Method 3546 for Semivolatiles
T-OE-SVOA-WI11432	Separatory Funnel Extraction by Method 3510C for BNAs in Wastewater
T-SVOA-WI9598	GC/MS Preventative and Corrective Maintenance
T-SVOA-WI11998	Semivolatile Spiking and Calibration Standards
T-SVOA-FRM9602	Dept 4026 Calculations
QA-SOP11178	Demonstrations of Capability

Scope

This method is suitable for the determination of parent and Alkyl substituted PAH compounds and Geochemical biomarkers in solid, water, oil, and tissue samples. The analysis applies to a concentration range that spans from an MDL of 0.02 µg/L in water (0.67 µg/kg for solid) to an upper calibration concentration of 10 µg/L in water (330 µg/kg in solid) for PAHs. Geochemical biomarkers are evaluated to a signal to noise ratio of 3:1.

Basic Principles

A predetermined aliquot of a mixture of organic compounds in methylene chloride is injected onto a fused silica capillary column coated with a relatively non-polar stationary phase, which is enclosed in a temperature controlled oven. A carrier gas, ultra pure helium, passes continuously through the column. The GC oven is temperature programmed and the organic mixture separates into its individual components as it moves along the length of the column. This separation is a function of the polarity and boiling point of the individual compounds. The column empties into a mass selective detector. When a compound reaches the detector, it is bombarded by high energy electrons (70 eV). This causes the compounds to fragment, forming ions. By applying various voltages to lenses in the area where the ions are formed, the positive ions are thrust into a quadrupole mass analyzer, which selects for a given mass fragment at a given time. These selected fragments reach an electron multiplier, which detects and generates a signal for each mass fragment. The signals are amplified and sent to a computer making storage and manipulation of the data possible. By analyzing for specific masses over a narrow mass range, SIM analysis allows for longer dwell times at specific masses. This allows for significantly greater sensitivity of analysis with a small reduction in specificity of analysis.

Target compounds are identified on the basis of relative retention times and spectral match to standards that are injected every 12 hours on the same system. Quantification is achieved via use of the internal standard calibration technique.

Reference Modifications

Analytical grade reference standards are not commercially available for all of the Alkyl homologs and geochemical biomarkers detected in this method. Therefore, the response factor (RF) for each Alkyl homolog series and the

geochemical biomarkers is derived from a representative target compound, which has been specifically identified for that homolog series or biomarker. (See table III)

Interferences

Method interferences may be caused by impurities in solvents, reagents, glassware, or other hardware used in the processing of samples. All glassware is solvent rinsed before use and a method blank is performed with each extraction batch to demonstrate that the extraction system is free of contamination.

Sample matrices can have an effect on the ability of the GC/MS system to resolve the individual masses used for quantification. Samples may require dilutions, a reduction in the extraction volume/weight used, a raised final extraction volume, or extract clean-up using various techniques in order to achieve proper target separation and determination.

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 should 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, lab coats, safety glasses, and gloves.

All solvent waste generated from this analysis must be collected for recycling (if applicable) or must be disposed of in designated containers. These will then be transferred to a lab-wide disposal facility. Any solid waste material (disposable pipettes, broken glassware, pH paper) must be disposed of in the normal solid waste collection containers or sharps containers, as applicable.

Personnel Training and Qualifications

All personnel performing this procedure must have documentation of reading, understanding, and agreeing to follow the current version of this SOP and an annual documented Demonstration of Capability (DOC) which is maintained in the analyst's training records.

Initially, each analyst performing instrumental analysis must work with an experienced analyst for a period of time until they can independently perform daily maintenance, calibrate the instrument, change the column, clean the source, interpret chromatograms, perform calculations, review data, and enter data into the LIMS. Proficiency is measured through documented audits of the tasks listed and over checking of data as well as an Initial Demonstration of Capability (IDOC).

The IDOC consists of four laboratory control samples that are spiked at 1-4x the LOQ and are carried through all steps of the procedure. The defined acceptance criteria must be met. The criteria include the calculation of mean accuracy and standard deviation. The mean accuracy for all compounds must fall within the laboratory's most recent statistically derived LCS limits $\pm 20\%$ and must exhibit a standard deviation $\leq 20\%$.

It is a requirement that Demonstration of Capability (DOC) studies are performed by each analyst on an annual basis. Various options are available for a DOC and can include four laboratory control samples or one blind sample. Refer to [QA-SOP11178](#) for more guidance on these options.

Sample Collection, Preservation, and Handling

Water samples are collected in 250mL or 1L glass amber glass containers with PTFE-lined lids and may be preserved with sodium thiosulfate ($\text{Na}_2\text{S}_2\text{O}_3$). They are stored at 0°C to 6°C, not frozen, prior to extraction and must be extracted within 7 days of collection.

Solid samples are collected in glass wide-mouth jars with PTFE-lined lids and are not preserved. They are stored at 0°C to 6°C, not frozen, prior to extraction and must be extracted within 14 days of collection.

All sample extracts must be stored at $\leq -10^\circ\text{C}$ (freezer) and protected from light using amber glass vials. All samples, sample extracts, and standards must be stored separately and in an area free from contamination. All extracts must be analyzed within 40 days of sample extraction.

Apparatus and Equipment

1. Hewlett-Packard/Agilent 6890 Gas Chromatograph or equivalent.
2. Hewlett-Packard/Agilent 5973, 5975 Mass Selective Detector or equivalent.
3. Hewlett-Packard Chemstation Software
4. Test America Chrom PeakReview © 2014 or equivalent.

5. Column – 30M x 0.25 mm ID x 0.25 µm df Restek XT15– 5SIL MS or equivalent
6. Hamilton Gastight syringe, or equivalent – various volumes
7. Amber GC vials with crimp caps

Reagents and Standards

All reagents are stored per manufacturer guidelines unless otherwise noted. Standard/spiking concentration and reagent vendors are subject to change without notification.

A. Reagents

1. Helium carrier gas, UPC grade
2. Methylene chloride (MeCl₂ or CH₂Cl₂) – Baker Ultra Resi-Analyzed

B. Standards

All standards are capped, labeled, and refrigerated at 0°C to 6°C in amber glass GC vials. Standards are prepared every 6 months or sooner as needed. Do not measure volumes <20% of syringe capacity. Preparation of all standards is recorded in the Reagent module in LIMS.

1. Windowing Standard - Weigh 0.25g of a suitable reference oil into 20 mL of methylene chloride.
2. Refer to [T-SVOA-WI11998](#) for all other standard preparation instructions.

Calibration

A. PAH

Standardization is performed by analyzing at least five levels of calibration standards ranging from 0.05 µg/mL to 10 µg/mL for PAHs and representative biomarker compounds. One of the calibration standards is at a concentration at or below the reporting limit (RL). The other concentrations correspond to the expected range of concentrations found in samples or define the working range of the GC/MS system.

Use the internal standard calibration technique to generate an average relative response factor for each target compound and surrogate. The relative standard deviation (%RSD) of the response factors determines the suitability of the average relative response factor for calculation of compound concentration. At the end of the calibration standard injections, inject a Method Detection Limit (MDL) standard and an initial calibration verification (ICV) standard. See the tables below for acceptance criteria and corrective actions.

Frequency	Acceptance Criteria	Corrective Action
Initially and then when the daily calibration standard fail criteria. Initially establish with at least five levels of standards and an MDL standard and ICV.	<ol style="list-style-type: none"> 1. %RSD ≤ 30%. 2. All compounds of interest must be detected in the MDL standard. 3. The relative retention times of the target compounds must agree within 0.06 relative retention time units. 4. Structural isomers that produce very similar mass spectra should be identified as individual isomers if they have sufficiently different GC retention times. Sufficient GC resolution is achieved if the height of the valley between two isomer peaks is <25% of the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs. 	<ol style="list-style-type: none"> 1. Any target analyte with a %RSD of ≤ 30% should use the average RRF. 2. Re-inject any levels that appear to be outliers due to an injection error or calibration standard issue. 3. If standard levels on the outside of the curve appear to be outliers for individual compounds and are throwing off the calibration curve, they can be dropped from the calibration keeping the following in mind: <ol style="list-style-type: none"> a. If a low calibration point is dropped, the analyst must ensure that the compound is still being calibrated to or below its LOQ. b. If a high calibration point is dropped, any detections must recover below the new upper calibration limit. c. Use of the average relative response factor requires at least four calibration levels. 4. Re-prep calibration standards. 5. If a %RSD is >30%, more aggressive maintenance may be

		<p>needed.</p> <p>6. If a compound is not detected in the MDL standard, then report to the level of the lowest standard detected. All compounds manually integrated in this standard must be checked for in each sample analyzed under this initial calibration.*</p> <p>7. Perform more aggressive system maintenance as outlined in T-SVOA-WI9598 and re-calibrate.</p>
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*If these situations occur, your supervisor is to be consulted immediately.

B. ICV

ICV Frequency	Acceptance Criteria	Corrective Action
Immediately following an initial calibration and before sample analysis	<ol style="list-style-type: none"> The ICV must be prepared at the mid-point of the calibration using a second source standard. The %D must be $\leq 30\%$ for all compounds. The EICP area for each internal standard must fall within the window of -50% to +100% of the areas from the mid-level calibration standard produced during the initial calibration. 	<ol style="list-style-type: none"> Re-prep and re-analyze the ICV. If the recovery for any analyte fails these criteria low, the analyte cannot be analyzed for under the calibration until a new calibration has been established or a new ICV is analyzed. If the recovery for any analyte fails these criteria high, the analyte may be analyzed for but any samples with detections should be re-analyzed under a valid ICAL or will be reported with a qualifying comment.* Perform more aggressive system maintenance as outlined in T-SVOA-WI9598 and re-calibrate.

*All data associated with failed quality control will be qualified on the final report. QC outlier qualifiers are added to the associated sample results on the report by the LIMS.

C. Continuing Calibrations

PAH Calibration

Frequency	Acceptance Criteria	Corrective Action
<ol style="list-style-type: none"> Every 12 hours. The CCV is analyzed each day a curve is not analyzed. The CCV is analyzed after the DFTPP. 	<ol style="list-style-type: none"> %Drift $\leq 20\%$ for PAHs and representative biomarker compounds. Up to 10% of the compounds can have $\leq 30\%$ Drift. The relative retention times of the target compounds must agree within 0.06 relative retention time units. The exception would be for the case of system maintenance. The EICP area for each internal standard must fall within the window of -50% to +100% from the mid-level calibration standard produced during the initial calibration. Structural isomers that produce very similar mass spectra should be identified as individual isomers if they have sufficiently different GC retention times. Sufficient GC resolution is achieved if the height of the valley between two isomer peaks is <25% of the sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs. 	<ol style="list-style-type: none"> If the recovery for any analyte fails these criteria high, the analyte may be analyzed for but any samples with detections should be re-analyzed under a valid CCV or will be reported with a qualifying comment.* If the recovery for any analyte fails these criteria low, the analyte cannot be analyzed for under the calibration until a new calibration has been established or a passing CCV has been analyzed. Perform more aggressive system maintenance as outlined in T-SVOA-WI9598 and re-calibrate.

*All data associated with failed quality control will be qualified on the final report. QC outlier qualifiers are added to the associated sample results on the report by the LIMS.

In the event that the CCV fails and the cause is not obvious such as in the case of a concentrated standard or a mis-injection, corrective action must be taken. The corrective action must be documented in the form of a non-conformance memo or with an internal non-conformance form (*Q-EQA-FRM6869*). If the CCV does not pass after corrective action, a new initial calibration must be established.

D. Alkyl substituted PAH and Biomarker Calibration

The RF for each Alkyl homolog series and geochemical biomarker compound is derived from a representative target compound. The response for that compound is assumed to represent the RF for the homolog series or biomarker compound. See Table III for mass ion assignments and for associated internal standards.

NOTE: The naphthobenzothiophene response factor is derived from the dibenzothiophene calibration.

E. Windowing Standard

Every 12 hours a windowing standard must be analyzed following the injection of a valid DFTPP. The windowing standard ensures all of the ions used to quantify the Alkyl PAHs are falling within the appropriate SIM scan windows and is used to update the retention times for the Alkyl PAHs and geochemical biomarkers.

Procedure

A. Standard preparation

Solutions are used to standardize the GC/MS system every 12 hours. See Reagents and Standards or *T-SVOA-WI11998* for standard preparation. Calibration solutions may be used up to the labeled expiration date or until component degradation is observed. Degradation is determined by the inability to pass continuing calibration checks or by observations of unacceptable chromatography.

