FINAL

UNIFORM FOR FEDERAL POLICY FOR QUALITY ASSURANCE PROJECT PLAN

CONTAMINATED SOIL REMEDIAL DESIGN

IOWA ARMY AMMUNITION PLANT
MIDDLETOWN, IOWA

Contract No. W912QR20D0002
Delivery Order No. W912QR20F0384

Prepared for:

U.S. Army Corps of Engineers
Louisville District

Prepared by:

TAC Environmental, LLC.
1915 North 12th Street
Toledo, OH 43604

March 2022

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APPENDIXES

Appendix A Field Standard Operating Procedures
Appendix B Laboratory Standard Operating Procedures
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ACRONYMS AND ABBREVIATIONS

%	percent
2,4-DNT	2,4-dinitrotoluene
µg/kg	microgram(s) per kilogram
AEC	Atomic Energy Commission
ATI-CTI	ATI-CTI JV, LLC
B.S.	Bachelor of Science
bgs	below ground surface
CA	Corrective Action
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	chemical of concern
COR	Contracting Officer's Representative
CSM	conceptual site model
DNT	dinitrotoluene
cy	cubic yards
DoD	U.S. Department of Defense
DQO	data quality objective
ELAP	Environmental Laboratory Accreditation Program
ESD	Explanation of Significant Differences
ft	feet/foot
FTL	Field Team Leader
FUSRAP	Formerly Utilized Sites Remedial Action Program
Harza	Harza Environmental Services, Inc.
HMX	High Melt Explosive
IAAAP	Iowa Army Ammunition Plant
IDNR	Iowa Department of Natural Resources
IROD	Interim Action Record of Decision
LAP	load, assemble, and pack
LCS	laboratory control sample
LOD	limit of detection
LOQ	limit of quantitation
M.S.	Master of Science

mg/kg	milligram(s) per kilogram
mm	millimeter
MS	matrix spike
MSD	matrix spike duplicate
NTCRA	non-time critical removal action
OU	Operable Unit
PA	Preliminary Assessment
PAH	polynuclear aromatic hydrocarbon
PAL	Project Action Limit
PCB	polychlorinated biphenyl
PE	Professional Engineer
PG	Professional Geologist
PID	photoionization detector
PM	Project Manager
POC	Point of Contact
PRG	preliminary remediation goal
QA	quality assurance
QC	quality control
QSM	Quality Systems Manual
RACR	Remedial Action Completion Report
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RDX	Royal Demolition Explosive
RG	Remediation Goal
RL	reporting limit
ROD	Record of Decision
RPD	relative percent difference
SI	Site Investigation
SOP	standard operating procedure
SVOC	semivolatile organic compound
TAC JV	TAC Environmental, LLC
TNT	2,4,6-trinitrotoluene

TTL	TTL Associates, Inc.
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plan
USACE	United States Army Corps of Engineers
USAEC	United States Army Environmental Center
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

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INTRODUCTION

This Uniform Federal Policy for Quality Assurance Project Plan (UFP-QAPP) describes the technical approach, project quality objectives, analytical, and sampling program for completing Contaminant Soil Remedial Design (RD) at the Iowa Army Ammunition Plant (IAAAP) in Middletown, Iowa. TAC Environmental, LLC (TAC JV), a joint venture between TTL Associates, Inc. and ATI-CTI JV, LLC. (ATI-CTI), has prepared this document under United States Army Corps of Engineers (USACE) Louisville District as Delivery Order No. W912QR20F0384 under Contract No. W912QR20D0002.

The IAAAP is currently undergoing a modernization effort involving the demolition of numerous buildings throughout the Installation. Investigation is required to determine if contaminated soil exists beneath recently demolished buildings and delineate the contamination in vadose zone soil that exceeds Remediation Goals (RGs) provided in the Operable Unit (OU) 1 Record of Decision (ROD) (Harza Environmental Services, Inc. [Harza], 1998). The IAAAP is currently divided into 11 operable units; OU1 includes soil on the IAAAP other than those contaminated by use or testing of military munitions or by radiological constituents. Using an industrial land use scenario, OU1 soil RGs were developed for the protection of human health and were established at a target carcinogenic risk of 10^{-6} for all chemicals of concern, in addition to more conservative “leaching RGs” for Royal Demolition Explosive (RDX) and 2,4,6-trinitrotoluene (TNT). Soil analytical data will be used in support of an RD for removal of contaminated soil that exceeds RGs (the selected short-term remedy presented in the OU1 ROD) or for implementation of land use controls preventing residential land use (the selected long-term remedy presented in the Explanation of Significant Differences [ESD] completed in 2018 [Leidos, 2018]). Should an OU1 metals evaluation conclude that OU1 RGs will change, and those metals are included in the UFP-QAPP sampling list, results will be screened against the new RGs where applicable in the Remedial Design.

SUMMARY OF EXISTING INFORMATION

Site Background

The IAAAP encompasses 19,011 acres adjacent to the town of Middletown in Des Moines County, Middletown, Iowa. The property is bordered by U.S. Highway 34 to the north, upland agricultural farms to the east and west, and the Skunk River Valley to the south. The IAAAP is an active Joint Munitions Command facility currently operated by a civilian contractor, American Ordnance, LLC.

INTRODUCTION, CONT'D

The plant, originally called the Iowa Ordnance Plant, was built between 1941 and 1945 for production of munitions. Production activities included load, assemble, and pack (LAP) of munitions, including projectiles, including those of the current mission, as well as anti-tank mines and anti-personnel mines. LAP operations used explosives-containing materials and lead-based initiating compounds. The historic Atomic Energy Commission (AEC) operated at some facilities at the IAAAP from 1947 to 1975, assembling components of nuclear weapons. (Leidos, 2018).

Past munitions production has resulted in contamination of soil and groundwater and discharge of wastewater containing explosives and explosives by-products to surface water. The primary source of contamination is attributable to past operating practices in which explosives-contaminated (TNT, RDX, High Melt Explosive [HMX]) wastewaters and sludges were discharged to uncontrolled lagoons and impoundments at the IAAAP. Additional sources of contamination included open burning of explosives materials and munitions and landfilling of waste material. Volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), explosives, polychlorinated biphenyls (PCBs), and metals were also identified as chemicals of concern (COCs) at certain areas (Leidos, 2018).

IAAAP Site Features

The IAAAP is located in the dissected till plain section of the Central Lowland Province of the Southern Iowa Drift Plain Region. Continental glaciation is exhibited in this area by broad, flat to gentle undulating terrain, which at the IAAAP is observed in upland topography. Shallow drainage systems and parts of three large drainage basins (the Des Moines, Skunk, and Iowa Rivers) dissect the terrain. The basins drain into the Mississippi River which forms the eastern boundary of the region (Tetra Tech, 2009a).

The site is underlain by silty clay and deposits of loess (wind blown non-stratified silts and clays). A glacial till consisting of clay and silt with primarily discontinuous sand and gravel seams underlies the loess. The Kellerville Till member of the Glasford Formation is the uppermost till unit, occurring at approximately 100 feet (ft) deep in the Line 1 area. The Warsaw Formation underlies the glacial deposits, consisting of intercalated shale, dolomitic shale, limestone, dolomite, and chalcedonic chert. Remnants of discontinuous shales of Pennsylvanian age locally may overlie the Mississippian-aged Warsaw Formation below the glacial till. The Keokuk Limestone, comprised of mottled gray bioclastics and chert underlies the Warsaw

Formation, followed by the Burlington Limestone that comprises the Dolbee Creek Member (base), Haight Creek member (middle), and Cedar Fork Member (top) (JAYCOR, 1993).

Current and Potential Future Site and Resource Uses

The current mission of the IAAAP is to LAP ammunition items, including projectiles, mortar rounds, warheads, demolition charges, and munitions components such as fuses, primers, and boosters. The current and reasonably anticipated future land use is industrial.

Previous Investigations and Current Understanding of Nature and Extent of Potential Contamination

Numerous investigations have been conducted at the site by the Army from 1975 to the present. Forty-three subsites of known or suspected contamination were identified and investigated in an initial Preliminary Assessment (PA), and a Site Investigation (SI) was conducted for each of the 43 areas in 1991 (JAYCOR, 1994). The presence of chemical constituents above analytical reporting limits (RLs) indicated that additional investigation was required. A Phase I Remedial Investigation (RI) completed in 1992 included characterization of background levels of metals in soils, a soil gas sampling effort to evaluate VOC contamination, and field screening for metals and explosives in soil, with 20 percent (%) verification sampling and analysis at a fixed laboratory. Data from the Phase I RI was used to refine soil and groundwater investigations in a Phase II RI that began in 1993 and continued through 1995. Non-time critical removal actions (NTCRAs) were completed to address contamination at several sites. In addition to the subsites for which NTCRAs were performed, 15 areas with soils containing COCs greater than cleanup goals for the site were identified. The 15 areas included Lines 1, 2, 3, 3A, 4A/4B, 5A/5B, 6, 8, 9, and 800, the East Burn Pads Area, Demolition Area/Deactivation Furnace, Burn Cages/West Burn Pads Area (including West Burn Pads Area [south of the road]), North Burn Pads Area (and Landfill), and Roundhouse Transformer Storage Area (Figure 1). The contaminated soils at the 15 subsites were evaluated as OU1. A Focused Feasibility Study was completed in 1997, followed by an Interim Action Record of Decision (IROD) (United States Army Environmental Center [USAEC], approved in March 1998), with a selected remedy of temporarily stockpiling the most highly contaminated soils for future treatment; and by permanently disposing the remaining contaminated soils. The subsequent ROD (Harza, 1998) selected a remedy consisting of excavation/stabilization/solidification and disposal for contaminated soil and implementation. Several ESDs documents were approved after finalization of the IROD and ROD:

- In 2003, an ESD (United States Environmental Protection Agency [USEPA], 2003) documented biological treatment of soils contaminated with explosives as the primary remedy, with an increase in proposed contaminated soil to be removed from the West Burn Pads Area.

- Particular areas of concern at the IAAAP are addressed by the USACE under the Formerly Utilized Sites Remedial Action Program (FUSRAP), and include response actions at seven areas associated with historical AEC activity, including Line 1 and the West Burn Pads Area (South of the Road) of OU1. In 2006, an ESD (Tetra Tech, 2006) documented removal of radioactive nuclides as contaminants requiring remediation at OU1. The USACE is the lead agency for implementing environmental restoration activities in areas within the scope of the FUSRAP Facility Agreement between the USEPA, USACE, United States Department of Energy, and the State of Iowa (Administrative Docket Number: Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA]-07-2005-0378). To the extent that the remedy selected in the IAAAP Soils RODs is appropriate for areas identified for FUSRAP response, the USACE is implementing the selected remedy, and the FUSRAP responses at Line 1 and the West Burn Pads Area (South of the Road) are being executed pursuant to the IAAAP Soils RODs.
- In 2008, an ESD (Tetra Tech, 2008) documented additional soil excavation required at Line 3, Line 3A, and Line 800 following ecological risk evaluation; additionally, the Incendiary Disposal Area, Possible Demolition Site, and Central Test Areas (Figure 1) were added to OU1.
- In 2009, an ESD (Tetra Tech, 2009b) documented a change of primary treatment technology from biological to alkaline hydrolysis chemical treatment for soils contaminated with TNT.
- In 2011, an ESD (Tetra Tech, 2011) documented the addition of soil volume and a site-specific remedial goal for barium within the West Burn Pads Area (South of the Road) and offsite treatment and disposal as a remedy for contaminated soil excavated at Line 2 and the West Burn Pads Area (South of the Road).
- An ESD completed in 2018 (Leidos, 2018) documented three separate additions to the selected remedy, including land use controls at OU1 areas, offsite treatment and disposal of contaminated soil removed during future remedial actions, and the addition of the former Fire Training Pit located south of Plant Road O and west of the Burn Pads Area

and north of the Explosive Waste Incinerator in the northeastern portion of the IAAAP (Figure 1).

Remedial actions for seven sites were completed during four phases (Phases 1 through 4) and documented in separate Remedial Action Reports. Remedial actions for the remaining sites were completed in three phases (Phases 5, 7, 8) and documented in a Remedial Action Completion Report (RACR) completed in 2008 (Tetra Tech, 2009a). Excavation at some of the areas was not able to be performed due to the presence of buildings and/or structures. A recent modernization effort resulted in demolition of buildings beneath which contaminated soil may be present. A listing of the recently demolished, or yet to be demolished, buildings identified as having potential contaminated soils is provided as Table 17.1 of this UFP-QAPP. The location of the buildings and a description of the subsite within which of the buildings are located is provided below.

Project Objectives and Investigative Approach

Investigation work will consist of the collection of soil samples in areas (106 former building locations) for which potential impact from spills and leaks has not been investigated. The former building locations are located across the IAAAP and include 19 former building footprints at Line 2; eight at Line 3; 19 at Line 3A; 16 at Line 5A/5B; 15 at Line 6; two at Line 9; eight at Line 800; and 19 in miscellaneous other areas. Table 17.1 in Worksheet #17 of this UFP-QAPP provides a summary list of the former buildings, the area of the building footprint, and the number of proposed borings for collection of soil samples.

To investigate the soil below foundation footprints, 395 soil borings will be blind drilled to the depth of former building footers or base of the building foundation, and then continuously screened for approximately 10 ft for the collection of two subsurface soil samples (e.g., two soil samples will be collected from each soil boring). Footers for buildings at IAAAP reportedly average 15 ft below ground surface (bgs); borings will be blind drilled to 15 ft bgs, and then advanced to 25 ft bgs for collection of soil samples at these locations. The base of the foundation of smaller buildings (less than 300 square ft) may be closer to 4 ft bgs; soil borings at these locations may extend to between 13 and 16 ft bgs (approximately 10 ft below the former base of the foundation).

Borings will not be advanced below the water table for the collection of soil samples. Contamination in groundwater within and outside of the IAAAP boundary is addressed under OU6 and OU3, respectively. If groundwater is encountered at depths less than 10 ft below the building foundation, one soil sample will be collected within the available vadose zone interval, if possible, and collection of a second soil sample will be determined based on the available vadose zone sample interval.

At each boring where groundwater is not encountered, one soil sample will be collected from a depth correlating with the highest photoionization detector (PID) readings and/or visual or olfactory evidence of impact, and one soil sample will be collected at a depth 2 to 5 ft below this depth, or when there is no longer visual or olfactory evidence of impact. If the soil column appears homogeneous, the initial soil sample will be collected approximately 2 to 5 ft below the building footer, and the second soil sample will be collected approximately 2 to 5 ft below the first sample depth. Soil will be analyzed for the chemicals of concern identified during previous investigations, and may include VOCs (if elevated PID readings [sustained readings above background] are observed or if there is a noticeable odor), polynuclear aromatic hydrocarbons (PAHs), explosives, and/or metals. Soil results will be compared to RGs and to industrial regional screening levels (RSLs) (for constituents not specified in the OU1 ROD). Should an OU1 metals evaluation conclude that OU1 RGs will change, and those metals are included in the UFP-QAPP sampling list, results will be screened against the new RGs where applicable in the Remedial Design. Analytical results will demonstrate that soil meets RGs and will be maintained under land use controls in accordance with the 2018 ESD, or that removal is required in accordance with the OU1 ROD; data will be presented in the Contaminant Soil RD.

QAPP Worksheets #1 and #2
Title and Approval Page

Site Name/Project Name: IAAAP, Middletown, Iowa

Site Location/Number: Contaminated Soil (OU1) Remedial Design

Contract/Delivery Order Number: W912QR-20-D0002/ W912QR-20-F0384

Lead Agency: USACE, Louisville District
600 Dr. Martin Luther King Jr. Place
Louisville, Kentucky 40202

Lead Organization Contracting Officer's Representative and Quality Assurance Manager:

STEELE.AARON.B.1368382090 Digitally signed by STEELE.AARON.B.1368382090 Date: 2022.04.01 14:01:56 -04'00'

Aaron Steele, USACE-Louisville District

Lead Organization Technical Manager

STEPHENS.MAGGIE.E.1594389600 Digitally signed by STEPHENS.MAGGIE.E.1594389600 Date: 2022.04.04 08:38:55 -04'00'

Maggie Stephens, USACE-Louisville District

Environmental Restoration Program Manager:

BUSARD.JENNIFER.LYNN.1464645930 Digitally signed by BUSARD.JENNIFER.LYNN.1464645930 Date: 2022.03.31 16:36:29 -05'00'

Jennifer Busard, IAAAP

Federal Regulatory Agency:

ANGELA SENA Digitally signed by ANGELA SENA Date: 2022.04.04 08:22:02 -05'00'

Angela Sena, USEPA, Region 7 Project Manager

DIANE HARRIS Digitally signed by DIANE HARRIS Date: 2022.04.05 14:54:20 -05'00'

Diane Harris, USEPA Region 7 Investigative Organization Project Quality (QA) Officer

Prime Contractor Quality Control Manager

Veronica Winkeljohn Digitally signed by Veronica Winkeljohn Date: 2022.04.01 07:57:21 -04'00'

Veronica Winkeljohn, TAC JV

Regulatory Program: CERCLA

03/14/2022
2022073

WORKSHEETS #1 AND #2, CONT'D

Plans and Reports from Previous Investigations Relevant to this Project:

Site Characterization Reports (JAYCOR, 1993)

Preliminary Assessments for the 43 Iowa Army Ammunition Plant Sites (JAYCOR, 1994)

Remedial Investigation/Risk Assessment, Iowa Army Ammunition Plant (JAYCOR, 1996)

Focused Feasibility Study, Iowa Army Ammunition Plant, Middletown, Iowa (Engineered Efficiency 1997)

Interim Action Record of Decision, Soils Operable, Iowa Army Ammunition Plant Soils Operable Unit, Middletown, Iowa (USAEC, 1998)

Soils Feasibility Study Report Operable Unit No. 1, Iowa Army Ammunition Plant, Middletown, Iowa (USACE, 1998)

Record of Decision, Iowa Army Ammunition Plant Soils Operable Unit #1, Middletown, Iowa (Harza, 1998)

Remedial Action Report, Iowa Army Ammunition Plant, Focused Feasibility Study Sites, Phase II (Environmental Chemical Corporation, 2001)

Preliminary Assessment, Iowa Army Ammunition Plant (USACE 2001)

Field Sampling Report for the Environmental Technology Site at Building 600-84, Iowa Army Ammunition Plant (Advanced Environmental Technology, 2001).

Line 1 and Firing Site Supplemental Remedial Investigation Report, Iowa Army Ammunition Plant, Middletown, Iowa (TN & Associates, 2002)

Explanation of Significant Differences for the Record of Decision Soils Operable Unit 1 (OU-1), Iowa Army Ammunition Plant, Middletown, Iowa (USEPA, 2003)

Explanation of Significant Differences, Deletion of Radiological Contaminants from Interim Record of Decision (IROD), Soils Operable Unit #1 (OU-1), Iowa Army Ammunition Plant, Middletown, IA (Tetra Tech, 2006)

QAPP Worksheets #1 and #2

Explanation of Significant Differences, for the Interim Action Record of Decision Soils Operable Unit, Addition of Environmental Protectiveness to the Remedy and Transfer of Sites from OU-4 to OU-1, Iowa Army Ammunition Plant, Middletown, IA (Tetra Tech, 2008)

Iowa Army Ammunition Plant FUSRAP Remedial Investigation Report for Firing Sites Area, Yards C, E, F, G, and L, Warehouse 3-01 and Area West of Line 5B (USEPA, with assistance from Science Applications International Corporation, 2008)

Remedial Action Completion Report for Operable Unit 1 (OU-1) Soils, Phase 5, 7, and 8 Sites and Installation-wide Ecological (Tetra Tech, Inc., 2009a)

Explanation of Significant Differences for the Final Record of Decision (ROD) Soils Operable Unit (OU-1), Change of Primary Treatment Technology from Biological to Alkaline Hydrolysis Chemical Treatment for Iowa Army Ammunition Plant, Middletown, Iowa (Tetra Tech, Inc., 2009b)

Explanation of Significant Differences for the Records of Decision Soils Operable Unit 1 (OU-1), Addition of Soil Volume, Site-specific Remedial Goal for Barium, and Offsite Disposal of Contaminated Soil for Iowa Army Ammunition Plant, Middletown, Iowa (Tetra Tech, Inc., 2011)

IAAAP Line 1 and West Burn Pad Area South of the Road Remediation Action for Iowa Army Ammunition Plant Final Progress Report (SEC, 2014)

Five-Year Review Report for Iowa Army Ammunition Plant, Middletown, Iowa (USACE, 2016).

Uniform Federal Policy-Quality Assurance Project Plan for Remedial Investigation at Iowa Army Ammunition Plant, Middletown, Iowa (CH2M HILL, 2017)

Explanation of Significant Differences for the Record of Decision Soils Operable Unit 1 (OU-1) Addition of Land Use Controls, Off-site Disposal of Contaminated Soil, and the Fire Training Pit for Iowa Army Ammunition Plant, Middletown, Iowa (Leidos, 2018)

FUSRAP Five-Year Review Report for Operable Unit 1 (OU-1) and Operable Unit 8 (OU-8), Iowa Army Ammunition Plant, Middletown, Iowa (USACE, with assistance from Leidos)

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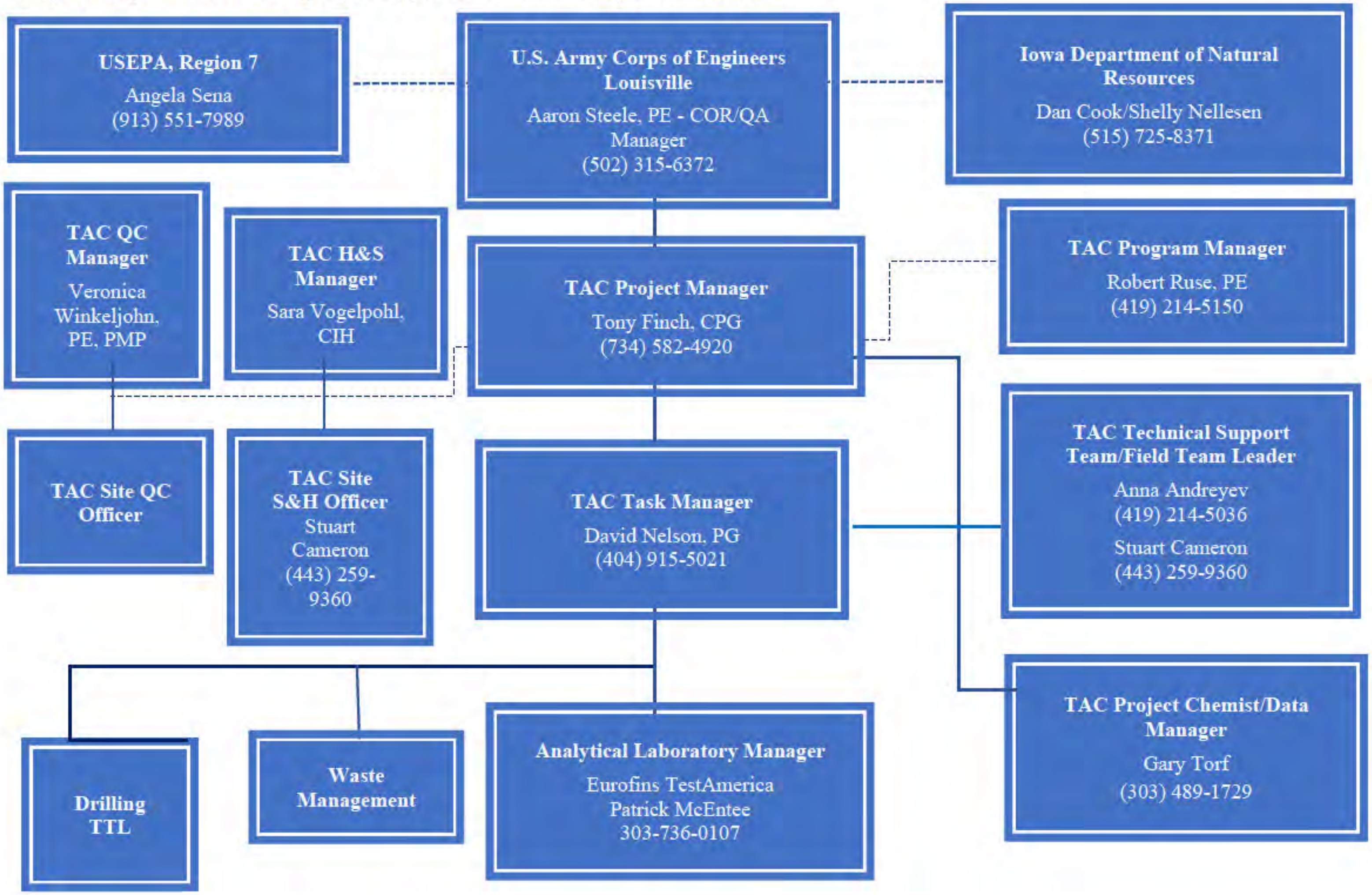
QAPP Worksheets #3 and #5
QAPP Distribution and Project Organization

Distribution: The following is the distribution list for this QAPP.