Internal standard mix is added to all standards and subsequent samples at a concentration of 1 µg/mL. Using a 25 µL syringe, 10 µL of internal standard are added to 1 mL of sample extract or standard. See Table III for the list of compounds calibrated for and the internal standard that is assigned to each.

B. Daily maintenance

Refer to *T-SVOA-WI9598* for this procedure.

C. Instrument conditions

Equip a GC/MS (as referenced under Apparatus and Equipment) in the following manner:

1. Column – 30M x 0.25 mm ID x 0.25 µm df Restek XT15– 5SIL MS or equivalent
2. Injector – Split/splitless operated in splitless mode
3. Injection Pressure – 40 PSI for 0.2 minutes
4. Injector Temp – 285°C
5. Transfer Line Temp – 280°C
6. Gas – Helium at approximately 1 - 2 mL/min, constant flow mode
7. Oven Temp – 50°C hold for 1 min; Ramp at 12°C/ min to 220°C hold 0.0 min; Ramp at 5°C/min to 315°C hold for 1 min.

NOTE: It is not necessary to use the exact parameters listed above. Equivalent columns and conditions may be used to improve the linearity, sensitivity, overall chromatography, and performance required by the method on each GC/MS system.

D. Tuning

1. The DFTPP tune check standard is used to assess GC column performance and injection port inertness as well as mass spectrometer performance. The GC/MS system's tune is checked by inspecting the mass spectrum of the DFTPP peak and column performance and injection port inertness is evaluated with pentachlorophenol, benzidine, and DDT.

2. The GC/MS should be tuned using a predetermined aliquot of a 50 ng/µL solution of DFTPP containing decafluorotriphenylphosphine, pentachlorophenol, benzidine, and DDT. This solution is prepared as indicated in *T-SVOA-WI11998*. See the table below for acceptance criteria and corrective actions.

Frequency	Acceptance Criteria	Corrective Action

Frequency	Acceptance Criteria	Corrective Action
Prior to initial calibration and every 12 hours prior to continuing calibration standard	1. Criteria in Table I 2. DDT breakdown $\leq 20\%$ * 3. Tailing factors* <ul style="list-style-type: none"> - Benzidine ≤ 2 - Pentachlorophenol ≤ 2 	1. Re-tune. Analysis cannot proceed until tune meets criteria. 2. More aggressive injection port maintenance. 3. Clean the source. 4. Change the column.

NOTE: The DDT breakdown and peak tailing is evaluated to monitor system performance, but no corrective action is needed unless a client, state, or agency requires that the acceptance criteria be met.

3. Use only the background-subtracted spectrum of the following when evaluating the DFTPP:

A three scan average of the apex of the scan, the apex of the scan -1, and the apex of the scan +1.

4. Once DFTPP meets all acceptance criteria, standardization can occur.

NOTE: All standards, samples, and associated quality control samples analyzed with a particular tune must use the identical conditions of the mass spectrometer.

E. Calibration

See calibration section for initial calibration and continuing calibration criteria.

F. Analysis of Samples

1. All sample extracts are stored at $\leq -10^{\circ}\text{C}$ and protected from light from the time of sample extraction.

2. Prior to sample analysis, add 10 μL of internal standard to each 1.0 mL of sample extract. Concentration of internal standard in extract is 1 ng/ μL .

3. Analyze a predetermined aliquot of each sample extract under the same conditions used for the initial and continuing calibrations.

4. At the conclusion of data acquisition, use the same software to tentatively identify peaks within the retention time window of interest. Examine the ion abundances of components of the chromatogram. If the ion abundance of the target ion used for quantitation exceeds the calibration range, dilute the aliquot and reanalyze.* When preparing dilutions, add sufficient internal standard to maintain the same concentration as that of the ICAL. Initial dilutions are recommended in the following situations:

- a. More than three internal standard areas are less than -50%.
- b. Either of the last two internal standard areas are less than -80%.
- c. The analyst's judgment of a sample extract's color or viscosity indicates possible matrix interference.

*Due to the nature of the alkyl PAH homologues, dilutions are performed when the concentration of the target homolog exceeds 10 ppm for the average of one peak. Example: If the homolog contains 5 main peaks and the calculated concentration is greater than 50 ppm a dilution is performed for that homolog.

G. Qualitative Analysis

A compound is identified by comparison of the following parameters with those of a standard of this suspected compound (standard reference spectra). The reference mass spectrum used for this comparison should be generated by the laboratory using the conditions of the method. In order to verify identification, the following criteria must be met:

1. The sample component relative retention time should compare within ± 0.06 RRT units of the RRT of the standard component.

2. The intensities of the characteristic ions of the compound must maximize in the same scan or within one scan of each other.

3. The relative intensities of the characteristic ions agree within 30% of the relative intensities of these ions in the reference spectrum. (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%.) The characteristic ions from the reference mass spectrum are defined to be the three ions of greatest relative intensity, or any ions over 20% relative intensity if less than three such ions occur in the reference spectrum.

4. The above criteria apply to detections greater than or equal to the LOQ. For detections between the MDL and the LOQ, the above criteria and analyst discretion are used to determine compound identification.

5. The primary and secondary ions are found in Table III.

6. The integrations for the Alkyl PAHs include a sum of the target ions for each specific homolog and may include 6 or more peaks. See Figure 1 for examples of homolog groups for entire run time as well as for specific time periods.

H. Quantitative analysis

When a compound has been identified, quantitation is based on the internal standard technique and the integrated abundance from the extracted ion current profile (EICP) of the primary characteristic ion. The list of primary characteristic ions is listed in Table III.

Calculations

Refer to [T-SVOA-FRM9602](#) for all calculations.

Statistical Information/Method Performance

LCS, MS, surrogate, and RPD recoveries are compared to the limits stored in the LIMS. LCS and surrogate limits are statistically derived every six months in accordance with T-SVOA-WI9604. All RPDs are set to a default value of 30%. MS limits are set equal to LCS limits.

Historical data for MS/Ds, LCS/Ds, surrogates, and measurement of uncertainty is reviewed at least annually and kept on file.

All current and historical limit data is stored in the LIMS under the methods listed in the header of this SOP.

Refer to the Quality Assurance/Quality Control section of this SOP and the criteria listed throughout this procedure for additional information on the performance of this method.

Quality Assurance/Quality Control

A. Batch QC

1. Each extraction batch of ≤ 20 samples must contain a method blank, a laboratory control sample (LCS) and an unspiked background sample (BKG), a matrix spike (MS), and a matrix spike duplicate (MSD).
2. A laboratory control sample/laboratory control sample duplicate (LCS/LCSD) is prepared with the extraction batch if adequate sample volume is not provided to prepare a matrix spike and matrix spike duplicate.
3. Additional QC samples may be required to meet project or state certification requirements.

B. QC and sample spiking

1. The LCS/D and MS/D are spiked at a concentration of 1 ppm.
2. All samples are spiked with surrogates at a concentration of 1 ppm by the extraction group to evaluate the extraction process.
3. Prior to analysis each 1.0 ml of extract is spiked with 10 μL of internal standard solution for a final concentration of 1 ng/ μL .

C. QC items, acceptance criteria, and corrective actions

NOTE: If any client, state, or agency has more stringent QC, QC limits, or batch requirements, these must be followed instead.

Quality Control Item	Acceptance Criteria	Corrective Action
Internal Standards	<ol style="list-style-type: none">1. Peak area 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.	<ol style="list-style-type: none">1. Check instrument for possible problems and then reanalyze samples.2. If re-injection meets the criteria, report this injection.3. If re-injection still shows same problem, report first injection and qualify data with a comment. NOTE: Some clients require re-extraction if internal standard failure(s) is confirmed by re-injection.4. If there is substantial matrix interference, the analyst may dilute the extract as outlined in Procedure G.4.

Quality Control Item	Acceptance Criteria	Corrective Action
Method Blank	<ol style="list-style-type: none"> 1. Must meet internal standard criteria. 2. Must meet surrogate criteria. 3. All target compounds must be less than the reporting limit for the associated samples. 	<ol style="list-style-type: none"> 1. Inspect system for possible problems and reanalyze. 2. If the surrogates are out of spec high the data can be used provided there aren't detections in the method blank. (Unless project requirements dictate otherwise). 3. If the method blank contains target analytes and the associated samples do not contain these analytes, no corrective action is required. 4. If the target analytes in the blank are also in the associated samples at a concentration <10x that in the blank, the samples are re-extracted unless the detection does not interfere with project data requirements. 5. If the surrogates are out of spec low and there aren't detections in the associated samples, the data can be used. 6. If the target compounds in the blank are also in the associated samples at a concentration >10x that in the blank the data is usable.
Instrument Blank*	<ol style="list-style-type: none"> 1. Must run after the CCV if no clean method blank is analyzed at the beginning of a 12-hour analytical period. 2. Must meet internal standard criteria. 3. All target compounds must be less than the reporting limit for the associated samples. 	<ol style="list-style-type: none"> 1. Inspect system for possible problems and reanalyze. 2. If the instrument blank contains target compounds and the associated samples do not contain these compounds, no corrective action is required. If the target compounds in the blank are also in the associated samples, the samples should be re-injected and/or re-extracted unless it does not interfere with project data requirements or if sample detections are at a level 10x higher than the detections in the blank.

Quality Control Item	Acceptance Criteria	Corrective Action
Laboratory Control Sample/Laboratory Control Sample Duplicate	1. Must meet internal standard criteria. 2. Must meet surrogate criteria. 3. % Recoveries within QC limits. 4. RPDs within QC limits.	1. If non-compliant, check for calculation or preparation errors. 2. If no errors found, check system for problems and reanalyze. 3. If LCS/LCSD recoveries are still outside acceptance limits, one of the following actions must be taken: <ul style="list-style-type: none"> a. If recoveries are outside acceptance limits low, the sample(s) must be re-extracted. b. If recoveries are outside acceptance limits high, data may be usable if the analytes that recovered above QC limits are not detected in samples. c. If recoveries are outside acceptance limits high and there are detections for the failing analytes, the sample(s) must be re-extracted. 4. If RPDs fail but recoveries are within QC limits, no further action is needed. 5. If surrogates fail to meet criteria but all target analytes are within specification, data is usable. 6. Marginal exceedance limits, as defined in the NELAC standards, may be used if the defined requirements have been met.
Matrix Spike/ Matrix Spike Duplicate (MS/MSD)	1. Must meet internal standard criteria. 2. Must meet surrogate criteria. 3. % Recoveries within LCS limits. 4. RPDs within QC limits.	1. If LCS within QC limits, proceed with sample analysis. 2. If most recoveries or RPDs out of spec, consult supervisor. BKG, MS, MSD may need to be re-extracted to rule out extraction error.
Surrogates	1. % Recoveries within QC limits.	1. If non-compliant, check for calculation or preparation errors. 2. If no errors found, check analytical system for problems and reanalyze. 3. If no problem is found, re-extract and reanalyze. 4. If surrogates are out of spec high and no target analytes are detected in the sample no corrective action is required. 5. For samples analyzed only at a dilution $\geq 10x$, no further action is required.

*Method blank or instrument blank in each 12-hour analytical period required for 8270E.

NOTE: Any failures without corrective action require approval of supervisor and completion of a non-conformance memo (NCM).

NOTE: All data associated with failed quality control will be qualified on the final report. QC outlier qualifiers are added to the associated sample results on the report by the LIMS.

D. Lower Limit of Quantitation (LLOQ)

1. The lower limit of quantitation (LLOQ) is verified annually through the extraction and analysis of an LCS at 0.5 to 2 times the established LLOQ. The LLOQ is performed on similar analytical instruments such that all are included,

at a minimum, within a 3 year time period. Until the laboratory has sufficient data to determine the acceptance limits, the LLOQ criteria is $\pm 20\%$ of the statistically determined LCS limits.

2. Refer to QA-SOP11892 for initial and ongoing LLOQ requirements.

E. Method Detection Limit (MDL)

1. After the initial MDL study, MDLVs are analyzed quarterly on each instrument. Every 13 months the data is reviewed, and MDLs are updated if necessary.

2. Refer to QA-SOP11892 for initial and ongoing MDL requirements.

F. Limit of Quantitation (LOQ)

1. After the initial LOQ study, LOQs are analyzed quarterly on each instrument. The data is reviewed, and LOQs are updated if necessary.

2. Refer to QA-SOP11892 for initial and ongoing LOQ requirements.

3. Until the laboratory has sufficient data to determine the acceptance limits, the LLOQ criteria is $\pm 20\%$ of the statistically derived LCS limits.