Name of QAPP Recipients	Title/Role	Organization	Telephone Number	E-mail Address	Documents
Aaron Steele	Contracting Officer's Representative/QA Manager	USACE-Louisville District	(502) 315-6372	aaron.b.steele@usace.army.mil	Electronic Copy
Maggie Stephens	Technical Manager	USACE-Louisville District	(502) 315-6251	maggie.e.stephens@ususace.army.mil	Electronic Copy
Tony Finch	Project Manager	TAC JV	(734) 582-4920	tfinch@ttlassoc.com	Electronic Copy
Angela Sena	Remedial Project Manager	USEPA	(913) 551-7989	sena.angela@epa.gov	Electronic Copy
Dan Cooke	Point of Contact	IDNR	(515) 725-8371	dan.cook@dnr.iowa.gov	Electronic Copy
Shelly Nellesen	Point of Contact	IDNR	(515) 725-8371	shelly.nellesen@dnr.iowa.gov	Electronic Copy
Robert Ruse	Program Manager	TAC JV	(419) 214-5150	rruse@ttlassoc.com	Electronic Copy
David Nelson	Task Manager	TAC JV	(404) 915-5021	david.nelson@atiinc.com	Electronic Copy
Gary Torf	Project Chemist	Torf Environmental Chemistry	(303) 489-1729	gary.torf@torf.us	Electronic Copy
Veronica Winkeljohn	QC Manager	TAC JV	(734) 582-4992	vwinkeljohn@ttlassoc.com	Electronic Copy
Anna Andreyev	Technical Support	TAC JV	(419) 214-5036	aandreyev@ttlassoc.com	Electronic Copy
Stuart Cameron	Technical Support	TAC JV	(443) 259-9360	stuart.cameron@atiinc.com	Electronic Copy
Teresa Offner	Project Geologist	TAC JV	(678) 592-0024	teresa.offner@atiinc.com	Electronic Copy
Gary Torf	Data Manager	Torf Environmental Chemistry	(303) 489-1729	gary.torf@torf.us	Electronic Copy
Patrick McEntee	Laboratory PM	Eurofins/TestAmerica	(303) 736-0107	patrick.mcentee@eurifinset.com	Electronic Copy
Sara Vogelpohl	Site Safety and Health Manager	TAC JV	(202) 631-0704	svogelpohl@ttlassoc.com	Electronic Copy

Project Organization: The project organizational chart is presented below:



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

ORGANIZATION: TAC JV Team

Name	Project Title/Role	Personnel Qualifications or Special Training	Signature	Date
Tony Finch	PM	• B.S. Geology • Certified CPG • 40-hour HAZWOPER with 8-hour refresher • Experience: 29 years	Tony Finch	4/6/2022
David Nelson	Task Manager	• M.S. Geology • PG • Experience: 29 years		4/6/22
Robert Ruse	Program Manager	• Ph. D., M.S., B.S. Civil Engineering • PE • Experience: 34 years		4/6/2022
Veronica Winkeljohn	QC Manager	• B.S. Environmental Engineering • PE • 40-hour HAZWOPER with 8-hour refresher • Experience: 24 years	Veronica J Winkeljohn	4/6/2022
Gary Torf	Project Chemist	• B.S. Natural Resources • 40-hour HAZWOPER with 8-hour refresher • Experience: 37 years	Gary Torf	4/19/2022
Anna Andreyev	Technical Support	• M.S., B.S. Geology • 40-hour HAZWOPER with current 8-hour refresher • Experience: 5 years		4/6/2022

QAPP Worksheets #4, #7, and #8, Cont'd.

Teresa Offner	Project Geologist	• M.S. Geology • PG • Experience: 25 years		
Stuart Cameron	Technical Support/Field Team Leader	• M.S. Environmental Engineer • 40-hour HAZWOPER with current 8-hour refresher • PE • Experience: 12 years		

Notes:

1. Site worker qualifications include Occupational Safety and Health Administration (OSHA) 40-hour Hazardous Waste with annual 8-hour Hazardous Waste Refresher Training, Bloodborne Pathogens, Dangerous Goods Shipping, Waste Management, Fire Extinguishers, and Remediation Waste Training, First Aid, Automated External Defibrillator, and Cardiopulmonary Resuscitation Training with annual or biannual Medical Monitoring.

B.S. = Bachelor of Science
M.S. = Master of Science
PE = Professional Engineer
PG = Professional Geologist
PM = Project Manager
QC = Quality Control

ORGANIZATION: Eurofins/TestAmerica Laboratory

Name	Project Title/Role	Personnel Qualifications or Special Training	Signature	Date
Patrick McEntee	Laboratory PM	• B.A. Geology • Experience: 33 years		4/25/2022
Anthony Grimaldi	Laboratory Director	• B.S. Molecular Biology • Experience: 12 years		4/25/2022
Maria Fayard	Quality Assurance Manager	• B.S. Biology, minor in Chemistry • Experience: 24 years	Maria Fayard	4/26/2022

Notes:
B.A. = Bachelor of Arts
B.S. = Bachelor of Science
PM = Project Manager

QAPP Worksheet #6
Communication Pathways

Communication Drivers	Responsible Entity/Position	Responsible Individual	Contact Phone Number	Procedure (Timing, Pathways, etc.)
POC with USACE	TAC JV / PM	Tony Finch	(734) 582-4920 tfinch@ttlassoc.com	Project related issues, including changes in schedule, changes in scope of fieldwork or delays, and recommendations to stop work, will be communicated to the USACE PM by phone, email, or fax by close of business the next business day.
	TAC JV / Task Manager	David Nelson	(404) 915-5021 david.nelson@atiinc.com	Project information will be reported to the USACE PM through monthly progress reports, email updates, teleconferences, and meetings. The TAC JV PM will document deviations from the UFP-QAPP and any CAs and will report them to the USACE PM in memoranda. The USACE PM will be notified of any laboratory CAs within 24 hours of receiving notification from the laboratory or project chemist
Regulatory agency interaction	USACE / COR/QA Manager	Aaron Steele	(502) 315-2621 aaron.b.steele@usace.army.mil	All materials and information about the project will be forwarded to USEPA Region 7 and IDNR by the USACE COR/ PM.
	USEPA	Angela Sena	(913) 551-7989 sena.angela@epa.gov	Primary POC for USEPA and IDNR; can delegate communication to other internal or external POCs.
	IDNR/ Primary Contact	Dan Cook/ Shelly Nellesen	(515) 725-8371 dan.cook@dnr.iowa.gov shelly.nellesen@dnr.iowa.gov	

QAPP Worksheet #6, Cont'd.

Communication Drivers	Responsible Entity/Position	Responsible Individual	Contact Phone Number	Procedure (Timing, Pathways, etc.)
Daily field progress reports	TAC JV / FTL	Stuart Cameron	(703) 342-8389 stuart.cameron@atiinc.com	During field activities, the FTLs will prepare the field progress report for submission to the TAC JV PM by the end of the following business day. The progress report will include boring logs and well development forms during well installation, and sampling sheets and Chain-of-Custody forms during groundwater and soil sampling.
Stop work because of safety issues	TAC JV / SSHO	Stuart Cameron	(703) 342-8389 stuart.cameron@atiinc.com	If unsafe work conditions are noted, the SSHO will stop work immediately. Work will not be allowed to resume until the unsafe condition is corrected. The SSHO will notify the Corporate Health & Safety Manager immediately when a stop work situation is encountered. In some cases, such as inclement weather (for example, lightning or high winds), no CA is required and work may resume when the SSHO and Health & Safety Manager determine that conditions allow.
QAPP changes before fieldwork	TAC JV / Project Chemist	Gary Torf	(303) 489-1729 gary.torf@torf.us	If errors or changed conditions require modification of the UFP-QAPP prior to initiation of fieldwork, the TAC JV Project Geologist will prepare revised text in collaboration with the Project Chemist and PM. All changes to the UFP-QAPP will require final approval from USACE and regulatory agencies.

QAPP Worksheet #6, Cont'd.

Communication Drivers	Responsible Entity/Position	Responsible Individual	Contact Phone Number	Procedure (Timing, Pathways, etc.)
QAPP changes during project execution	TAC JV / FTL	Stuart Cameron	(703)342-8389 stuart.cameron@atiinc.com	The FTL will notify the PM and Project Chemist of any planned field deviations from the UFP-QAPP before implementing the changes. They will document changes in field daily progress reports and memoranda to the PM, review field operations daily and evaluate the need for field CAs (in collaboration with PM), and document CAs in the daily logs and in memoranda to the TAC JV and USACE PMs. All changes to the UFP-QAPP will require final approval from USACE and regulatory agencies.
Field CAs	TAC JV / FTL	Stuart Cameron	(703)342-8389 stuart.cameron@atiinc.com	A CA resulting from either failure to follow UFP-QAPP requirements or changes in site conditions will be documented by the FTL. The FTL will communicate the need for a CA to the PM prior to the change or at a minimum on the same business day. The FTL may initiate an interim CA in the field subject to final approval by the PM and QA/QC Officer.
Sample receipt discrepancies (e.g., broken or missing samples, improper preservation, missing analysis requests)	Eurofins/TestAmerica PM	Patrick McEntee	(303) 736-0166 patrick.mcentee@Eurofinset.com	The laboratory PM will communicate discrepancies in sample receipt to the TAC JV Data Manager on the same business day that the discrepancy is identified. The TAC JV Data Manager, in consultation with the Project Chemist and TAC JV PM, will instruct the laboratory PM on the appropriate course of action.

QAPP Worksheet #6, Cont'd.

Communication Drivers	Responsible Entity/Position	Responsible Individual	Contact Phone Number	Procedure (Timing, Pathways, etc.)
Laboratory QC variances	TAC JV / Project Chemist	Gary Torf	(303) 489-1729 gary.torf@torf.us	The Project Chemist will prepare variance requests in collaboration with laboratory PMs for transmittal to USACE for approval.
Data verification issues (for example, incomplete records)	TAC JV / Project Chemist	Gary Torf	(303) 489-1729 gary.torf@torf.us	The Data Validators will contact the laboratory directly in cases where the discrepancy is a simple report generation error (such as a skipped page or data missing for a subcontracted analytical method). For systematic problems, such as incorrectly formatted data reports or failure to include required data QC elements, the Data Validators will contact the Project Chemist. The Project Chemist will work with the laboratory PM to ensure that properly formatted data reports are delivered to the data validators on a timely basis.
Data validation issues (for example, noncompliance with procedures)	TAC JV / Project Chemist	Gary Torf	(303) 489-1729 gary.torf@torf.us	Where it is determined that the laboratory is not in compliance with the requirements of the QAPP, the Project Chemist will coordinate with the laboratory PM to bring the laboratory's practices into compliance. In some cases, this will require the preparation of the variance request (see above).
Day-to-Day Field Activities, Safety and QA, and Audits	TAC JV / FTL	Stuart Cameron	(703) 342-8389 stuart.cameron@atiinc.com	The FTLs will complete field progress reports and forward them to TAC JV PM. Report completion of milestones.

QAPP Worksheet #6, Cont'd.

Communication Drivers	Responsible Entity/Position	Responsible Individual	Contact Phone Number	Procedure (Timing, Pathways, etc.)
Reporting Laboratory Data Quality Issues	Eurofins/TestAmerica PM	Patrick McEntee	(303) 736-0107 Patrick.Mcentee @Eurofinset.com	The laboratory PM will report QA/QC issues with project field samples to the Project Chemist.
Laboratory Analytical CAs	TAC JV / Project Chemist	Gary Torf	(303) 489-1729 gary.torf@torf.us	The Project Chemist will determine the need for laboratory CAs in conjunction with the Laboratory PM or QA Manager. Any CAs will be documented in memoranda to TAC JV and USACE PMs.
Data Tracking and Management	TAC JV / Data Manager	Gary Torf	(303) 489-1729 gary.torf@torf.us	The Data Manager will track data from the collection of samples through login at laboratory to delivery by technical report/ sample delivery group and EDD into a database. The Data Manager will also review required validation reports and approve release of the final analytical data. The Data Manager will coordinate approval to changes to the QAPP by the TAC JV and USACE PM.

CA = corrective action
COR = Contracting Officer's Representative
EDD = electronic data deliverable
FTL = Field Team Leader
IDNR = Iowa Department of Natural Resources
PM = Project Manager
POC = point of contact
QA = quality assurance
QAPP= Uniform Federal Policy for Quality Assurance Project Plan 1
QC = quality control
SSHO = Site Safety and Health Officer
USACE = U.S. Army Corps of Engineers
USEPA = U.S. Environmental Protection Agency

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QAPP Worksheet #9
Project Scoping Session Participants Sheet

Project Name: IAAAP Contaminated Soil Remedial Design **Projected Date(s) of Sampling:** Summer/Fall 2022 **TAC JV Team Project Manager:** Tony Finch	**Site Name:** USACE IAAAP **Site Location:** IAAAP, Middletown, Des Moines County, Iowa
An internal (project team) kickoff meeting was conducted on September 30, 2020. If external meetings (including regulatory representatives) are conducted at a later date, a summary with a list of participants and key decisions and action items will be included in the final UFP-QAPP.	

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QAPP Worksheet #10
Conceptual Site Model

This worksheet describes the conceptual site model (CSM) for OU1 at the IAAAP. General background information relative to the IAAAP is provided in the Introduction to this UFP-QAPP. This worksheet provides a summary of existing information and working assumptions about the physical site conditions, operational history, nature and extent of contamination, and fate and transport of chemicals of concern in the areas that will be investigated for development of an RD in accordance with the existing ROD and subsequent ESDs.