Table I
DFTPP Key Ions and Ion Abundance Criteria

<u>Mass</u>	<u>Ion Abundance Criteria</u>
51	10% to 80% of mass 198
68	<2% of mass 69
70	<2% of mass 69
127	10% to 80% of mass 198
197	<2% of mass 198
198	Base peak, or >50% of mass 442
199	5% to 9% of mass 198
275	10% to 60% of mass 198
365	>1% of mass 198
441	Present but less than 24% of mass 442
442	Base peak, or >50% of mass 198
443	15% to 24% of mass 442

Table II

<u>PAH Standard</u>	
Acenaphthene	Dibenz(a,h)anthracene
Acenaphthylene	Dibenzofuran
Anthracene	Dibenzothiophene
Benzo(a)anthracene	Fluoranthene
Benzo(a)pyrene	Fluorene
Benzo(e)pyrene	Indeno(1,2,3-cd)pyrene
Benzo(b)fluoranthene	1-Methylnaphthalene
Benzo(k)fluoranthene	2-Methylnaphthalene
Benzo(g,h,i)perylene	Naphthalene
Biphenyl	Perylene
Chrysene	Phenanthrene
Decahydronaphthalene (Decalin)	Pyrene

Table III

Internal Standard with Corresponding Analytes Assigned for Quantitation and Characteristic Ions for Semivolatile Compounds				
Compound	Internal Standard Reference	Primary Ion	Secondary Ions	Response Factor Source
cis/trans Decalin	1,4-Dichlorobenzene-d4	138		cis/trans Decalin
C1-Decalins	1,4-Dichlorobenzene-d4	152		cis/trans Decalin
C2-Decalins	1,4-Dichlorobenzene-d4	166		cis/trans Decalin
C3-Decalins	1,4-Dichlorobenzene-d4	180		cis/trans Decalin
C4-Decalins	1,4-Dichlorobenzene-d4	194		cis/trans Decalin
Naphthalene	Naphthalene-d8	128	129	Naphthalene
2-Methylnaphthalene	Naphthalene-d8	142	141	2-Methylnaphthalene
1-Methylnaphthalene	Naphthalene-d8	142	141	1-Methylnaphthalene
C1-naphthalenes	Naphthalene-d8	142	141	Naphthalene
C2-naphthalenes	Naphthalene-d8	156	141	Naphthalene
Biphenyl	Naphthalene-d8	154	153	Biphenyl
C3-naphthalenes	Naphthalene-d8	170	155	Naphthalene
C4-naphthalenes	Naphthalene-d8	184	169	Naphthalene
Acenaphthylene	Acenaphthene-d10	152	151	Acenaphthylene
Acenaphthene	Acenaphthene-d10	154	153	Acenaphthene
Dibenzofuran	Acenaphthene-d10	168	139	Dibenzofuran
C1-fluorenes	Acenaphthene-d10	180	165	Fluorene
C2-fluorenes	Acenaphthene-d10	194	179	Fluorene
Fluorene	Acenaphthene-d10	166	165	Fluorene
Phenanthrene	Phenanthrene-d10	178	176	Phenanthrene
Anthracene	Phenanthrene-d10	178	176	Anthracene
C1-phenanthrene anthracenes	Phenanthrene-d10	192	191	Phenanthrene
C2-phenanthrene anthracenes	Phenanthrene-d10	206	191	Phenanthrene
C3-fluorenes	Acenaphthene-d10	209	193	Fluorene
Fluoranthene	Phenanthrene-d10	202	101	Fluoranthene
Pyrene	Chrysene-d12	202	101	Pyrene
Retene	Phenanthrene-d10	234		Retene
C1-fluoranthrenes pyrenes	Phenanthrene-d10	216		Fluoranthene
C3-Phenanthrene anthracenes	Phenanthrene-d10	220	205	Phenanthrene
C4-phenanthrenes anthracenes	Phenanthrene-d10	234	219	Phenanthrene
Chrysene	Chrysene-d12	228	229	Chrysene
Benzo(a)anthracene	Chrysene-d12	228	229	Benzo(a)anthracene
C1-benzanthreneChrysenes	Chrysene-d12	242	241	Benzo(a)anthracene
C2-Benzanthrene Chrysenes	Chrysene-d12	256	241	Benzo(a)anthracene
C3-benzanthrene Chrysenes	Chrysene-d12	270	255	Benzo(a)anthracene
C4-benzanthrene Chrysenes	Chrysene-d12	284	269	Benzo(a)anthracene
Benzo(b)fluoranthene	Perylene-d12	252	253	Benzo(b)fluoranthene
Benzo(k)fluoranthene	Perylene-d12	252	253	Benzo(k)fluoranthene
Benzo(e)pyrene	Perylene-d12	252	253	Benzo(e)pyrene
Benzo(a)pyrene	Perylene-d12	252	253	Benzo(a)pyrene
Perylene	Perylene-d12	252	253	Perylene
Indeno(1,2,3-cd)pyrene	Perylene-d12	276	138	Indeno(1,2,3-cd)pyrene
Dibenz(a,h)anthracene	Perylene-d12	278	139	Dibenz(a,h)anthracene

Internal Standard with Corresponding Analytes Assigned for Quantitation and Characteristic Ions for Semivolatile Compounds

<u>Compound</u>	<u>Internal Standard Reference</u>	<u>Primary Ion</u>	<u>Secondary Ions</u>	<u>Response Factor Source</u>
Benzo(g,h,i)perylene	Perylene-d12	276	138	Benzo(g,h,i)perylene
Dibenzothiophene	Phenanthrene-d10	184	139	Dibenzothiophene
C1-Dibenzothiophene	Phenanthrene-d10	198	184	Dibenzothiophene
C2-dibenzothiophene	Phenanthrene-d10	212	197	Dibenzothiophene
C3-dibenzothiophene	Phenanthrene-d10	226	211	Dibenzothiophene
C4-dibenzothiophene	Phenanthrene-d10	240	225	Dibenzothiophene
Naphthobenzothiophene	Phenanthrene-d10	234		Dibenzothiophene
C1-naphthobenzothiophene	Phenanthrene-d10	248		Dibenzothiophene
C2-naphthobenzothiophene	Phenanthrene-d10	262		Dibenzothiophene
C3-naphthobenzothiophene	Phenanthrene-d10	276		Dibenzothiophene
C2-fluoranthrenes pyrenes	Phenanthrene-d10	230	215	Fluoranthene
C3-fluoranthrenes pyrenes	Phenanthrene-d10	244	229	Fluoranthene
C4-fluoranthrenes pyrenes	Phenanthrene-d10	258	243	Fluoranthene
17β(H),21β(H)-hopane	Chrysene-d12	191		17β(H),21β(H)-hopane
T4-C23 diterpane (C23 Tricyclic Terpene)	Chrysene-d12	191		17β(H),21β(H)-Hopane
T5-C24Diterpane	Chrysene-d12	191		17β(H),21β(H)-Hopane
T6-C25Diterpane	Chrysene-d12	191		17β(H),21β(H)-hopane
T6a-c24tetracyclicTerpane	Chrysene-d12	191		17β(H),21β(H)-hopane
T6b-c26tricyclic[s]	Chrysene-d12	191		17β(H),21β(H)-hopane
T6c-c26tricyclic[r]	Chrysene-d12	191		17β(H),21β(H)-hopane
T7-c28tricyclictriterpane[s]	Chrysene-d12	191		17β(H),21β(H)-hopane
T8-c28tricyclictriterpane[r]	Chrysene-d12	191		17β(H),21β(H)-hopane
T9-c29Tricyclictriterpane(s) (c29TricyclicTerpane22s)	Chrysene-d12	191		17β(H),21β(H)-hopane
T10-c29tricyclictriterpane(r) (c29TricyclicTerpane22r)	Chrysene-d12	191		17β(H),21β(H)-hopane
T11-trisnorhopane(ts)(18a(H)-22,29,30-trisnorhopane(ts))	Chrysene-d12	191		17β(H),21β(H)-hopane
T12-trisnorhopane(tm)(17a(H)-22,29,30-trisnorhopaneTm)	Chrysene-d12	191		17β(H),21β(H)-hopane
T13a-29,30-bisnorhopane(17b(H)-22,29,30-trisnorhopane)	Chrysene-d12	191		17β(H),21β(H)-hopane
T13-trisnorhopane(17a(H)-29,30-bisnorhopane)	Chrysene-d12	191		17β(H),21β(H)-hopane
T14-bisnorhopane	Chrysene-d12	191		17β(H),21β(H)-hopane
T14a-c28,C30bisnorhopane	Chrysene-d12	191		17β(H),21β(H)-hopane
T14b-c29,c25norhopane	Chrysene-d12	191		17β(H),21β(H)-hopane
17a(H)-diahopane(17a(H)-21b(H)-30-norhopane)	Chrysene-d12	191		17β(H),21β(H)-hopane
T16-norneohopane(18a(H)-30-norneohopane)	Chrysene-d12	191		17β(H),21β(H)-hopane
T15-c29norhopane(15a-methyl-17a(H)-27-norhopane)	Chrysene-d12	191		17β(H),21β(H)-hopane
T17-C30 normoretane(17b(H)-21a(H)-30-norhopane)	Chrysene-d12	191		17β(H),21β(H)-hopane
T18-C30 oleanane(18a(H)-oleanane)	Chrysene-d12	191	412	17β(H),21β(H)-hopane
T19-C30 hopane	Chrysene-d12	191	412	17β(H),21β(H)-hopane
T20-moretane(17b(H)-21a(H)-hopane)	Chrysene-d12	191		17β(H),21β(H)-hopane
T21-C31 homohopane(s)(17a(H)-21b(H),22s-homohopane)	Chrysene-d12	191		17β(H),21β(H)-hopane

Internal Standard with Corresponding Analytes Assigned for Quantitation and Characteristic Ions for Semivolatile Compounds

<u>Compound</u>	<u>Internal Standard Reference</u>	<u>Primary Ion</u>	<u>Secondary Ions</u>	<u>Response Factor Source</u>
T22-C31 homohopane(r) (17a(H)-21b(H),22r-homohopane)	Chrysene-d12	191		17β(H),21β(H)-hopane
T22a-gammacerane(gammacerane)	Chrysene-d12	191	412	17β(H),21β(H)-hopane
T23-homohopane	Chrysene-d12	191		17β(H),21β(H)-hopane
T24-homomoretane	Chrysene-d12	191		17β(H),21β(H)-hopane
T25-diploptene	Chrysene-d12	191		17β(H),21β(H)-hopane
T26-C32-bishomohopane(s) (17a(H),21b(H),22s-bishomohopane)	Chrysene-d12	191		17β(H),21β(H)-hopane
T27-C32-bishomohopane(r) (17a(H),21b(H),22r-bishomohopane)	Chrysene-d12	191		17β(H),21β(H)-hopane
T28-bishomomoretane	Chrysene-d12	191		17β(H),21β(H)-hopane
T29-homohopane	Chrysene-d12	191		17β(H),21β(H)-hopane
T30-C33-trishomohopane(s) (17a(H),21b(H),22s-trishomohopane)	Chrysene-d12	191		17β(H),21β(H)-hopane
T31-C33-trishomohopane(r) (17a(H),21b(H),22r-trishomohopane)	Chrysene-d12	191		17β(H),21β(H)-hopane
T32-Tetrakishomohopane (17a(H),21b(H),22S-Tetrakishomohopane)	Chrysene-d12	191		17β(H),21β(H)-hopane
T33-Tetrakishomohopane(17a(H),21b(H),22R-Tetrakishomohopane)	Chrysene-d12	191		17β(H),21β(H)-hopane
T34-Pentakishomohopane(17a(H),21b(H),22S-Pentakishomohopane)	Chrysene-d12	191		17β(H),21β(H)-hopane
T35-pentakishomohopane(17a(H),21b(H),22r-pentakishomohopane)	Chrysene-d12	191		17β(H),21β(H)-hopane
S4-diacholestane(13b(H),17a(H),20s-Cholestane)	Chrysene-d12	217		17β(H),21β(H)-hopane
s5-diaCholestane(13b(H),17a(H),20r-Cholestane)	Chrysene-d12	217		17β(H),21β(H)-hopane
5a-Cholestane	Chrysene-d12	217		5a-Cholestane
s6-diaCholestane	Chrysene-d12	217		5a-Cholestane
s7-diacholestane	Chrysene-d12	217		5a-Cholestane
s8-methylDiaCholestane	Chrysene-d12	217		5a-Cholestane
S10-methylDiaCholestane	Chrysene-d12	217		5a-Cholestane
S11-methylDiaCholestane	Chrysene-d12	217		5a-Cholestane
S12-Cholestane	Chrysene-d12	217		5a-Cholestane
Cholestane	Chrysene-d12	217		5a-Cholestane
S14-Cholestane(20R) (5a(H),14b(H),17b(H),20r-Cholestane)	Chrysene-d12	218		5a-Cholestane
S15-Cholestane(20S) (5a(H),14b(H),17b(H),20s-Cholestane)	Chrysene-d12	218		5a-Cholestane
S18-ethylDiaCholestane	Chrysene-d12	217		5a-Cholestane
s19-ethylDiacholestane	Chrysene-d12	217		5a-Cholestane
S20-methylcholestane	Chrysene-d12	217		5a-Cholestane
S22-methylCholestane(20R) (24-methyl-5a(H),14b(H),17b,20r-Cholestane)	Chrysene-d12	218		5a-Cholestane
S23-methylCholestane(20S) (24-methyl-5a(H),14b(H),17b,20s-Cholestane)	Chrysene-d12	218		5a-Cholestane
S24-methylCholestanemso- (24-methyl-5a(H),14a(H),17a,20R-Cholestane)	Chrysene-d12	217		5a-Cholestane
S25-ethylCholestane (24-ethyl-5a(H),14a(H),17a,20s-Cholestane)	Chrysene-d12	217		5a-Cholestane

Internal Standard with Corresponding Analytes Assigned for Quantitation and Characteristic Ions for Semivolatile Compounds				
<u>Compound</u>	<u>Internal Standard Reference</u>	<u>Primary Ion</u>	<u>Secondary Ions</u>	<u>Response Factor Source</u>
S26-ethylCholestane(20R)(24-ethyl-5a(H),14b(H),17b,20r-Cholestane)	Chrysene-d12	218		5a-Cholestane
S27-ethylCholestane(20S)(24-ethyl-5a(H),14b(H),17b,20s-Cholestane)	Chrysene-d12	218		5a-Cholestane
S28-ethylCholestane (24-ethyl-5a(H),14a(H),17a,20r-Cholestane)	Chrysene-d12	217		5a-Cholestane
A1-C20TAS (C20-Triaromatic steroid hydrocarbon)	chrysene-d12	231		Chrysene
A2-C21TAS (C21-Triaromatic steroid hydrocarbon)	Chrysene-d12	231		Chrysene
A3-c26TAS (20S)(c26,20s-Triaromatic steroid hydrocarbon)	Chrysene-d12	231		Chrysene
A4-c26C27TAS (c26,20r- + 27,20s-Triaromatic steroid hydrocarbon)	Chrysene-d12	231		Chrysene
A5-c27TAS (20R)(c27,20r-Triaromatic steroid hydrocarbon)	Chrysene-d12	231		Chrysene
A6-TAS (20S)(C28,20S-Triaromatic steroid hydrocarbon)	Chrysene-d12	231		Chrysene
A7-TAS (20R)(C28,20R-Triaromatic steroid hydrocarbon)	Chrysene-d12	231		Chrysene

Attachment:
Figure 1 (.doc)

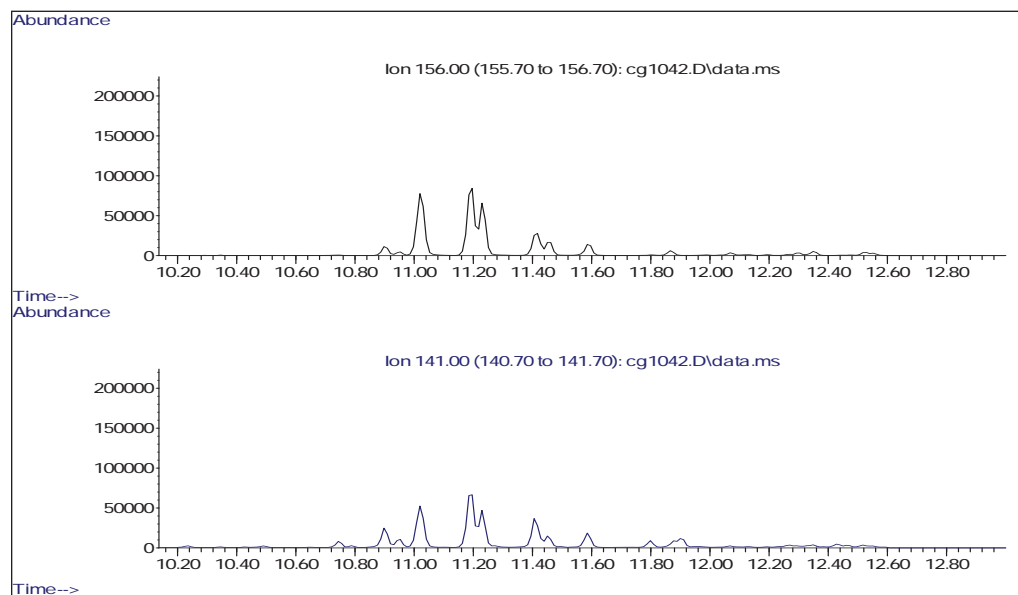
10880 Microwave Extraction for the Determination of Semivolatiles in a Solid Matrix
 10928 Microwave Extraction by Method 3546 for Semivolatiles
 10931 Separatory Funnel Extraction by Method 3510C for BNAs by 8270 SIM in Wastewater
 11178 Demonstrations of Capability
 11432 Separatory Funnel Extraction by Method 3510C for BNAs in Wastewater
 11998 Semivolatile Spiking and Calibration Standards
 6869 Nonconformance Form
 9598 GC/MS Preventative and Corrective Maintenance
 9602 Dept 4026 Calculations
 9995 Semivolatiles in Waters and Soils by Methods 8270C/D/E SIM and 625.1 SIM by GC/MS

End of document

Version history

Version	Approval	Revision information
7	21.JUN.2012	
8	02.OCT.2019	
9	16.NOV.2020	

C2-Naphthalenes; Mass - 156, 141 amu, 10.2 min to 12.8 min.





Always check on-line for validity.

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VOCs and GRO by GC/MS in Waters and Wastewaters by EPA 8260C/D

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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

Work Instruction

Organisation level:

5-Sub-BU

Responsible:

5_EUUSLA_GC/MS Volatiles_Manager

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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.

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 μ L (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 μ L 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 μ L 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 \times 0.25 mm ID DB624 capillary column with a 1.4- μ m 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 \times 0.18 mm ID DB624 capillary column with a 1.0- μ m 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 \times 0.18 mm ID DB-VRX capillary column with a 1.0- μ m 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 $\geq 96\%$. Pre-made solutions can be used if the supplier documents the concentrations of the solutions. All ampulated standards are stored at $\leq -10^{\circ}\text{C}$ 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 $\mu\text{g}/\text{mL}$ 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 $\mu\text{g}/\text{mL}$ stock standard solution of fluorobenzene, chlorobenzene-d5, 1,4-dichlorobenzene-d4, and 12500 $\mu\text{g}/\text{mL}$ 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- $\mu\text{g}/\text{mL}$ stock unleaded gasoline composite prepared in methanol by a commercial supplier.

e. GRO QC standard – a 20,000- $\mu\text{g}/\text{mL}$ 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 $\leq -10^{\circ}\text{C}$. 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 $\leq -10^{\circ}\text{C}$. 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- $\mu\text{g}/\text{mL}$ 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 $\mu\text{g}/\text{mL}$, 1250 $\mu\text{g}/\text{mL}$ 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 $\mu\text{g}/\text{L}$ for 5-mL purge, 10 $\mu\text{g}/\text{L}$ 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 $\leq -10^{\circ}\text{C}$ 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	$12^{\circ}/\text{min}$ until 100°C then $25^{\circ}/\text{min}$ until 240°C	$12^{\circ}/\text{min}$ until 100°C then $25^{\circ}/\text{min}$ until 235°C	$25^{\circ}/\text{min}$ until 60°C then $36^{\circ}/\text{min}$ 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.	<p>1. % RSD of $\leq 20\%$ is required for all analytes. 10% of the analytes may fail this criteria.</p> <p>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.</p> <p>3. Minimum response factors must be met for select compounds. See Table 3.</p>	<p>1. Any target analyte with a %RSD of $\leq 20\%$ 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 $\leq 30\%$ for all standards. For some data uses, $\leq 50\%$ may be acceptable for the lowest calibration point.</p> <p>NOTE: Quadratic regression cannot be used for South Carolina compliance samples.</p> <p>2.-3. Perform system maintenance and recalibrate.</p>

**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 $\leq 20\%$. 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.	<ol style="list-style-type: none"> 1. % Drift of $\leq 20\%$ 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. 	<p>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.</p>

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 $\leq 20\%$. 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-W/7692](#) 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: $Y = CX^2 + MX + B$

Where:

$x = \text{Area(Std)} / \text{Area(Istd)}$

$Y = \text{Conc. (Std)} / \text{Conc. (Istd)}$

$M =$ 1st degree slope

$C =$ 2nd degree slope

$B =$ Y-intercept

3. Percent relative standard deviation (%RSD):

$$\% \text{ RSD} = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100$$

4. Calculation of the percent drift:

$$\% \text{ Drift} = \frac{C(i) - C(c)}{C(i)} \times 100$$

Where:

$C(i) =$ Calibration check compound standard concentration

$C(c) =$ Measured concentration using selected quantification method

B. QA Calculations

1. Calculation of percent recovery

$$\% \text{ Recovery} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

Where:

$\text{SSR} =$ Spiked sample result

$\text{SR} =$ Sample result

$\text{SA} =$ Spike added

2. Relative percent difference (RPD):

$$\text{RPD} = \frac{\text{MSR} - \text{MSDR}}{(1/2) (\text{MSR} + \text{MSDR})} \times 100$$

Where:

$\text{MSR} =$ Matrix spike measured concentration

$\text{MSDR} =$ Matrix spike duplicate measured concentration

3. Analyte Concentration

$$\text{Concentration } (\mu\text{g/L}) = \frac{(Ax)(Is)}{(Ais)(RRF)}$$

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 $\mu\text{g/L}$

RRF = Relative response factor from the initial calibration

Statistical Information/method Performance

The LCS must contain 80% to 100% 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 than 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 $\mu\text{g/L}$ for a 5-mL purge or 10 $\mu\text{g/L}$ 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 \leq 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	1. % Recoveries must fall within statistically derived QC limits, which are evaluated on a semi-annual basis	1. If LCS within QC limits, proceed with sample analysis. 2. If most recoveries and/or RPDs outside of

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

<u>Mass</u>	<u>Ion Abundance Criteria</u>
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

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
<i>trans</i> -1,2-Dichloroethene	96	61, 63
<i>cis</i> -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
<i>cis</i> -1,3-Dichloropropene	75	77, 110
<i>trans</i> -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
<i>trans</i> -1,2-Dichloroethene	0.100
<i>cis</i> -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
VOA3= 1:5 dilution of VCS#3B and Vaprolein
VOA6= 1:5 dilution of VCS#6
2CEVE= 1:5 dilution of VCS#1B-2CEVE
VOA8= 1:5 dilution of Hexachloroethane and 2,2'-oxybis(1-Chloropropane)

Stock mix name	VOA1	VOA3	VOA2	VOA6	n-PEN	CYC	EOH	Restek Gases (2000 ppm)	Flask mL
	2CEVE			EE	VOA8			Lt#	
	1,3-BUT			Custom VLG Freons				TAAE	
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	CS#6	5000	300	100	50	20	10	4	1	0.5
Pentachloroethane		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	CS#3B	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		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	TAEF	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)(μ L 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
1,1,1,2-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	2000	25	10	5	2	1	.5	.2	.1
Chloroethane	mix	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
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)(μ L stock) / flask mL

Analyst: _____

Date: _____

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(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	QVOA6	QEOH	8260 SS 2500 ppm Lot# _____	QGASES _____ QVOA8 _____ QDCFM _____	Final Volume	MeOH Lot#	Used
	QARC	QEE	QCYC					
		QDEM						
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	2000	20
Chloroethane	mix	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)(μ l 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	2000	5
Chloroethane	mix	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
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)(μ l 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	2000	200	100	50	20	10	2	1	.4
Bromoform	V	2000	200	100	50	20	10	2	1	.4
Chlorobenzene	Mix	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)(μ L 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
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: _____
Date: _____

Restek V Unleaded Gasoline Composite Standard

Lot: _____ Exp: _____

INITIAL CALIBRATION TSC

Compound Name	CAS #	ul stock FV H2O MI Stock ppm	level 6	level 5	level 4	level 3	level 2	level 1	MDL
			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 C

INVESTIGATION-DERIVED WASTE MANAGEMENT PLAN

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C. 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 additional remedial design (RD) sampling at RVAAP-38 National Advisory Committee on Aeronautics [NACA] Test Area, RVAAP-42 Load Line 9, RVAAP-45 Wet Storage Area, and CC RVAAP-76 Depot Area within Camp James A. Garfield (CJAG). Activities are limited to surface and subsurface soil 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 soil drill cuttings and residual soil samples. Non-indigenous IDW potentially generated includes decontamination rinse fluids, acetate liners from soil cores, disposable aluminum trays and foil, 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.