Physical Setting

Climate in the IAAAP area is humid continental, with hot humid summers and cold wet winters. Average annual precipitation is 42.2 inches, with greatest rainfall in May and July. Snowmelt during spring combined with frozen or saturated soil conditions that reduce infiltration, can result in high runoff and substantial erosion. Additionally, severe thunderstorms in summer can results in high volume of precipitation over a short period of time and also create high runoff volumes (CH2M HILL, 2017).

Topography at the IAAAP is generally flat in the uplands, sloping gently toward the south. Elevation ranges from 732 feet above mean sea level along the northern extent of the installation to approximately 544 feet above mean sea level throughout the extensive southern area of Long Creek and Skunk River (CH2M HILL, 2017).

At the IAAAP, the Brush Creek and Long Creek watersheds drain the majority of the installation. The Brush Creek watershed is in the east-central portion of the IAAAP and is fed by intermittent tributaries. Water that drains into Brush Creek flows south ad exits at the southeastern boundary of the IAAAP. Approximately 3 miles beyond the IAAAP, the creek flows into the Skunk River. The Long Creek watershed is in the west central portion of the IAAAP and is fed by unnamed perennial tributaries from the north and many small intermittent tributaries. Long Creek has been dammed to form George H. Mathes Lake, within the central area of the IAAAP. Water that drains into Long Creek flows east-southeast and south and exits at the southeastern boundary of the installation. Approximately half a mile beyond the IAAAP, the creek flows into the Skunk River (Tetra Tech, 2006).

The IAAAP is located in the dissected till plain section of the Central Lowland Province of the Southern Iowa Drift Plain Region. Continental glaciation is exhibited in this area by broad, flat to gentle undulating terrain, which at the IAAAP is observed in upland topography. Shallow drainage systems and parts of three large drainage basins (the Des Moines, Skunk, and Iowa Rivers) dissect the terrain. The basins drain into the Mississippi River which forms the eastern boundary of the region (Tetra Tech, 2009a).

The site is underlain by silty clay and deposits of loess (wind blown non-stratified silts and clays). A glacial till consisting of clay and silt with primarily discontinuous sand and gravel seams underlies the loess. The Kellerville Till member of the Glasford Formation is the uppermost till unit, occurring at approximately 100 ft deep in the Line 1 area. The Warsaw Formation underlies the glacial deposits, consisting of intercalated shale, dolomitic shale, limestone, dolomite, and chalcedonic chert. Remnants of discontinuous shales of Pennsylvanian age locally may overlie the Mississippian-aged Warsaw Formation below the glacial till. The Keokuk Limestone , comprised of mottled gray bioclastics and chert underlies the Warsaw Formation, followed by the Burlington Limestone that comprises the Dolbee Creek Member (base), Haight Creek member (middle), and Cedar Fork Member (top) (JAYCOR, 1993).

Groundwater beneath the IAAAP is encountered in the surficial (overburden) aquifer and the bedrock aquifers of Mississippian, Devonian, and Cambro-Ordovician units. The overburden aquifer is composed predominantly of unconsolidated glacial drift in the northern portion of the IAAAP and the alluvium within the lower creek and river valleys in the southern portion of the IAAAP. In areas where the overburden aquifer exists within glacial till, the silt and clay aquifer does not typically yield much water; however, because the till includes beds of sand and gravel, more permeable zones can be found within the aquifer. These more permeable areas are generally thin and discontinuous lenses. Where the overburden aquifer includes loess, water migrates vertically until reaching till, and then may spread horizontally within the loess layer. Because the permeability of the till is typically much lower than the loess, vertical flow into the glacial till is restricted and may create perched water conditions. Where the overburden aquifer exists primarily within alluvium the aquifer may yield moderate or high volumes of water. These aquifers are generally confined to stream valleys. Groundwater flow direction in the overburden aquifer mimics surface topography, with flow in southeasterly or southwesterly directions. Groundwater flow within the bedrock aquifers occurs primarily in fractures, joints, or bedding planes. Overall flow direction is to the south and east.

Background

Past munitions production has resulted in contamination of soil and groundwater and discharge of wastewater containing explosives and explosives by-products to surface water. The primary source of contamination is attributable to past operating practices in which explosives-contaminated (TNT, RDX, HMX) wastewaters and sludges were discharged to uncontrolled lagoons and impoundments at the IAAAP. Additional sources of contamination included open burning of explosives materials and munitions and landfilling of waste material. VOCs, SVOCs, explosives, PCBs, and metals were also identified as COCs at certain areas (Leidos, 2018).

Numerous investigations have been conducted at the site by the Army from 1975 to the present. Forty-three subsites of known or suspected contamination were identified and investigated in an initial PA, and an SI was conducted for each of the 43 areas in 1991 (JAYCOR, 1994). The presence of chemical constituents above analytical RLs indicated that additional investigation was required. A Phase I RI completed in 1992 included characterization of background levels of metals in soils, a soil gas sampling effort to evaluate VOC contamination, and field screening for metals and explosives in soil, with 20 percent verification sampling and analysis at a fixed laboratory. Data from the Phase I RI was used to refine soil and groundwater investigations in a Phase II RI that began in 1993 and continued through 1995. NTCRAs were completed to address contamination at several sites. In addition to the subsites for which NTCRAs were performed, 15 areas with soils containing COCs greater than cleanup goals for the site were identified. The 15 areas included Lines 1, 2, 3, 3A, 4A/4B, 5A/5B, 6, 8, 9, and 800, the East Burn Pads Area, Demolition Area/Deactivation Furnace, Burn Cages/West Burn Pads Area (including West Burn Pads Area [south of the road]), North Burn Pads Area (and Landfill), and Roundhouse Transformer Storage Area (Figure 1). Lines 1, 2, 3, and 3A are currently open. Lines 5A/5B, 6, and 9 are currently inactive. Contaminated soils at the 15 subsites were evaluated as OU1. A Focused Feasibility Study was completed in 1997, followed by an IROD (United States Army Environmental Center [USAEC], 1997) with a selected remedy of temporarily stockpiling, for future treatment, the most highly contaminated soils; and by permanently disposing the remaining contaminated soils. The subsequent ROD (Harza, 1998) selected a remedy consisting of excavation/stabilization/solidification and disposal for contaminated soil and implementation. Several ESD documents were approved after finalization of the IROD and ROD:

- In 2003, an ESD (USEPA, 2003) documented biological treatment of soils contaminated with explosives as the primary remedy, with an increase in proposed contaminated soil to be removed from the West Burn Pads Area.
- Particular areas of concern at the IAAAP are addressed by the USACE under FUSRAP, and include response actions at seven areas associated with historical AEC activity, including Line 1 and the West Burn Pads Area (South of the Road) of OU1. In 2006, an ESD (Tetra Tech, 2006) documented removal of radioactive nuclides as contaminants requiring remediation at OU1. The USACE is the lead agency for implementing environmental restoration activities in areas within the scope of the FUSRAP Facility Agreement between the USEPA, USACE, U.S. DOE and the State of Iowa (Administrative Docket Number: CERCLA-07-2005-0378). To the extent that the remedy selected in the IAAAP Soils RODs is appropriate for areas identified for FUSRAP Response, the USACE is implementing the selected remedy, and the FUSRAP responses at Line 1 and the West Burn Pads Area (South of the Road) are being executed pursuant to the IAAAP Soils RODs.
- In 2008, an ESD (Tetra Tech, 2008) documented additional soil excavation required at Line 3, Line 3A, and Line 800 following ecological risk evaluation; additionally, the Incendiary Disposal Area, Possible Demolition Site, and Central Test Areas (Figure 1) were added to OU1.
- In 2009, an ESD (Tetra Tech, 2009b) documented a change of primary treatment technology from biological to alkaline hydrolysis chemical treatment for soils contaminated with TNT.
- In 2011, an ESD (Tetra Tech, 2011) documented the addition of soil volume and a site-specific remedial goal for barium within the West Burn Pads Area (South of the Road) and offsite treatment and disposal as a remedy for contaminated soil excavated at Line 2 and the West Burn Pads Area (South of the Road).
- An ESD completed in 2018 (Leidos, 2018) documented three separate additions to the selected remedy, including land use controls at OU1 areas, offsite treatment and disposal of contaminated soil removed during future remedial actions, and the addition of the former Fire Training Pit

located south of Plant Road O and west of the Burn Pads Area and north of the Explosive Waste Incinerator in the northeastern portion of the IAAAP (Figure 1)

Remedial actions for seven sites were completed during four phases (Phases 1 through 4) and documented in separate Remedial Action Reports. Remedial actions for the remaining sites were completed in three phases (Phases 5, 7, 8) and documented in a RACR completed in 2008 (Tetra Tech, 2009a). Excavation at some of the areas was prevented due to presence of buildings and/or structures. A recent modernization effort resulted in demolition of buildings beneath which contaminated soil may be present. A listing of the recently demolished buildings identified as having potential contaminated soils is provided as Table 17.1 of this UFP-QAPP. The location of the buildings and a description of the subsite within which of the buildings are located is provided below.

Site Descriptions and CSMs

Modernization efforts at IAAAP involved demolition of buildings throughout the Installation. There is potential for subsurface contamination at some of the buildings based on historic use, proximity to remediated soil areas (soil removed and confirmation soil samples collected/analyzed), and prior soil sampling results adjacent to or in the area of the buildings. In accordance with the ROD (Harza, 1998) and 2018 ESD (Leidos, 2018), soil sampling within the building footprint will be conducted, and if sample results indicate contamination exceeds the OU1 RGs, then soil will be recommended for removal in accordance with the IAAAP Soils RODs and ESDs; if soil sample results indicate chemicals do not exceed OU1 RGs, then implementation of land use controls in accordance with the 2018 ESD will be recommended.

The buildings identified as having potential subsurface contamination are described below, grouped by area addressed in the OU1 ROD. Line 1 buildings (five of which were originally identified as being included for investigation under this Delivery Order) will be addressed under FUSRAP.

Line 2:

The Line 2 portion of OU1 is located on approximately 140 acres in the northeastern portion of the IAAAP, south of Line 1 (Figures 1 and 2). The production line was constructed in 1941 and included 70 buildings, 31 of which were used for LAP of 120 millimeter (mm) ammunition and blank ammunitions. Explosives were shipped to Line 2 via rail lines and off-loaded onto loading pads. The explosives were melted and packed into metal ammunition cases. Final assembly was completed within the plant, and ammunition was either shipped offsite, used, or stored onsite until required. The remaining buildings included equipment rooms, explosives magazines, and nine sump buildings (JAYCOR, 1993). Line 2 equipment and buildings were cleaned and placed in extended storage status in 1945. The line was reactivated and in the early 1950s. Primary explosives used in ammunition production included black powder, HMX, RDX, pentaerythritol tetranitrate, and TNT. In 1954, an improved vacuum system was used to collect 500 pounds of TNT for reclamation, and loading of practice rounds began with inert materials, including wax, barium, polychloronaphthalene compound, and red lead. Several buildings were put into layaway status in the mid to late-1950s, and a preventive maintenance program for TNT-contaminated soils was initiated to prevent and eliminate TNT contamination of surface and subsurface soil. Production during the 1970s and 1980s included artillery rounds, anti-tank mines, warheads, demolition blocks, mines, fuzes, detonators, igniters, and related ammunition components. Line 2 is currently open.

Line 2 was investigated as part of the PA/SI (JAYCOR, 1994), and as part of a 1995 removal action, wastewater sumps and associated soils at Line 2 were removed. An RI completed in 1996 (JAYCOR, 1996) identified low level metals in surface soil, with highest concentrations associated with filter houses and at an area adjacent to a support pillar northeast of [redacted] Following completion of a Focused Feasibility Study (Engineered Efficiency, 1997), an IROD identified 18 separate areas adjacent to explosives production buildings, assembly areas, and shipping areas, that required remediation. The IROD identified Line 2 contaminants (chemicals exceeding regional screening levels under an industrial scenario) as explosives and lead.

Additional soil sampling was conducted at Line 2 in 2005 and 2006, and in 2007, based on analysis of the chemicals of concern for human health risk identified, 23 excavation sites were proposed at Line 2. Excavations were completed and documented in the 2009 RACR (Tetra Tech, 2009a). Approximately 3,170 cy of soil was removed from 23 separate excavations. Contaminant drivers were PAHs, metals, and explosives.

Contaminated soil may be present beneath the following buildings based on their historical use. A description of buildings/structures is provided below. Building locations are shown on Figure 2.

<u>2-06-1: Explosives magazine occupying approximately 1,440 square ft.</u> [redacted] was an ammonium nitrate service magazine.

Surface soil samples collected next to [redacted] the PA/SI and 1996 RI contained metals and SVOCs. Screening for metals and explosives along the west, south, and north faces of the building reported explosives in surface soils and at the 1-ft depth in front of the loading doors on the west face of the building. Explosives were not reported in other locations. Metals were identified in surface soils, with highest concentrations reported in samples collected at 2 ft bgs between the west face of the building and the railroad tracks and around the south face of the building near a sump (i.e., away from the building). Screening for metals and explosives identified elevated metals in surface soil along the east face of the building next to a doorway. Explosives-impacted soil was removed in an approximately 54-square foot area within shed [redacted] on the south side of [redacted] during an NTCRA completed prior to the IROD (Leidos, 2018). No additional sampling was planned.

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building, proximity to remediated soil areas, and prior soil sampling results adjacent to the building.

2-06-2: Explosives magazine occupying approximately 1,440 square ft. Surface soil samples collected southwest of [redacted] for the PA/SI and 1996 RI contained metals and TNT. Screening for metals and explosives around the northwest corner of the building around the doorways and adjacent to the railroad tracks reported metals in surface soil and to 2 ft bgs. Screening for metals and explosives conducted along the east face of the building next to a doorway reported elevated metals in surface soil. Detections decreased to trace, generally, at 2 ft bgs. Screening for metals and explosives conducted along the south face of the building reported metals in surface soil along the wall of the building and adjacent to walkways, decreasing to trace concentrations at 1 ft bgs. No further sampling was planned.

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building and prior soil sampling results adjacent to the building.

2-08-1: Explosives magazine occupying approximately 1,440 square ft. Surface soil samples collected next to [redacted] the 1993 PA/SI and 1996 RI, contained metals. Additional screening for metals and explosives was not conducted around the building, but based on the known use of Line 2 TNT service magazines and screening along the west and south faces of the building, it was assumed that surface soil generally contains metals that decrease in concentration with depth, leaving only trace metals at 1 ft depth. No additional sampling was planned.

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building.

2-08-2: Explosives magazine occupying approximately 1,440 square ft. Surface soil samples collected next to [redacted] for the 1993 PA/SI and 1996 RI, identified low levels of HMX and RDX in a surface soil sample collected near the building, and screening for metals and explosives conducted along the north and west (between the loading dock and the RR tracks) faces of the building reported elevated metals, which generally decreased to trace at 3 ft bgs. No further sampling was planned.

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building and prior soil sampling results adjacent to the building.

2-50: Explosives treatment area occupying approximately 2,662 square ft. Selenium and several SVOCs were detected in surface soil samples collected next to Building 2-50 during the PA/SI and 1996 RI. Screening for metals and explosives conducted along the west face of the building between the wall and RR tracks reported elevated metals in surface soil collected around the doorway. The levels decreased to trace at 3 ft bgs. TNT was reported at 0.5, 1, and 2 ft depths in one sample location next to the doorway. No further soil sampling was planned. Based on evaluation of additional soil sampling at Line 2, excavation L2-E19, approximately 164 square ft and 1 foot deep, was completed to remove lead-impacted soil adjacent to the northeast side of Building 2-50. The RACR documented that the contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

QAPP Worksheet #10, Cont'd.

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building, proximity to remediated soil areas, and prior soil sampling results adjacent to the building.

[redacted] **Vacuum houses occupying approximately 100 square ft each.** Surface soil samples collected around [redacted] for the PA/SI and 1996 RI, contained several metals and one sample exhibited detections of HMX. Elevated metals concentrations were not identified below 1 ft bgs. The screening effort was considered to sufficiently characterize the surface and subsurface contamination in this area and additional sampling was not recommended.

Based on evaluation of soil sampling at Line 2 in 2005 and 2006, excavation L2-E18, approximately 126 square ft and 2 ft deep, was completed to remove lead-impacted soil east of [redacted]; excavation L2-E17, approximately 238 square ft and 1.5 foot deep, was completed to remove RDX-impacted soil east of [redacted] and excavation L2-E13, approximately 1,542 square ft and 7.5 ft deep, was completed to remove RDX- and TNT-impacted soil approximately 4 ft north of [redacted] and 20 ft west of [redacted] Impacted soil was not identified immediately adjacent to the vacuum houses. The RACR documented that the contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

There is a potential of subsurface soil contamination beneath the former building footprints based on historic use of the building, proximity to remediated soil areas, and/or prior soil sampling results adjacent to the building.

[redacted] **Ammunitions wash facility occupying approximately 96 square ft.** A surface soil sample collected around [redacted] for the PA/SI and 1996 RI exhibited detections of metals. No additional soil sampling was planned based on the fact that most soils around the perimeter of the building within similar lines contained surface metals contamination, with levels decreasing significantly with depth. A surface water sampled collected in a drainage ditch behind the building exhibited detections of RDX, copper, iron, magnesium, manganese, bis(2-ethylhexyl)phthalate, and chloroform. The associated sediment sample reported beryllium, magnesium, and thorium.

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building and prior soil sampling results adjacent to the building.

Buildings with Limited Historical Sampling Documentation:

There is a potential of subsurface soil contamination based on historic use of the building and/or proximity to remediated soil areas for the following buildings:

- [redacted] **Ammunitions wash facility occupying approximately 82 square ft.**
- [redacted] **Ammunitions wash facility occupying approximately 96 square ft.**
- [redacted] **Ammunitions wash facility occupying approximately 325 square ft.**
- [redacted] **Ammunitions wash facility occupying approximately 203 square ft.**
- [redacted] **on platform occupying approximately 100 square ft.**

Line 3:

The Line 3 portion of OU1 is located on approximately 149 acres west of Lines 1 and 2 (Figures 1 and 3). The production line for ammunition at Line 3 operated beginning with the inception of the IAAAP in the early 1940s, operating continuously with the exception of a temporary shutdown period from 1945 to 1949. Line 3 produced heavy artillery and projectiles. Explosives were shipped by way of rail lines to the line, then melted and packed into metal cases. Assembly of the finished product took place within the line, and the ammunition was then either shipped or stored. The line included approximately 56 buildings, composed of equipment rooms, explosive magazines, and 9 sump buildings for explosive waste processing. Wastewater from the metal houses at Line 3 was treated by settling tanks/carbon adsorption at Filter Houses 3-70-1 and 3-70-2. From 1977 until approximately 1985, metal cleaning operations were conducted at Line 3 that involved several stainless steel dip tanks where ammunition casings were immersed in a sulfuric acid/hydrochloric bath, followed by a chromic acid bath and then rinsed with water. Sludge was treated and disposed in the Line 3A pond (USACE, 2016). Line 3 is currently open.

Line 3 was investigated as part of the PA/SI (JAYCOR, 1994). An RI completed in 1996 (JAYCOR, 1996) identified explosives contamination, with the highest concentrations located at wastewater sumps, foundations of buildings (where wastewater was generated), and at the loading docks. Sampling indicated explosives were confined to surficial soils and did not extend beyond approximately 10 to 20 ft from the most impacted soils. Elevated metals were more widespread across the building areas rather than concentrated at a particular building. Lead was the primary contaminant and to a lesser degree chromium. Several SVOCs were reported in soil samples also collected throughout Line 3 (USACE 2016). The IROD identified 22 separate areas of contamination, located near a solvent storage building, the explosives production buildings, pump houses, and a filter house. The IROD identified Line 3 contaminants as SVOCs, explosives, and metals, with lead the primary metals contaminant.

Between 2003 and 2006, approximately 210 samples were collected at Line 3 for SVOC, PAH, explosives, and metals analysis. Based on analysis of the COCs, 37 excavation sites were completed and documented in the 2009 RACR (Tetra Tech, 2009a). Approximately 3,440 cy of soil was removed from 23 separate excavations. Contaminant drivers were PAHs, explosives, and metals (lead, copper, thallium, arsenic, and beryllium).

Contaminated soil may be present beneath the following buildings based on their historical use. A description of buildings/structures is provided below. Building locations are shown on Figure 3.

[redacted] **Melt loading area occupying approximately 27,372 square ft**. Surface soil samples collected during the PA/SI and RI identified elevated detections of metals and SVOCs east of the building and TNT, metals and SVOCs north of the building. Screening for metals and explosives identified explosives in surface soil around the baghouses and doorways. Subsurface explosive contamination was identified in soils around the doorway at 3 ft bgs. Metals in surface soil appeared widespread, encompassing the perimeter of the building and extending southeast in the drainage channel, but decreasing to trace concentrations at 2 ft bgs. Samples collected close to the building extended to depths below 2 ft bgs. No sampling during Phase II RI was planned as the screening effort adequately delineated surface and subsurface soil contamination. It was noted, however, that the melt buildings had depths in basements that could reach 20 ft bgs and were known to have both concrete and dirt floors.

Based on evaluation of soil sampling at Line 3 in 2005 and 2006, four excavations were completed on the south and east sides of Building 3-05-2: Excavation L3-E01 was approximately 352 square ft, extending 1.5 deep on the south east side of the building, and was completed to remove RDX-, TNT-, and dinitrotoluene (DNT)-impacted soil. The excavation is L-shaped, with one stem of the excavation adjacent to the building wall. Excavation L3-E03 was approximately 142 square ft, and extended to 3.5 ft deep to remove RDX- and TNT-impacted soil. The excavation is L-shaped, with one stem of the excavation adjacent to the north side of the east extension of the building. Excavation L3-E04 was approximately 273 square ft, and extended 3.5 deep to remove RDX-impacted soil. The excavation is rectangular and is west of excavation L3-E03, in the northwest corner of the eastern building extension. Excavation L3-E05, approximately 1,512 square ft and 1.5 ft deep, was completed to remove RDX-, TNT-, DNT-, arsenic, and lead-impacted soil. The excavation was irregularly shaped, and located along the south side of the eastern building extension. The RACR documented that the contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building, proximity to remediated soil areas, and prior soil sampling results adjacent to the building.

3-70-3: Industrial waste treatment (carbon column) area occupying approximately 1,068 square ft. Surface water and sediment samples were collected in a drainage channel 63 ft southeast of Building 3-70-3 during the PA/SI and RI. The surface water sample results indicated several metals were detected exceeding evaluation criteria. The sediment sample contained a high copper concentration similar to copper in the screening samples collected in the area.

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building and prior soil sampling results adjacent to the building.

3-163-2: Industrial waste treatment area occupying approximately 285.6 square ft. Based on evaluation of soil sampling at Line 3 in 2005 and 2006, excavation L3-E31, approximately 1,125 square ft and 1.5 ft deep, was completed to remove copper-impacted soil northeast of Building 3-162-2. The excavation was completed to the northwest and north sides of the building to address ecological risk. The RACR documented that the contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building, proximity to remediated soil areas, and prior soil sampling results adjacent to the building.

[redacted]**Vacuum house occupying approximately 100 square ft**. Based on evaluation of soil sampling at Line 3 in 2005 and 2006, excavation L3-E27, approximately 1,034 square ft and 1.5 ft deep, was completed to remove TNT- and lead-impacted soil adjacent to the east side and extending north of Building 3-99-1. The excavation is trapezoidal and extends from the southeast side of Building 3-99-1. The RACR documented that the contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building, proximity to remediated soil areas, and prior soil sampling results adjacent to the building.

3-99-2: Vacuum house occupying approximately 100 square ft. Based on evaluation of soil sampling at Line 3 in 2005 and 2006, excavation L3-E29, approximately 1,009 square ft and 1.5 foot deep, was completed to remove RDX-, TNT-, and lead-impacted soil adjacent to the east side and extending north of Building 3-99-2. The RACR documented that the contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building, proximity to remediated soil areas, and prior soil sampling results adjacent to the building.

Buildings with Limited Historical Sampling Documentation:

There is a potential of subsurface soil contamination based on historic use of the building and/or proximity to remediated soil areas for the following buildings:

- **3-99-5: Vacuum house occupying approximately 100 square ft**.
- **3-99-6: Vacuum house occupying approximately 100 square ft**.
- **3-163-1: Industrial waste treatment area occupying approximately 66.9 square ft**.

Line 3A:

The Line 3A portion of OU1 is located on approximately 119 acres on the western side of IAAAP, west of the Firing Site Area and northwest of the Demolition Area (Figures 1 and 4). Line 3A was constructed in 1941 and began operation in 1943. The line was shut down from 1945 to 1949 and resumed operation until 1989. Line 3A was a LAP production line for artillery. Explosives were shipped into the plant, melted, then packed into 155mm artillery rounds. Final assembly of the finished munitions was conducted, then the completed product was either stored or shipped offsite. Metal cleaning operations were conducted from 1977 to 1985, and included several stainless steel dip tanks where ammunitions casings were immersed in a sulfuric/hydrochloric acid bath, followed by a chromic acid bath and water rinse. The floors of the buildings were routinely washed down and explosive-contaminated wastewater was discharged directly onto the ground surface (JAYCOR, 1993). Line 3A is currently open.

Line 3A was investigated as part of the PA/SI (JAYCOR, 1994). An RI completed in 1996 (JAYCOR, 1996) reported that the majority of explosives (primarily RDX and HMX) were detected around Building

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3A-05-1 and its associated buildings. The IROD identified eight areas of contamination that were located adjacent to explosives production buildings and a pump house. Contaminants that were detected at concentrations that exceeded cleanup criteria included explosives and lead.