C.1 INVESTIGATION-DERIVED WASTE COLLECTION AND CONTAINERIZATION

All indigenous solid IDW (soil) from borehole installations will be collected from each area of concern (AOC). The IDW will be combined instead of segregated by AOC. All indigenous solid IDW will be contained in a labeled, U.S. Department of Transportation (DOT)-approved, open-top 55-gallon drums and sealed with bung-top lids. Generator knowledge from prior sampling data from each of the four AOCs suggests that this waste is unlikely to be characterized as hazardous waste.

All solid non-indigenous (e.g., expendable sampling equipment, PPE, trash) IDW will be segregated and disposed of as municipal waste. Leidos will remove all the municipal trash it produces from the facility and will not use onsite trash receptacles.

All liquid non-indigenous IDW (e.g., decontamination rinse water, soap, and water/water rinses from alcohol rinses [e.g., isopropanol], and acid rinses [e.g., nitric acid]) will be contained in labeled, DOT-approved, 55-gallon closed-top drums. The volume of alcohol and acid rinses used for decontamination purposes is anticipated to be minimal. The chemical rinses used for decontamination of sampling equipment will be combined with decontamination water generated from drilling activities and water used for decontamination of sampling equipment.

C.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 C-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 C.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 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).

C.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. Soil IDW drums will be stored on pallets outside Building 1036. Liquid IDW drums will be stored inside Building 1036 on secondary containment pallets. Building 1036 will also be used as the centralized decontamination area to support the investigation and to store non-indigenous liquid and

solid IDW resulting from decontamination activities. All indigenous (solid) IDW will be stored at Building 1036 until the IDW is characterized for disposal in accordance with Section C.4. After IDW characterization, the wastes will be disposed of according to Section C.5 or stored at Building 1036 pending disposal.

All non-indigenous (decontamination rinse and expendable material) IDW will be stored at Building 1036 until it is characterized for disposal in accordance with Section C.4. After characterization of the non-indigenous IDW, the wastes will be disposed of according to Section C.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 from each of the four AOCs suggests 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 C-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 analysis, will be inspected and inventoried weekly. Documentation of the inspection will be recorded on the CJAG 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 C-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.

C.4 INVESTIGATION-DERIVED WASTE CHARACTERIZATION AND CLASSIFICATION FOR DISPOSAL

All indigenous IDW (e.g., soil) and non-indigenous liquid IDW (e.g., water generated from decontamination of drilling and soil 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 (VOCs), TCLP semivolatile organic compounds (SVOCs), 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) 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 C-1, C-2, and C-3. Table C-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 C.5.) Table C-2 presents the maximum concentrations for non-TCLP analytes for hazardous waste determination. Table C-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 the U.S. Army Corps of Engineers. 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.

C.4.1 Solid Investigation-Derived Waste Composite Sampling Procedure

Solid IDW (soil) will be characterized by composite sampling. Composite sampling of solid IDW (soil) for disposal characterization will be performed using a composite grab sampling technique. The equipment used in solid IDW sampling will consist of small-diameter hand augers or soil push probes, stainless steel bowls, and mixing instruments (e.g., knives and spoons) decontaminated following the procedure presented on Worksheet 18, Section 18.4.1. Composite grab sample collection will be performed as follows:

1. Collect discrete grab samples using clean, decontaminated, or disposable equipment such as small-diameter hand augers or soil push probes from each segregated IDW waste container. Each discrete grab sample should be collected in an identical fashion (frequency and volume).
 - a. For volatile organic characterization, grab samples of equal proportions will be transferred directly from each IDW waste container to the sample container with minimum head space for laboratory analysis.
 - b. For all analyses other than VOCs, individual grab samples will be transferred into a sample bowl for homogenizing.
2. Homogenize individual grab samples using a sampling bowl and mixing instrument by stirring and turning over the sample until the mixture is adequately homogenized. The mixture is then divided by half, and equal portions from each half will be used to fill sample containers.
3. Assemble the sample containers that contain the homogenized grab samples that will make up a specific composite sample.
4. Remove an aliquot of sample from each container to be sampled and place it in a decontaminated stainless steel mixing bowl. Each aliquot amount is to be as identical as possible to facilitate representativeness.
5. Homogenize the aliquots as described in Step 2.
6. Remove sample amounts from the homogenized composite sample and place them into the proper containers for shipment to the laboratory.

C.4.2 Liquid Investigation-Derived Waste Composite Sampling Procedure

Sampling of liquid IDW (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.

C.5 INVESTIGATION-DERIVED WASTE DISPOSAL

Table C-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. 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. Non-hazardous, non-contaminated waste contains contaminants at concentrations at or below acceptable criteria (i.e., background concentrations) and may be disposed of onsite with prior approval from the OHARNG Environmental Specialist, ARNG Program Manager, and USACE.

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 (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 18.4.1 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 C-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

^aIf 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.

^bQuantitation 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 C-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 ≤ pH ≤ 12.5	--
D003	Cyanide, total*	57-12-5	Not applicable.	
D001	Flashpoint	Q376	<140°F	<180°F
D003	Sulfide, total*	Q1314	Not applicable.	

*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 C-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 C-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 offsite as municipal trash	N/A	N/A

IDW = Investigation-Derived Waste

N/A = Not Applicable

Figure C-1. Example of Waste Storage Container Label Information

<p>Drum Number: Leidos-MSRD-NACA-S-001 (for soil), Leidos MSRD-NACA-L-001 (for decontamination water)</p> <p>Contents: (Soil Cuttings or Decontamination Water)</p> <p>Source of Waste: Additional RD Sampling (NACA Test Area, Load Line 9, Wet Storage Area, or Depot Area)</p> <p>Source Location: NACA Test Area, Load Line 9, Wet Storage Area, or Depot Area</p> <p>Generation Dates: Day/Month/Year</p> <p>Address: 8451 State Route 5, Ravenna Ohio 44266</p> <p>Contact: Katie Tait (614) 366-6136, Charles Spurr (216) 317-5726</p>
--

Notes:

The third suffix in the drum number is the abbreviation of the AOC associated with the waste. Waste from NACA Test Area should use NACA, waste from Load Line 9 should use LL9, waste from Wet storage Area should use WSA, and waste from the Depot Area should use DA.

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

DA = Depot Area

IDW = Investigation-Derived Waste

L = Liquid IDW

LL9 = Load Line 9

MSRD = Multi-Site Remedial Design Addendum

NACA = National Advisory Committee on Aeronautics

RD = Remedial Design

S = Solid IDW

WSA = Wet Storage Area

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ATTACHMENT C-1

CJAG WASTE MANAGEMENT

- CJAG Waste Management Guidelines
- CJAG Weekly IDW Inspection Sheet
- Waste Disposal Tracker

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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 WEEKLY 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)

CONTAINER LOG

Container No. ⁽¹⁾

Page 1 of 1

Drum Staging Area: Building 1036

Date ⁽²⁾	Material Name ⁽³⁾	Quantity Added ⁽⁴⁾	Cumulative Quantity ⁽⁵⁾	Person Adding Material ⁽⁶⁾	Label	Notes

(When 55 gals total reached, must move from SAA within 3 calendar days.)

Date Container Transferred to Generator Accumulation Area _____

Materials shipped offsite date: _____

- (1) Container ID Number (e.g., FC-FMS#1-2)
- (2) Date when waste was added to container
- (3) Name of waste added (e.g., Diesel Fuel)
- (4) For items such as filters, note the number of items. For liquids, note the number of gallons.
- (5) The total quantity of items or numbers of gallon currently in the container
- (6) The name of the person adding the waste

APPENDIX D

OHARNG ENVIRONMENTAL PROCEDURES

- D.1 – OHARNG Environmental Procedures
- D.2 – First Responder Reporting Form (Spill Response)
- D.3 – OHARNG Inadvertent Discovery Procedures

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D.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 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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D.2 – First Responder Reporting 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

D.3 – OHARNG Inadvertent Discovery Procedures

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**STANDARD OPERATING PROCEDURES NO. 5A
OHARNG Procedures for Inadvertent Discovery of Cultural Materials at
Camp Ravenna Joint Military Training Center
(taken from OHARNG ICRMP and modified for CRJMTC)**

Contact(s): Kim Ludt, OHARNG Cultural Resources Manager, 614-336-6569
(Alternate contact, CRJMTC Environmental Office, 614-336-6568/6136)
CRJMTC Range Control 614-336-6041 or MARCS radio Channel #1

Scope: This Standard Operating Procedure (SOP) outlines the steps to be taken upon inadvertent discovery of human remains or artifacts at Camp Ravenna Joint Military Training Center (CRJMTC) during construction, demolition, training events, or other ground disturbing activities. If archaeological surveys or excavations become necessary as a result of the inadvertent discovery, they must be conducted by a person meeting the Secretary of Interior's professional qualification standards for archaeology. Anyone who does not meet these standards and engages in any excavations, including probing during metal detecting, shall be considered to be looting the cultural resources of CRJMTC and subject to prosecution under ARPA. This SOP is intended for all OHARNG personnel, contractors and users of CRJMTC.

Statutory Reference(s):

- Native American Graves Protection and Repatriation Act (NAGPRA) and its implementing regulation (43 CFR 10)
- Archaeological Resources Protection Act (ARPA)
- National Historic Preservation Act (NHPA) and its implementing regulation (36 CFR 800).

Procedures: In the event that artifacts or human remains are encountered, the ground disturbing activity should stop immediately and the following steps should be followed.

- Report any observations or discoveries of artifacts or human remains immediately to CRJMTC Range Control (614-336-6041 or MARCS radio Channel #1). Range Control will immediately notify the OHARNG Cultural Resources Manager (CRM)/CRJMTC Environmental Office.
- The Range Control or the CRM will secure any artifacts or human remains, as appropriate. If human remains are suspected, they are not to be disturbed and Range Control will promptly notify Ohio State Highway Patrol or Federal Bureau of Investigation, as appropriate.
- The CRM and Range Control will take measures to protect the location from further disturbance until appropriate parties are notified.
- If a concentration of artifacts or a burial site is identified as the source of materials discovered, the CRM will make arrangements for site recordation and stabilization, in consultation with the OHPO and any interested Native American tribes.
- Once the site has been cleared by the CRM and CRJMTC Range Control, the activity may resume. Depending on the findings, activities may be cleared to resume in 48 hours or up to 6 months.

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APPENDIX E

**PROJECT PLANNING SESSION
PRESENTATION AND MEETING MINUTES**

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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-](https://gov.teams.microsoft.us/l/meetup-join/19%3agqch%3ameeting_cda85b1ea1d341708ecc6d0bdfcc2f13%40thread.v2/0?context=%7b%22id%22%3a%22b64da4ac-e800-4cfc-8931-e607f720a1b8%22%2c%22oid%22%3a%220ba6af77-6847-4d7d-a264-ea9e7b8ae673%22%7d)

[join/19%3agqch%3ameeting_cda85b1ea1d341708ecc6d0bdfcc2f13%40thread.v2/0?context=%7b%22id%22%3a%22b64da4ac-e800-4cfc-8931-](https://gov.teams.microsoft.us/l/meetup-join/19%3agqch%3ameeting_cda85b1ea1d341708ecc6d0bdfcc2f13%40thread.v2/0?context=%7b%22id%22%3a%22b64da4ac-e800-4cfc-8931-e607f720a1b8%22%2c%22oid%22%3a%220ba6af77-6847-4d7d-a264-ea9e7b8ae673%22%7d)

[e607f720a1b8%22%2c%22oid%22%3a%220ba6af77-6847-4d7d-a264-ea9e7b8ae673%22%7d](https://gov.teams.microsoft.us/l/meetup-join/19%3agqch%3ameeting_cda85b1ea1d341708ecc6d0bdfcc2f13%40thread.v2/0?context=%7b%22id%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.

Project Planning Session

Former Ravenna Army Ammunition Plant

Meeting Minutes (Revision 1)

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.

Project Planning Session

Former Ravenna Army Ammunition Plant

Meeting Minutes (Revision 1)

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



- **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



- **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.

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.

Sand Creek Disposal Road Landfill Additional Delineation Sampling

- **Proposed Delineation Sampling Breakdown**

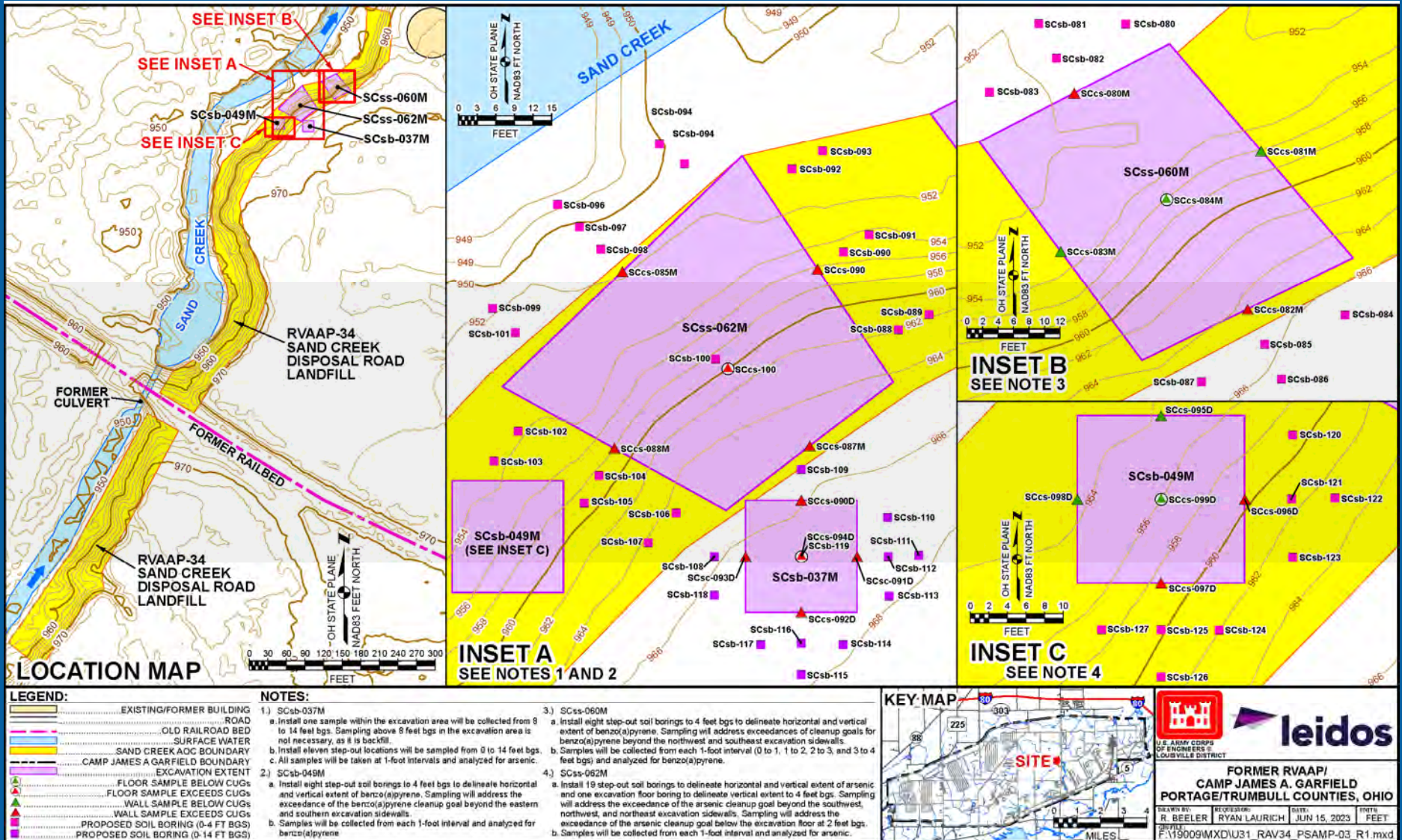
Excavation Area	Soil Borings	Soil Samples	
		Surface	Subsurface
SCsb-037M	12	11	149
SCsb-049M	8	8	24
SCss-060M	8	8	24
SCss-062M	20	20	60

- **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



Questions?

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.

- **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



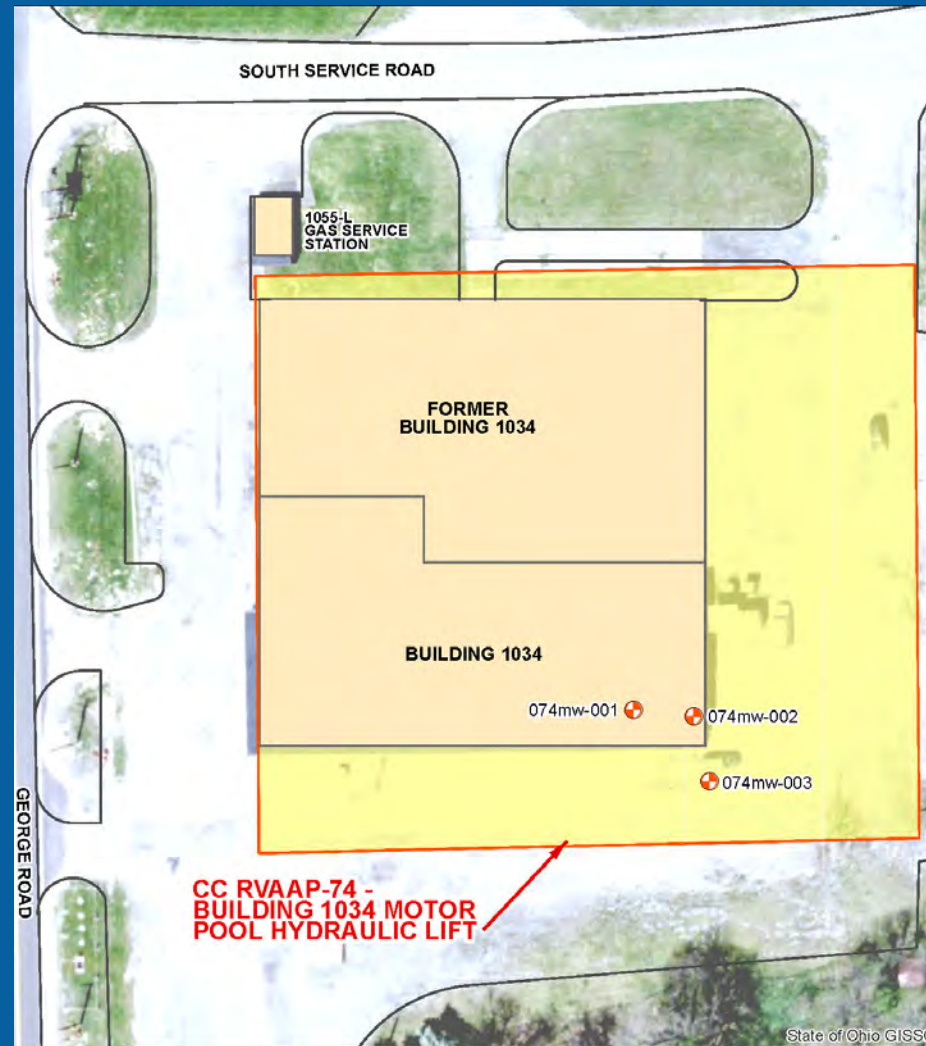
- **Groundwater Sampling**

- 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}

Building 1048 Fire Station Groundwater Sampling Locations at Building 1048



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.

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*	%

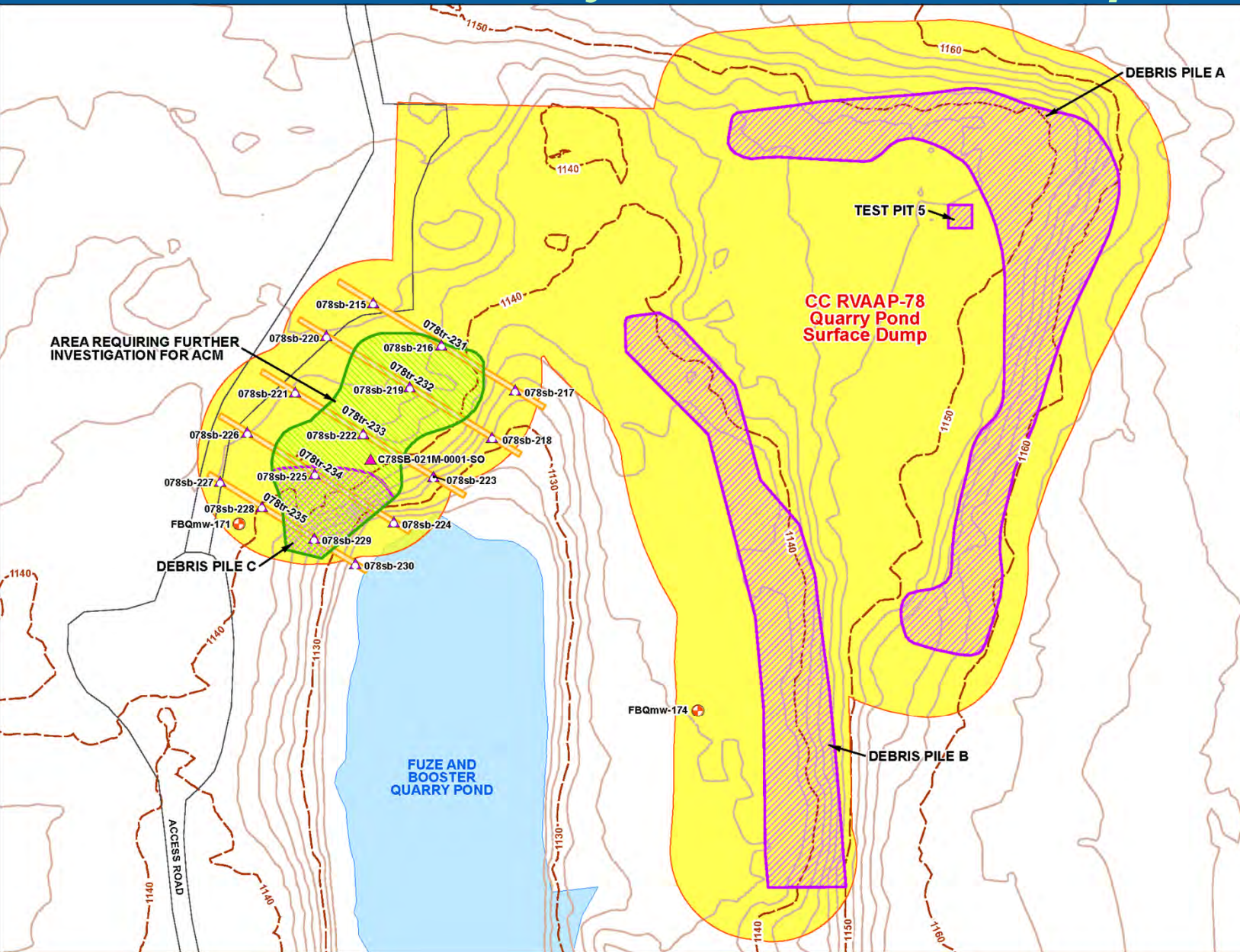
• Proposed delineation sampling

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



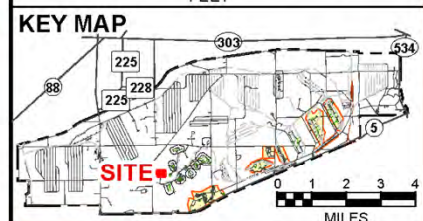
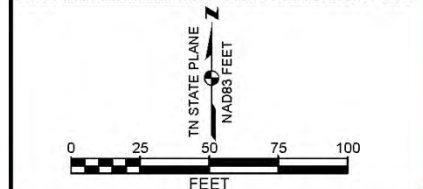
LEGEND:

	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



**FORMER RVAAP/
CAMP JAMES A. GARFIELD
PORTAGE/TRUMBLE COUNTIES, OHIO**

DESIGNED BY: R. BEELER	REQUESTOR: SARAH KOSBAB	DATE: JUN 06, 2023	UNITS: FEET
GIS FILE: \\chs-fs01\CAD\19009MXDU\31_RAV78_TRENCH-01.mxd			