Additional soil sampling was conducted at Line 3A in 2005 and 2006, and in 2007, based on analysis of the chemicals of concern for human health risk identified at Line 3A, 17 excavation sites were completed and documented in the 2009 RACR (Tetra Tech, 2009a). Approximately 1,440 cy of soil was removed from 23 separate excavations. Contaminant drivers were explosives (TNT and 2,4-dinitrotoluene [2,-DNT]) and lead.

Contaminated soil may be present beneath the following buildings based on their historical use. A description of buildings/structures is provided below. Line 3A building locations are shown on Figure 4.

3A-03-1: Solvent storage area occupying approximately 983 square ft. Soil gas screening did not detect VOCs in subsurface soil analyzed. No further sampling was recommended and additional sample information for this solvent storage area east of Building 3A-12 (used to wash shells and process inert polychloronaphthalene) is not available.

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building.

3A-03-2: Explosives storage area occupying approximately 983 square ft. Surface soil sample results collected from 6 ft west of the building for the PA/SI and RI indicated no VOCs or SVOCs were detected above action levels. Soil gas screening did not detect VOCs. No further sampling was recommended and additional sample information for this explosives storage area is not available.

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building.

3A-05-1: Melt loading area occupying approximately 19,269 square ft. Surface and subsurface soil sampling for the PA/SI and RI was performed on the south side of the building, outside the doorways where washdown water was swept out and at the surrounding sumps. Analytical results indicated detections of explosives and metals. Sampling at the melt buildings and in the immediately surrounding buildings and sumps indicate extensive explosives and metals contamination in a widespread area to a depth of 3 ft bgs.

Based on evaluation of soil sampling at Line 3A in 2005 and 2006, excavations L3A-E12, L3A-13, and L3A-14 were completed across a roadway from Building 3A-05-1 on the southwest side. The excavations were adjacent to other buildings (3A-140-5 and 3A-140-7); no sampling information is available adjacent to Building 3A-05-1. The three excavations were completed to 4.5, 4, and 3 ft deep respectively. All of the excavations were completed to remove RDX-impacted soil; Excavation L3A-E12 and -E13 were completed to also remove TNT-impacted soil, and excavation L3A-E12 was completed to also remove lead-impacted soil. The RACR documented that the contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building, proximity to remediated soil areas, and prior soil sampling results adjacent to the building.

3A-05-2: Melt loading area occupying approximately 18,629 square ft. During the PA/SI and RI, surface soil samples collected north of the building and surrounding buildings 3A-99-5 and -8 indicated detections of explosives and metals. TNT, RDX, and HMX were detected in surface soil along the north wall (within 5 ft) of Building 3A-99-8 and surrounding the shed located between Building 3A-05-2 and 3A-99-8 to 2 ft bgs and a distance 10 ft away. The melt buildings and immediately surrounding buildings and sumps (3A-140-3, 3A-140-4) indicate extensive explosives and metals contamination in a widespread area to a depth of 3 ft bgs.

Based on evaluation of soil sampling at Line 3A in 2005 and 2006, excavation L3A-E02 was completed to 1 foot bgs in a drainage swale emanating from the north corner of the Building 3A-05-2 to remove copper-impacted soil adjacent to the east side and extending north of Building 3-99-1 based on ecological risk. The RACR documented that the contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building, proximity to remediated soil areas, and prior soil sampling results adjacent to the building.

3A-06: High explosives magazine occupying approximately 981 square ft. Screening samples collected from the area below the loading dock doors located on the north side of Building 3A-06 for the PA/SI and RI indicated detections of explosives and metals. TNT, RDX, and HMX were detected along the length of the north side of the building as much as 5 ft away at a depth of 1 ft. Antimony, cadmium, copper, lead, manganese, magnesium, nickel, and zinc were detected in soil 1 ft bgs and 10 ft away from the dock doors. Screening samples for explosives and metals collected during the RI at loading dock areas (3A-06, 3A-08-1 and 3A-08-2) indicate localized surficial (no more than 1 ft bgs) metals and explosives contamination around the loading/unloading doors.

Based on an evaluation of soil impact at Line 3A in 2005 and 2006, excavation L3A-E08, approximately 88 square ft and 2.5 ft deep, was completed to remove RDX-impacted soil across a roadway and along a ditch approximately 20 ft northeast of Building 3A-06. The RACR documented that the contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building, proximity to remediated soil areas, and prior soil sampling results adjacent to the building.

3A-08-1: Explosives magazine occupying approximately 981 square ft. Screening samples analyzed for explosives and metals collected during the RI at loading dock areas (3A-06, 3A-08-1 and 3A-08-2) indicate localized surficial (no more than 1 ft bgs) metals and explosives contamination around the loading/unloading doors.

Based on an evaluation of soil results at Line 3A in 2005 and 2006, excavation L3A-E09, approximately 97 square ft and 3.5 ft deep, was completed to remove RDX-impacted soil across a roadway and along a ditch approximately 20 ft northeast of Building 3A-06. The RACR documented that the contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building, proximity to remediated soil areas, and prior soil sampling results adjacent to the building.

3A-08-2: Explosives magazine occupying approximately 981 square ft. Screening samples analyzed for explosives and metals collected during the RI at loading dock areas (3A-06, 3A-08-1 and 3A-08-2) indicate localized surficial (no more than 1 ft bgs) metals and explosives contamination around the loading/unloading doors.

Based on an evaluation of soil results at Line 3A in 2005 and 2006, excavation L3A-E05, approximately 136 square ft and 2.5 ft deep, was completed to remove RDX-impacted soil extending from the north corner of the building. The RACR documented that all contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building, proximity to remediated soil areas, and prior soil sampling results adjacent to the building.

3A-10-5: Explosives drilling building occupying approximately 1,420 square ft. Based on an evaluation of soil results at Line 3A in 2005 and 2006, excavation L3A-E03, approximately 1,028 square ft and 6 ft deep, was completed to remove RDX-impacted soil across the roadway on the northeast side of Building 3A-10-5. The RACR documented that all contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building, proximity to remediated soil areas, and prior soil sampling results adjacent to the building.

3A-20-2: Assembly building occupying approximately 10,354 square ft. Based on an evaluation of soil results at Line 3A in 2005 and 2006, excavation L3A-E07, approximately 645 square ft and 1 foot deep, was completed to remove RDX-impacted soil within a rectangular shaped excavation on the northwest side and across a roadway from Building 3A-20-2. The RACR documented that all contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building, proximity to remediated soil areas, and prior soil sampling results adjacent to the building.

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3A-50-1: Explosives screening area occupying approximately 3,315 square ft. PA/SI and RI screening samples for explosives and sump sampling data indicate the area north of Building 3A-50-1 and surrounding sump 3A-140-3 to have elevated levels of both explosives and metals. The melt buildings and immediately surrounding buildings (3A-50-1) and sumps (3A-140-3, 3A-140-4) indicate extensive explosives and metals contamination in a widespread area to a depth of 3 ft bgs.

Based on an evaluation of soil results at Line 3A in 2005 and 2006, excavation L3A-E10, approximately 265 square ft and 4 ft deep, an excavation was completed to remove RDX-, TNT-, and DNT-impacted soil extending from the northeast side of the building. Additionally, excavation L3A-E11, approximately 107 square ft and 2.5 ft deep, was excavated from an area approximately 10 ft east of the building and adjacent to the roadway, to remove RDX- and TNT-impacted soil. The RACR documented that all contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building, proximity to remediated soil areas, and prior soil sampling results adjacent to the building.

3A-99-8: Vacuum House occupying approximately 672 square ft. Explosives and metals were detected during screening of soil in the area north of Building 3A-05-2 and surrounding Building 3A-99-8. Surface soil samples collected from less than 0.5 ft bgs along the north wall and to 2 ft bgs within 5 ft of and to 10 ft away Building 3A-99-8 and during the PA/SI identified TNT, RDX, and HMX.

Based on an evaluation of soil results at Line 3A in 2005 and 2006, excavation L3A-E03, approximately 1,028 square ft and 6 foot deep, was completed to remove RDX-impacted soil across the roadway on the northeast side of Building 3A-10-5 and approximately 5 ft west of Building 3A-99-8. Additionally, excavation L3A-E02 was completed to 1.5 ft bgs in a drainage swale located on the northeast and southeast sides of Building 3-99-8 to remove copper-impacted soil based on ecological risk. The RACR documented that all contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building, proximity to remediated soil areas, and prior soil sampling results adjacent to the building.

3A-140-3: Sump house occupying approximately 54 square ft. Screening samples and sump sample results for the PA/SI and RI indicate the area north of Building 3A-50-1 surrounding sump 3A-140-3 to have both explosives and metals impact. 2,4-Dinitrotoluene, TNT, 1,3,5-dinitrobenzene and RDX have been detected at depths of 4 ft and 25 ft away from the sump. Samples around the sump exhibited detections of cadmium, lead, and mercury at depths of 3 ft in a 5-ft radius surrounding the sump. Contaminants were not detected above criteria in the area of the sump house, and excavation of soil to meet RGs was not required.

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building, proximity to remediated soil areas, and prior soil sampling results adjacent to the building.

3A-140-4: Ammunitions wash facility (only concrete remains) occupying approximately 54 square ft. PA/SI and RI surface and subsurface soil sample results indicate that the melt buildings and immediately surrounding the buildings and sumps (3A-140-3, 3A-140-4) had detection of explosives and metals contamination in a widespread area to a depth of 3 ft bgs.

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building, proximity to remediated soil areas, and prior soil sampling results adjacent to the building.

Buildings with Limited Historical Sampling Documentation:

There is a potential of subsurface soil contamination based on historic use of the building and/or proximity to remediated soil areas for the following buildings:

- **3A-20-1: Assembly building occupying approximately 10,774 square ft**.
- **3A-99-1: Vacuum House occupying approximately 100 square ft**.
- **3A-99-2: Vacuum House occupying approximately 100 square ft**.
- **3A-99-7: Vacuum House occupying approximately 100 square ft**.
- **3A-140-2: Ammunitions wash facility occupying approximately 100 square ft**.
- **3A-100: X-ray building occupying approximately 4,231 square ft**.

Lines 5A and 5B:

Lines 5A and 5B were booster and grenade lines located in the north-central portion of IAAAP (Figures 1 and 5). Line 5A is approximately 33 acres, and Line 5B is approximately 41 acres. The lines were constructed in 1941 and operated from 1942 to 1945 for pelletizing and assembly of explosive components. Production resumed in 1949 and intensified in 1961 but production was discontinued in the 1990s. Most of Line 5A was demolished in 2010. Lines 5A and 5B are currently inactive.

Lines 5A and 5B were investigated as part of the PA/SI (JAYCOR, 1994), and as part of a removal action, 18 wastewater sumps were removed at Lines 5A and 5B in 1995 (USACE, 2016). An RI completed in 1996 identified explosives and metals in soil. Metals were detected at elevated concentrations to a depth of 2 ft and explosives were detected to a depth of 4 ft during screening of soils around sumps and in drainage pathways. Elevated metals were not detected in samples collected below 4 ft bgs, and explosives concentrations decreased rapidly from the surface to the depth of 4 ft bgs. The IROD identified 10 areas of concern that were located adjacent to the tetryl screening and blending facility, the tetryl pelleting operations, the explosives assembly area, and pump house areas. The IROD identified Lines 5A/5B contaminants (chemicals exceeding regional screening levels under an industrial scenario) as explosives, lead, and arsenic.

In October 1999, approximately 590 cy were excavated from seven locations, located near Buildings 5A-26, 5A-28, 5A-99-1, 5A-99-2, 5A-140-1, 5A-140-2, and 5A-140-3. Approximately 475 cy were excavated from three locations near Buildings 5B-26, 5B-28, and 5B-140-3 at Line 5B. Verification sampling showed that all contaminated soil had been removed and the areas were backfilled and revegetated (remediation of contaminated soil was completed for Lines 5A/5B in 1999 (USACE, 2016).

Contaminated soil may be present beneath the following buildings based on their historical use. A description of buildings/structures is provided below. Available sample data and locations of sampling is limited. The PA/SI and RI indicated that localized metals and explosives contamination was present around sumps. Approximately 590 cy of contaminated soil was removed from seven locations at Line 5A and approximately 475 cy of contaminated soil was removed from Line 5B in 1999 (USACE, 2016). Building locations are shown on Figure 5:

5A-140-3: Explosives drilling building occupying approximately 944 square ft. During the PA/SI and RI, surface and subsurface soil sample results from samples collected around sumps near Buildings 5A-140-3 indicated metals and explosives contamination at 2 ft bgs (metals) and 4 ft bgs (explosives), localized around sumps and in drainage pathways to these depths.

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building and prior soil sampling results in the building area.

5B-140-3: Explosives screening area occupying approximately 944 square ft. During the PA/SI and RI, surface and subsurface soil sample results from samples collected around sumps near Buildings 5B-140-3 indicated metals and explosives contamination at 2 ft bgs (metals) and 4 ft bgs (explosives), localized around sumps and in drainage pathways to these depths.