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**

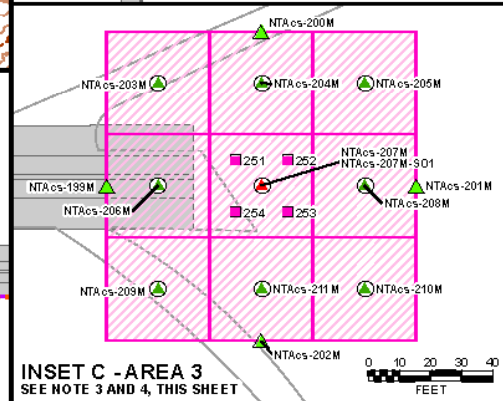
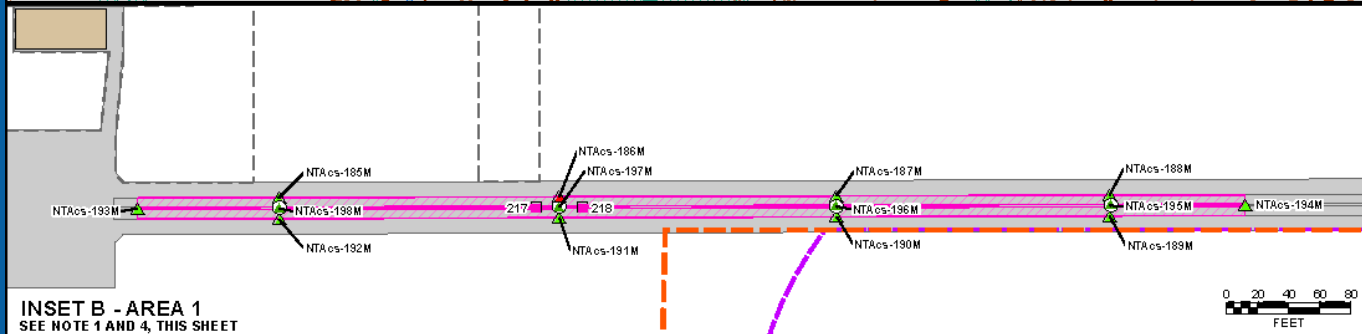
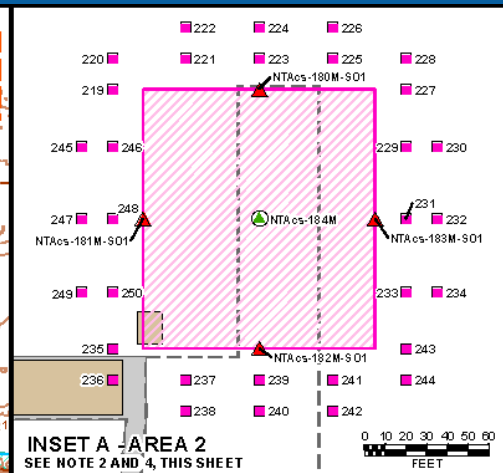
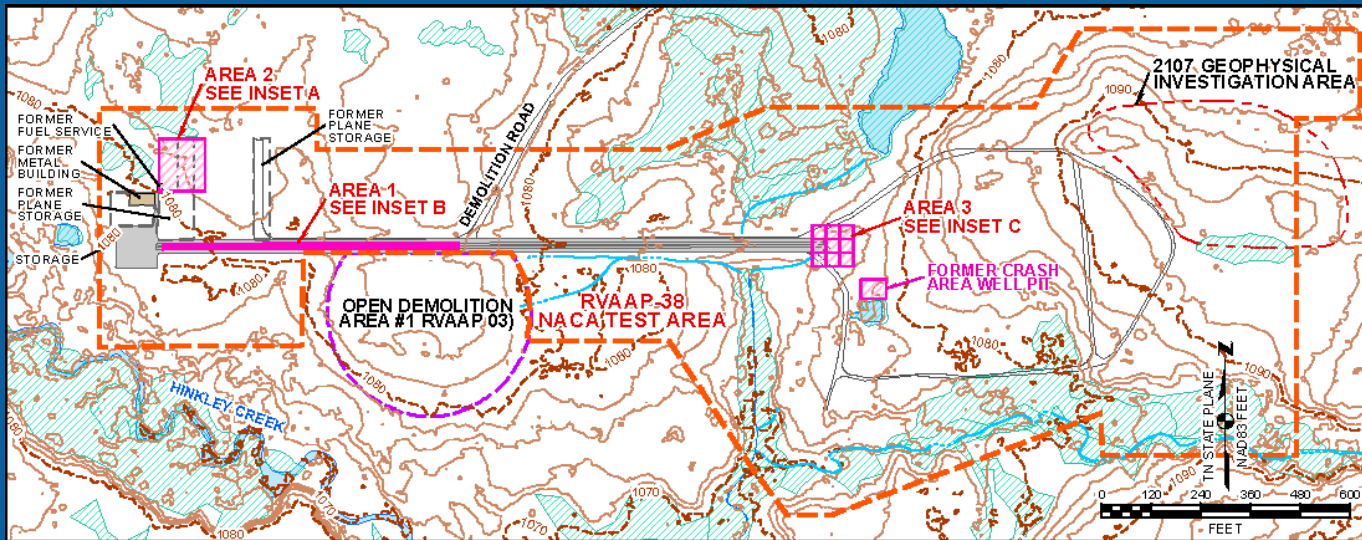
- Surface: 0-1 ft bgs
- Subsurface: 1 ft intervals down to 4 ft bgs

- **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
	GROUND CONTOUR 10 FT INTERVAL
	GROUND CONTOUR 2 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
	FLOOR CONFIRMATION SAMPLE > CRITERIA
	FLOOR CONFIRMATION SAMPLE < CRITERIA
	PROPOSED SOIL BORING (SEE NOTES)

- NOTES:**
- Sample locations are preceded by "NTAcs". However, this is omitted from the figure for brevity.
 - Inset A, Area 2:
 - Samples collected from 0-1, 1-2, 2-3, and 3-4 ft bgs.
 - North sidewall: Soil samples collected north of NTAcs-180M-S01 will be analyzed for benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene.
 - West sidewall: Soil samples collected west of NTAcs-181M-S01 will be analyzed for benzo(a)pyrene.
 - South sidewall: Soil samples collected south of NTAcs-182M-S01 will be analyzed for benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene.
 - East sidewall: Soil samples collected east of NTAcs-183M-S01 will be analyzed for benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene.
 - Inset B, Area 1:
 - Samples collected from 0-1 ft bgs.
 - Soil samples analyzed for benzo(a)pyrene.
 - Inset C, Area 3:
 - Samples collected from 2-3 and 3-4 ft bgs. (The 0-2-foot interval is backfill from previous excavation).
 - Soil samples analyzed for benzo(a)pyrene.



leidos

U.S. ARMY CORPS OF ENGINEERS
LOUISVILLE DISTRICT

FORMER RVAAP/
CAMP JAMES A. GARFIELD
PORTAGE/TRUMBULL COUNTIES, OHIO

DESIGNED BY:	REVISIONS BY:	DATE:	UNITS:
R. BEELEER	RYAN LAURICH	JUN 08, 2023	FEET
GEO FILE: \\chs-1901\CAD\19009\MXD\U31_R_AV38_NACA_F_PSMAP-01_RD			

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

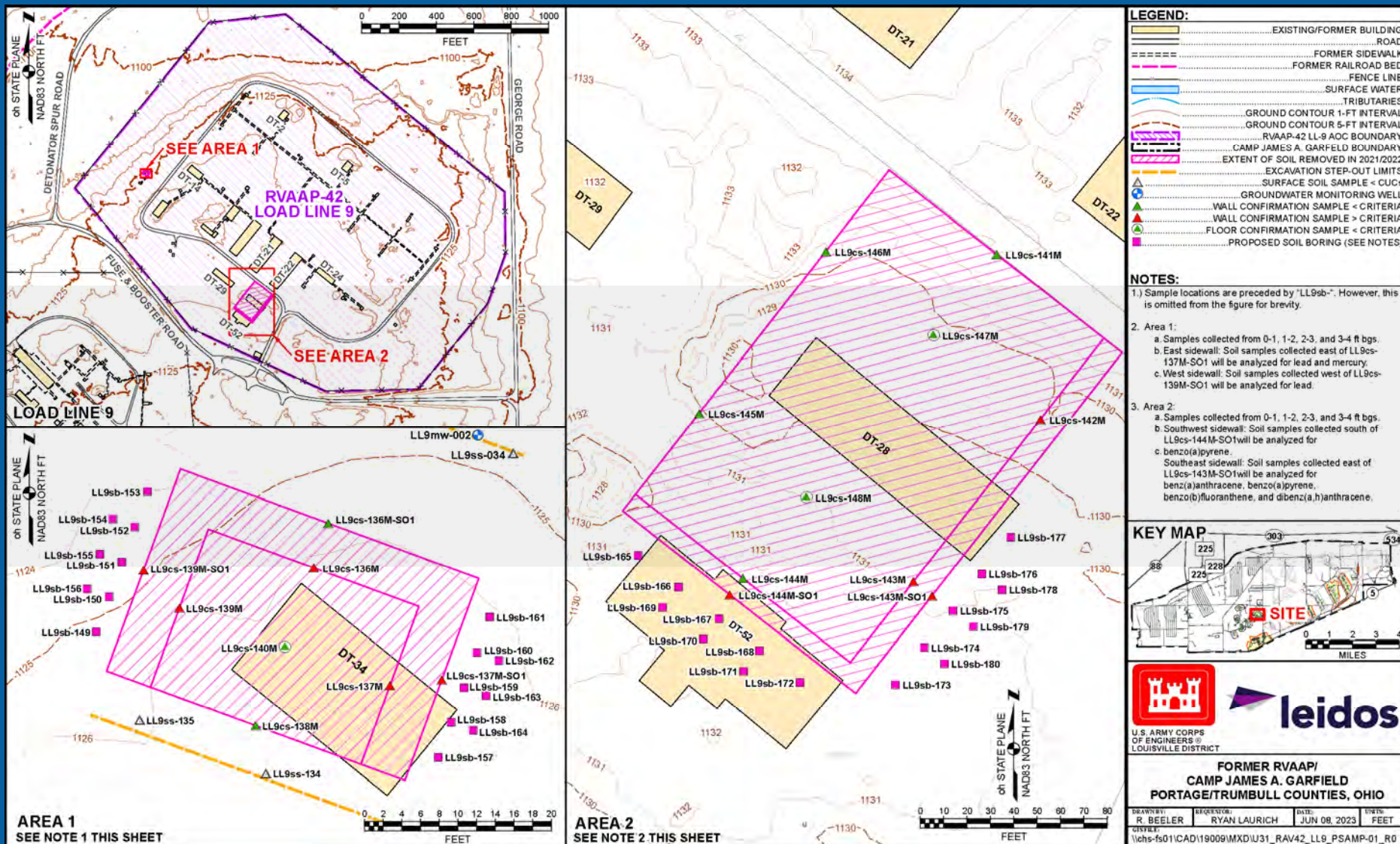
- **Soil Samples**

- 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





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**

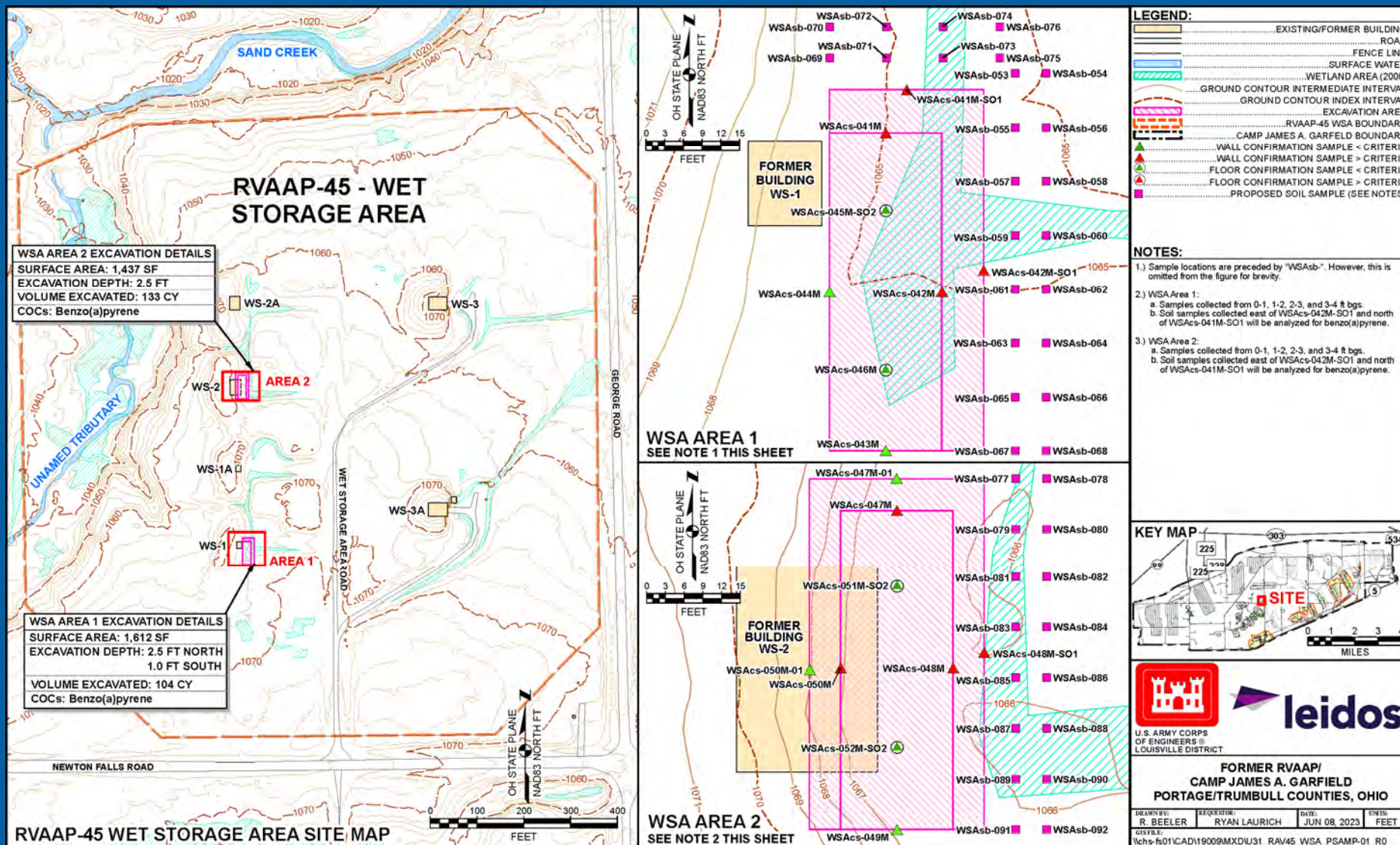
- Surface: 0-1 ft bgs
- Subsurface: 1 ft intervals down to 4 ft bgs

- **Sampling Analytes**

- Area 1 and Area 2: benzo(a)pyrene



Multiple Areas of Concern RVAAP-45 Wet Storage Area Exceedances and Proposed RD Sampling



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

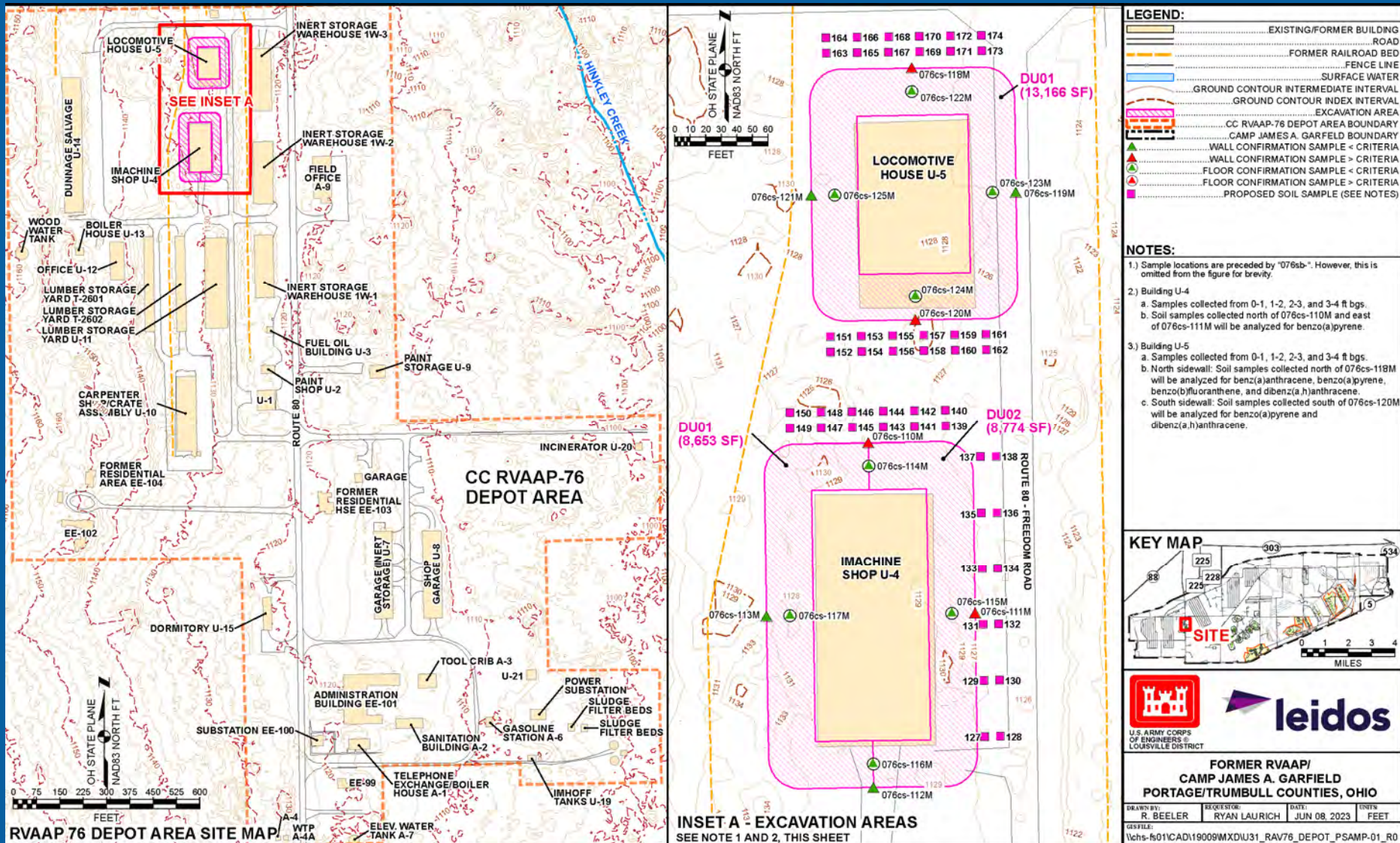
- **Soil Samples**

- 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



Questions?

APPENDIX F
OHIO EPA COMMENTS

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Received January 26, 2024

January 25, 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 Plt RVAAP
Remediation Response
Project records
Remedial Response
Portage County
267000859243, 267000859137, 267000859098,
267000859264 and 267000859127

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

Subject: Approval of Uniform Federal Policy-Quality Assurance Project Plan for Additional Remedial Design Sampling at Multiple Areas of Concern

Dear Mr. Sedlak:

On January 4, 2024, the Ohio Environmental Protection Agency (Ohio EPA), Northeast District Office (NEDO), Division of Environmental Response and Revitalization (DERR) received the Army's Response to Ohio EPA's December 5, 2023, comment letter¹ on the Draft Uniform Federal Policy-Quality Assurance Project Plan for Additional Remedial Design Sampling at Multiple Areas of Concern². It was prepared by Leidos.

Ohio EPA approves the document. Please submit the document in final form.

If you have any questions concerning this letter, please contact me at (330) 963-1170 or ed.damato@epa.ohio.gov.

Sincerely,

Edward D'Amato, Site Coordinator
Division of Environmental Response and Revitalization

ec: Nicole Walworth, USACE Baltimore
Katie Tait, OHARNG RTLS, CJAG
Steve Kvaal, USACE Louisville
Nathaniel Peters, USACE Louisville
Jennifer M. Tierney, Chenega Reliable Services,
Angela Cobbs, Chenega Reliable Services
Megan Oravec, Ohio EPA, DERR, NEDO
Natalie Oryshkewych, Ohio EPA, DERR, NEDO
Brian Tucker, Ohio EPA, DERR, CO
Thomas Schneider, Ohio EPA, DERR, SWDO

ED/cm

¹ <http://edocpub.epa.ohio.gov/publicportal/ViewDocument.aspx?docid=2660288>

² <https://edocpub.epa.ohio.gov/publicportal/ViewDocument.aspx?docid=2641597>



NATIONAL GUARD BUREAU
111 SOUTH GEORGE MASON DRIVE
ARLINGTON VA 22204-1373

January 4, 2024

Ohio Environmental Protection Agency
DERR-NEDO
Attn: Mr. Edward D'Amato
2110 East Aurora Road
Twinsburg, OH 44087

Subject: Ravenna Army Ammunition Plant (RVAAP) Restoration Program, Portage/Trumbull Counties, RVAAP-38 NACA Test Area, RVAAP-42 Load Line 9, RVAAP-45 Wet Storage Area, CC RVAAP-76 Depot Area, Responses to Comments on the Draft Uniform Federal Policy-Quality Assurance Project Plan (UFP-QAPP) for Remedial Design Sampling at Multiple Areas of Concern (Work Activity No. 267-000-859-243, 267-000-859-137, 267-000-859-098, 267-000-859-264, and 267-000-859-127)

Dear Mr. D'Amato:

The Army appreciates your comments on the *Draft Uniform Federal Policy-Quality Assurance Project Plan for Additional Remedial Design Sampling at Multiple Areas of Concern*. Enclosed for your review is a response to your comment. Upon final resolution of the comment, the Army National Guard 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.SE
RENA.1289508275

Digitally signed by
TAIT.KATHRYN.SERENA.12895082
75
Date: 2024.01.04 12:03:22 -05'00'

FOR Kevin M. Sedlak
Restoration Project Manager
Army National Guard Directorate

ec: Megan Oravec, Ohio EPA, NEDO, DERR
Thomas Schneider, Ohio EPA, SWDO, DERR
Katie Tait, OHARNG
Steve Kvaal, USACE Louisville
Nathaniel Peters, USACE Louisville
Jed Thomas, Leidos
Ryan Laurich, Leidos
Jennifer Tierney, Chenega

Subject: Former Ravenna Army Ammunition Plant (RVAAP) Restoration Program, Portage/Trumbull Counties, Draft Uniform Federal Policy-Quality Assurance Project Plan for Remedial Design Sampling at Multiple Areas of Concern (Work Activity No. 267-000-859-243, 267-000-859-137, 267-000-859-098, 267-000-859-264, and 267-000-859-127)

COMMENTS

Ohio EPA Comment 1: Please add clarifying language stating that the results of the sampling will not change the selected remedy for the Areas of Concern or the required additional soil removal on side walls and/or floors of previous excavations that did not meet remedial clean up goals.

Army Response: Agree. The first paragraph of **Section 11.3 Step 2: Identify the Goals of the Study** has been revised as follows:

“The goal of the study will be to collect additional data to refine the soil contamination above CUGs within excavation areas at RVAAP-38 NACA Test Area (Area 1, Area 2, and Area 3), RVAAP-42 Load Line 9 (Area 1 and Area 2), RVAAP-45 Wet Storage Area (Area 1 and Area 2) and CC RVAAP-76 Depot Area (Building U-4 and Building U-5). **Results from the sampling will not change the selected remedy for the AOCs or the required additional soil removal on sidewalls and/or floors of previous excavations that did not meet CUGs.**”



December 5, 2023

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 Plt RVAAP
Remediation Response
Project records
Remedial Response
Portage County
267000859243, 267000859137,
267000859098, 267000859264 and
267000859127

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

Subject: Uniform Federal Policy-Quality Assurance Project Plan for Additional Remedial Design Sampling at Multiple Areas of Concern

Dear Mr. Sedlak:

On November 23, 2023, the Ohio Environmental Protection Agency (Ohio EPA), Northeast District Office (NEDO), Division of Environmental Response and Revitalization (DERR) received the Uniform Federal Policy-Quality Assurance Project Plan for Additional Remedial Design Sampling at Multiple Areas of Concern¹. It was prepared by Leidos.

Ohio EPA has the following comment:

1. Please add clarifying language stating that the results of the sampling will not change the selected remedy for the Areas of Concern or the required additional soil removal on side walls and/or floors of previous excavations that did not meet remedial clean up goals.

If you have any questions concerning this letter, please contact me at (330) 963-1170 or by email at ed.damato@epa.ohio.gov.

Sincerely,

Edward D'Amato, Site Coordinator
Division of Environmental Response and Revitalization

ec: Nicole Walworth, USACE Baltimore
Katie Tait, OHARNG RTLS, CJAG
Steve Kvaal, USACE Louisville
Nathaniel Peters, USACE Louisville
Jennifer M. Tierney, Chenega
Angela Cobbs, Chenega
Megan Oravec, Ohio EPA, DERR, NEDO
Natalie Oryshkewych, Ohio EPA, DERR, NEDO
Brian Tucker, Ohio EPA, DERR, CO
Thomas Schneider, Ohio EPA, DERR, SWDO

¹<https://edocpub.epa.ohio.gov/publicportal/ViewDocument.aspx?docid=2641597>