There is a potential of subsurface soil contamination beneath the former building footprints based on historic use of the building, proximity to remediated soil areas, and/or prior soil sampling results adjacent to the building.

Buildings with Limited Historical Sampling Documentation:

There is a potential of subsurface soil contamination based on historic use of the building and/or proximity to remediated soil areas for the following buildings:

- **5A-21: Solvent storage area occupying approximately 120 square ft.**
- **5A-25: Explosives storage area occupying approximately 120 square ft**.
- **5A-99-1: High explosives magazine occupying approximately 100 square ft**.
- **5A-99-2: Explosives magazine occupying approximately 100 square ft.**
- **5A-140-2: Explosives magazine occupying approximately 141 square ft.**
- **5A-28: Melt loading area occupying approximately 4,017 square ft.**
- **5A-29: Melt loading area occupying approximately 13,986 square ft.**
- **5B-03-3: Assembly building occupying approximately 69 square ft.**
- **5B-99-1: Explosives screening area occupying approximately 100 square ft.**

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- **5B-99-2: Explosives screening area occupying approximately 100 square ft.**
- **5B-140-1: Explosives screening area occupying approximately 141 square ft.**
- **5B-140-2: Explosives screening area occupying approximately 107 square ft.**
- **5B-26: Assembly building occupying approximately 960 square ft.**

Line 6:

Line 6 is located on approximately 30 acres near the central portion of IAAAP (Figures 1 and 6), with Lines 4A and 4B to the north, Line 3 to the east, and Line 9 to the south. Line 6 was a detonator production area, constructed in 1941 and operating until 1981. The facility included approximately 34 buildings involved in the production, storage, and shipping of detonators, relays, and hand grenade fuses. Remedial action conducted under a Resource Conservation and Recovery Act (RCRA) Closure Plan identified no explosives contamination, but the metals barium, chromium, lead, and nickel were reported above background (USACE, 2016). Line 6 is currently inactive.

Portions of Line 6 outside of the remedial action were investigated as part of the PA/SI, and three wastewater sumps were removed in 1995. An RI completed in 1996 (JAYCOR, 1996) focused on metals contamination and areas not addressed as part of remedial closure activities. The IROD identified lead and antimony at concentrations exceeding cleanup criteria in soils adjacent to the Building 6-96 sump.

In 2005, 155 soil samples were collected from 130 locations at Line 6. The RDX concentration in one sample exceeded the RG. In 2007, based on analysis of the chemicals of concern for human health risk identified at Line 6, three excavation sites were completed and 58 cy of soil were removed, as documented in the 2009 RACR (Tetra Tech, 2009a). Contaminant drivers were RDX, lead, and mercury.

Contaminated soil may be present beneath the following buildings based on their historical use. A description of buildings/structures is provided below. Building locations are shown on Figure 6:

6-19: Melt loading area occupying approximately 330 square ft. The IROD reported that none of the soil samples collected adjacent to the Building 6-19 sump contained explosives at levels exceeding cleanup criteria.

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building.

6-34-2: High explosives magazine occupying approximately 12,820 square ft. Based on evaluation of soil sampling at Line 6 in 2005 and 2006, excavation L6-E02, approximately 89 square ft and 1 foot deep, was completed to remove RDX-impacted soil at an isolated location on the east side of the building. The RACR documented that all contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

6-68: Explosives drilling building occupying approximately 596 square ft. Treatment of black powder was performed in Building 6-68 as a RCRA permitted unit. The unit underwent RCRA closure in 1994 after which time it was no longer maintained or used by the Army. As part of the RCRA closure, 800 cy of contaminated soil were removed in 1994.

There is a potential of subsurface soil contamination beneath the former building footprints based on historic use of the building, proximity to remediated soil areas, and/or prior soil sampling results adjacent to the building.

6-96: Explosives screening area occupying approximately 120 square ft. The IROD identified lead and antimony detected in soils adjacent to the Building 6-96 sump at concentrations exceeding cleanup criteria. Based on an evaluation of soil sampling at Line 6 in 2005 and 2006, excavation L6A-E03, approximately 144 square ft and 2 ft deep, was completed to remove lead-impacted soil along the north side of the building. The RACR documented that all contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

There is a potential of subsurface soil contamination beneath the former building footprints based on historic use of the building, proximity to remediated soil areas, and/or prior soil sampling results adjacent to the building.

6-98: Explosives screening area occupying approximately 230 square ft. Based on an evaluation of soil sample results at Line 6 in 2005 and 2006, an excavation L6A-E01 was completed (approximately 385 square ft and 3 ft deep) to remove mercury-impacted soil along the east side of the building, and extending halfway across its northern face. The RACR documented that all contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

There is a potential of subsurface soil contamination beneath the former building footprint based on historic use of the building.

Buildings with Limited Historical Sampling Documentation:

There is a potential of subsurface soil contamination based on historic use of the building and/or proximity to remediated soil areas for the following buildings:

- **6-11: Solvent storage area occupying approximately 519 square ft.**
- **6-18-1: Explosives storage area occupying approximately 127 square ft.**
- **6-25: Melt loading area occupying approximately 120 square ft.**
- **6-34-3: Explosives magazine occupying approximately 13,060 square ft.**
- **6-35: Explosives magazine occupying approximately 1,291 square ft.**
- **6-87: Assembly building occupying approximately 946 square ft**.
- **6-88: Assembly building occupying approximately 1,819 square ft**.
- **6-90: Explosives screening area occupying approximately 963 square ft.**
- **6-94: Explosives screening area occupying approximately 337 square ft.**
- **6-97: Explosives screening area occupying approximately 1,995 square ft**.

Line 9:

Line 9 is located on approximately 9 acres directly south of Line 6 (Figures 1 and 7). The line was built in 1942 as a component production facility for use during World War II. During the Vietnam War, the line produced mines and mine fuses, and the line was later used as an ammunition LAP facility. The buildings were generally used for mixing, loading, testing, packing, and shipping. Wastewater was transported to Line 2 for treatment. Explosives processed at the Line included TNT, RDX, Composition B, and plastic bonded explosives. Soil sampling for the PA/SI and RI identified limited metals concentrations associated with sumps, but found no evidence of pervasive metals contamination. No explosives were reported in samples obtained from Line 9 (JAYCOR, 1996). Five wastewater sumps were removed at Line 9 in 1995, along with approximately 70 cy of contaminated soil (USACE, 2016). Line 9 is currently inactive.

Contaminated soil may be present beneath the following buildings based on their historical use. A description of buildings/structures is provided below. Building locations are shown on Figure 7.

- **9-62: Magazine area occupying approximately 120 square ft.**
- **9-64: Flammable material building area occupying approximately 204 square ft.**

Line 800 (Optional Task 3A):

Line 800 is located on approximately 18 acres on the southeastern portion of IAAAP (Figures 1 and 8). Line 800 has operated since the inception of IAAAP, and from 1943 to 1955 its primary function was ammunition renovation, where explosives filler was washed from projectiles, and blank salute ammunition was loaded. Subsequently the line was used as a small detonator assembly facility, where the metals waste stream was in a closed loop system and the metals were collected and sold as scrap. The majority of explosive-contaminated wastewater generated by Line 800 operations until the 1970s was discharged to ditches at Line 800 and to the Line 800 Pink Water Lagoon. In the early 1970s, a settling/carbon filter system was installed to filter generated process water at the line. Line 800 was included in the PA/SI and RI (USACE, 2016).

The IROD identified four areas of contamination at Line 800 with soil results that exceeded cleanup criteria, including the settling ponds associated with the Line 800 Pink Water Lagoon (explosives), the northwest corner of Building 800-4 (explosives), and area adjacent to the east end of Building 800-04 (lead), and an area along the west side of Building 800-191 (lead).

Between 2005 and 2006, 304 soil samples were collected at Line 800, and in 2007, based on analysis of the chemicals of concern for human health risk identified at Line 3, 12 excavation sites were proposed for remediation at Line 800. Contaminant drivers were TNT, 2,4-DNT, RDX, arsenic, and lead.

Contaminated soil may be present beneath the following buildings based on their historical use. A description of buildings/structures is provided below. Building locations are shown on Figure 8:

800-03: Solvent storage area occupying approximately 120 square ft. Based on an evaluation of soil sample results at Line 800 in 2005 and 2006, excavation L800-E12, approximately 578 square ft and 6 ft deep, was completed to remove copper-impacted soil in a ditch that is located north and west of Building 800-03. The excavation was completed to remove the ecological risk. The RACR documented that all contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

There is a potential of subsurface soil contamination beneath the former building footprints based on historic use of the building, proximity to remediated soil areas, and/or prior soil sampling results adjacent to the building.

800-03-2: Solvent storage area occupying approximately 373 square ft. Based on an evaluation of soil sample results at Line 800 in 2005 and 2006, excavation L800-E12, approximately 578 square ft and 6 ft deep, was completed to remove copper-impacted soil in a ditch that is located approximately 20 ft east of Building 800-3-2. The excavation was completed to remove the ecological risk. The RACR documented that all contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

There is a potential of subsurface soil contamination beneath the former building footprints based on historic use of the building, proximity to remediated soil areas, and/or prior soil sampling results adjacent to the building.

800-192: Blank assay area occupying approximately 6,140 square ft. As part of a remedial action, a sump at Building 800-192 was removed along with 20 cy of contaminated soil. Based on an evaluation of soil sample results at Line 800 in 2005 and 2006, excavation L800-E07, approximately 145 square ft and 3.5 ft deep, was completed to remove RDX-impacted soil at an isolated location abutting the southeast side of the building. The RACR documented that all contaminated soil was removed, based on confirmation samples (Tetra Tech, 2009a).

There is a potential of subsurface soil contamination beneath the former building footprints based on historic use of the building, proximity to remediated soil areas, and/or prior soil sampling results adjacent to the building.

800-193: Receiving platform f/explosives area occupying approximately 800 square ft. During the PA/SI and RI, metals contamination to 3 ft bgs was identified immediately adjacent to Building 800-193 loading doors and sumps.

There is a potential of subsurface soil contamination beneath the former building footprints based on historic use of the building and prior soil sampling results adjacent to the building.

Buildings with Limited Historical Sampling Documentation:

There is a potential of subsurface soil contamination based on historic use of the building and/or proximity to remediated soil areas for the following buildings:

- **800-08: Ready magazine area occupying approximately 288 square ft.**
- **800-16: Ready magazine area occupying approximately 120 square ft.**
- **800-70-1: Industrial waste treatment area occupying approximately 115 square ft.**
- **800-70-2: Industrial waste treatment area occupying approximately 2,000 square ft.**

Other Building Footprints (Optional Task 3B):

Several buildings were demolished outside of the previously identified Line boundaries, along with some buildings within existing Lines, but are expected to be demolished at a later date. Contaminated soil may be present beneath the buildings based on their historical use. A description of buildings/structures is provided below. Building locations are shown on Figure 9.

BG-199-1: Ammunition demolition facility (EW1) occupying approximately 1,133 square ft. The explosives waste incinerator is located in the southwest corner of the explosive disposal area. The incinerator, a RCRA-permitted facility, was enclosed within Building BG-199-1. The incinerator prepared for a trial burn from November 1981 to April 1982 and then operated routinely until September 1990 when it was shut down for modifications to meet USEPA incinerator standards. Following modifications, the incinerator operated on an as-needed basis for treatment of sump scrap. Following incineration, residue accumulated in the bottom of the kiln was removed and placed in 55-gallon drums for waste characterization and disposal. Wastewater generated when the floor of the feed area was washed down at the end of each shift, and pumped into a sump on the south side of the building. The contents of the sump was pumped into a liquid waste dumpster and transported to Line 2 for treatment.

PA/SI and RI surface samples collected associated drainageways did not indicate a contaminant release to the surrounding soil.

There is a potential of subsurface soil contamination beneath the former building footprints based on historic use of the building.

BG-199-2: Contaminated waste processor area occupying approximately 4,000 square ft. The Contaminated Waste Processor was located within Building BG-199-2, located on the northeast side of IAAAP. The facility was used to flash or burn materials that had come in contact with explosives or other energetic substances. Such materials included equipment, pipe, steel, empty cartridge cases, empty projectiles, and lumber. The processor operated beginning in 1982, and waste was removed weekly. The processor contents was dumped onto the floor of the building, and metal of recoverable size was removed using a magnet. The remaining ash was shoveled into 55-gallon drums and staged pending waste characterization and appropriate disposal. Wash water generated inside the processor was collected in floor trenches and pumped into a sump on the south side of BG-199-2. The sump was then pumped into a liquid waste dumpster and transported to Line 2 for treatment. Soil sampling as part of the 1993 SI did not indicate a release occurring as a results of activities at the processor and no additional sampling was recommended.

The IROD identified lead at concentrations exceeding cleanup criteria in the Ash Disposal Landfill, west burn pads, and west burnpads landfill, and along the southeast corner of Building BG-13. Only low levels of explosives (less than 10 parts per million) were reported.

There is a potential of subsurface soil contamination beneath the former building footprints based on historic use of the building and prior soil sampling results adjacent to the building.

9**00-194-8: Ammunition demolition facility area occupying approximately 537 square ft.** Ash collected from the cyclone and baghouse of the air pollution control system for the deactivation furnace was put directly into 55-gallon drums and stored as D008 waste in Building 900-194-8 prior to characterization and proper disposal. Soil samples collected for the PA/SI and RI indicated surface and shallow subsurface metals contamination in and immediately around the exit of the furnace and/or around the craters used for demolition.

There is a potential of subsurface soil contamination beneath the former building footprints based on historic use of the building and prior soil sampling results adjacent to the building.

900-199-2: Ammunition demolition facility area occupying approximately 528 square ft. This former building is located within the approximately 10-acre Demolition Area in the southwest portion of IAAAP. The area was used for open detonation of large caliber ammunition that could not be safely dismantled or disassembled for removal of explosive filler. Scrap metal and other debris remaining after a detonation episode was collected and treated in the Contaminated Waste Processor and the affected area was turned under to a depth of approximately 6 ft and allowed to re-vegetate. The area was used in from the 1940s, with extensive used from 1966 to 1970 when 4,700 canisters containing lead azide and RDX were destroyed. Soil samples collected during the PA/SI and RI indicated surface and shallow subsurface metals contamination in and immediately around the exit of the furnace and/or around the craters used for demolition. The IROD identified explosives at concentrations exceeding cleanup criteria in the Explosives Demolition Area/East Burn Pads. The IROD identified lead as the only contaminant exceeding cleanup criteria in the Demolition Area/Deactivation Furnace.

There is a potential of subsurface soil contamination beneath the former building footprints based on historic use of the building and prior soil sampling results adjacent to the building.

600-84: Central test facility (AET tenants) area occupying approximately 5,014 square ft. Building 600-84 was built in 1941 and was used to test fire small items in metal vessels from 1942 until 1945. Operations resumed in 1949 and continued during the Viet Nam Conflict, after which the building was no longer used for testing. The building, a walled-in area south of the building and the field to the north and east of the building (the test-fire area), comprised the Central Test Area. Components tested inside the building were fuses, primers, and detonators (Advanced Environmental Technology, 2001).

Soil sampling during the PA/SI and RI for the IAAAP identified no contaminants below the surface and (cadmium and iron) in surface soil in the area of the building. Additional surface soil sampling was conducted in 2001 for the open field area east and south of Building 600-84 to evaluate the location for reuse and construction of a new facility . Six composite surface soil samples (0 to 1 ft bgs) collected south and east of the building were analyzed for metals and explosives. The study confirmed no impact to soil in these areas (Advanced Environmental Technology, 2001). Advanced Environmental Technology later operated in Building 600-84 (USACE, 2016).

Because the Central Test Area had not been fully investigated at the time of the OU1 IROD and ROD, it was included as part of OU4 at that time. A geophysical survey was conducted in 2004 and soil samples were collected from 29 locations across the Central Test Area in 2005. Based on analytical results, three areas (approximately 100 feet southeast of the building and two areas in the test-fire area north and east of the building) contained cadmium, iron, arsenic, and TNT at concentrations exceeding RGs.

Approximately 158 cy of contaminated soils were removed in accordance with the OU1 RODs and the 2003 ESD, and the Central Test Area was transferred to OU1 in accordance with the 2008 ESD. Excavations were completed to 1 ft bgs (Tetra Tech, 2009a).

Buildings with Limited Historical Sampling Documentation:

There is a potential of subsurface soil contamination based on historic use of the building and/or proximity to remediated soil areas for the following buildings:

- **BG-12: Ready magazine (post-RCRA closure) area occupying approximately 440 square ft.**
- **H-6: Ammunition storage area occupying approximately 192 square ft.**
- **H-7: Ammunition storage area occupying approximately 192 square ft.**
- **H-8: Ammunition storage area occupying approximately 192 square ft.**
- **H-9: Ammunition storage area occupying approximately 192 square ft.**
- **L-03-1: Solvent storage area occupying approximately 400 square ft.**
- **5B-21: Ready magazine located within Line 5B and occupying approximately 120 square ft.**
- **500-143-2: Bottle gas storage area occupying approximately 253 square ft.**
- **500-143-3: Gas storage shelter area occupying approximately 152 square ft.**
- **500-143-4: Acid storage area occupying approximately 271 square ft.**
- **500-206-1: Bottle gas storage area occupying approximately 88 square ft.**
- **700-186-1: Filter plant facility area occupying approximately 2,000 square ft.**
- **800-68: Explosives storage magazine area occupying approximately 575 square ft.**
- **900-198-2: Billet splitter building area occupying approximately 100 square ft.**

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QAPP Worksheet #11
Project Quality Objectives/Systematic Planning Process Statements

The primary decisions regarding residual chemicals present within select former building footprints at IAAAP will be evaluated through the data quality objective (DQO) process, leading to the optimization of a data collection strategy. Site-specific DQOs for these activities were developed using the USEPA seven-step process (USEPA, 2006), as summarized below. The tasks that will be performed will be described in Worksheets #14 and #16 and Worksheet #17.

Step	Description
Step 1: State the Problem	Previous Remedial Investigations and Removal Actions at Lines 1, 2, 3, 3A, 5A/5B, 6, 9, and 800 and at select other areas indicate that soil beneath buildings that have been demolished may be impacted by past use. Contaminated soil outside of the buildings has been delineated and removed in accordance with the OU1 ROD and subsequent ESDs. The 2018 OU1 ESD specifies that for each building planned for demolition at an OU1 area, the potential for subsurface contamination will be evaluated based on the historic use of the building, proximity to remediated soil areas, and prior soil sampling results adjacent to the building. If the evaluation determines that subsurface soil contamination is likely, soil sampling within the building footprint will be conducted. If sample results show contamination exceeds the OU1 RGs, then the soil will be recommended for remediation in accordance with the OU1 ROD; if sample results show that contamination does not exceed OU1 RGs, then land use controls will be recommended in accordance with the 2018 ESD. Per the 2018 ESD, 106 demolished buildings were identified as potentially having subsurface soil contamination (Table 17.1) (five buildings originally identified as potentially having subsurface soil contamination at Line 1 will be investigated under FUSRAP. Soil samples are therefore required to delineate potential contamination in the subsurface below the former building foundations and to provide data for preparation of an RD to support removal of the contaminated soil in accordance with the OU1 ROD or support maintenance of soils in place under land use controls in accordance with the 2018 ESD.
Step 2. Identify the Goals of the Study	The primary goal of this investigation is to obtain soil data to delineate contamination, if present, beneath former buildings, in support of a removal action (for soils with contaminants exceeding RGs) or implementation of land use controls (for soils with no contaminants exceeding RGs). If VOCs, which have not been identified as site contaminants in soil at IAAAP during previous RIs and Removal Actions, are identified as potential contaminants in subsurface soil samples based on elevated PID readings (sustained readings above background), noticeable odor, or visual observations, then soil samples will be collected and analyzed for VOCs. If subsurface soil samples collected within former building footprints contain VOCs or identified potential contaminants (PAHs, explosives, and/or metals) at concentrations that exceed OU1 RGs, then sufficient analytical data will be collected to define the lateral and vertical extent of the exceedances in the vadose zone for development of an RD to support removal of the contaminated soil in accordance with the OU1 ROD. Sufficient analytical data includes collection of stepout samples

QAPP Worksheet #11, Cont'd.

	(horizontally or vertically within the vadose zone) until contaminant concentrations are less than OU1 RGs. Determination of the need for additional sampling will be based on evaluation of the analytical data; if additional data will be required, a technical memorandum will be prepared summarizing the results of data collection and outlining the proposed scope for subsequent sampling and the UFP-QAPP will be amended as needed.
Step 3. Identify Information Inputs	• RI and Removal Action Reports identified PAHs, explosives, and/or metals as contaminants of potential concern at building locations. • Building use and location were evaluated to identify 106 former buildings as potentially having subsurface soil contamination. • Field observations (elevated PID readings [sustained readings above background] and/or staining) will be used to identify potential VOC contaminants in subsurface soil, and analytical data from collected subsurface soil samples will define lateral and vertical extent of VOC contamination, if present at concentrations exceeding PALs (Worksheet #15, in the vadose zone. • Analytical data will be collected from subsurface soil samples representative of the vadose zone within 106 former building footprints (Table 17.1). • Data will be used to determine if chemicals of concern are present in subsurface soil at concentrations exceeding OU1 RGs and if present, their lateral and vertical extent in vadose zone soils.
Step 4. Define the Project Boundaries	Lateral boundaries were determined based on geographical information system data provided by IAAAP and historical drawings. The boundary will consist of the area surrounding the existing building footprints as shown on Figures 3 through 9. Soil will be evaluated up to 10 ft below the base of each building foundation. Soil borings will not be advanced into the water table.
Step 5. Develop the Analytical Approach	Soil samples will be analyzed for historical contaminants identified in the OU1 IROD and in previous investigations and removal actions performed at the associated Line. As summarized in Table 17.1, samples collected at Lines 1, 2, and 3 will be analyzed for PAHs (Method 8270D), Explosives (Method 8330B) and Metals (Method 6010D/7471B); samples collected at Lines 3A, 5A/5B, 6, and 800 will be analyzed for explosives and metals, and samples collected at Line 9 will be analyzed for metals. Additionally, soil will be screened using a PID and will be analyzed for VOCs if elevated PID readings (sustained readings above background) and/or odor and staining are observed. If VOC, PAH, explosive, and/or metals concentrations exceed RGs, then collect additional stepout samples, as necessary, to delineate contaminants in the building footprint subsurface soil to support a remedial action (e.g., removal of soil in accordance with the OU1 ROD).
Step 6. Specify Performance or Acceptance Criteria	Analytical data quality will be compared to Department of Defense (DoD) Quality Systems Manual (QSM) (Version 5.3, DoD, 2019) specification for precision, accuracy, representativeness, comparability, completeness, and sensitivity. The analytical methods will provide the detection limits that will allow the data to be screened against the Project Action Levels in Worksheet #15. Acceptance and performance criteria are provided in Worksheet #28. Laboratory data are considered

QAPP Worksheet #11, Cont'd.

	usable if data validation criteria are met (Worksheets #34, #35, and #36) and data verification and validation in the context of the overall project decision or objectives are met (Worksheet #37). Decision errors will be minimized through incorporating findings from site visits, daily inspections, evaluation of field data, and refinement of the conceptual site model to optimally implement the sample design. Measurement errors will be minimized by following field Standard Operating Procedures (SOPs) and performing field audits to ensure activities are conducted in accordance with this UFP-QAPP and associated field SOPs. Field logbook, sampling forms, and records will be reviewed to assess ensure overall usability of data for project purposes.
Step 7. Develop the Detailed Plan for Obtaining the Data	A global positioning system unit will be used to locate proposed soil boring locations within each of the building footprints. The number of borings planned (two soil samples are proposed to be collected from each boring) within each building footprint is shown in Table 17.1. Sample collection will begin at the smaller buildings (less than 300 square ft), where no known contamination was historically established and one boring for collection of soil samples is initially proposed. As fieldwork continues and data become available, additional borings may be advanced within the smaller building footprints to delineate identified contamination, as necessary. Where larger buildings with no known contamination adjacent to the building has been identified, borings will be evenly spaced within the building footprint to indicate spatial variability. Borings will be blind drilled through backfill to the approximate depth of the foundation at each of the former building sites. Continuous soil cores will then be collected to approximately 10 ft below the foundation base, or to groundwater if encountered first. Two subsurface soil samples are proposed to be collected for VOC, PAH, explosives, and/or metals analysis dependent on site history and soil screening. Soils will be field screened using a PID, olfactory, and visual methods, and samples will be selected if there is evidence of visual staining, elevated PID readings (sustained readings above background), or unusual odor or texture to the soil; if there is no observed potential contamination, then one soil sample will be collected within The first five ft of the base of the building foundation, and a second soil sample will be collected within the next 5 ft. Samples will be submitted to an Environmental Laboratory Accreditation Program ELAP-approved analytical laboratory and analyzed for the select analyses shown in Table 17.1.

Data must be of sufficient quality to determine whether residual contamination is present in soil at levels that pose unacceptable risks to human health through with ingestion and dermal contact with contaminated soils by the reasonably maximum exposed individual under an industrial land use scenario, as well as criteria to evaluate possible leaching of RDX and TNT from soils to groundwater at unacceptable levels (see Project Action Levels, Worksheet #15). Planned field activities, number of samples, and analytical parameters are provided in Worksheet #17 of this UFP-QAPP. Analysis requirements are provided in Worksheets #19, 20, 24-28, and 30 of this UFP-QAPP.

QAPP Worksheet #11, Cont'd.

TAC JV will use the generated data to delineate soil contamination (if present) laterally and vertically in vadose zone soils beneath former buildings listed in Table 17.1, and to evaluate remedial action to address soil contamination in accordance with the OU1 ROD and associated ESDs.

Waste characterization results will be used to determine the appropriate methods of disposal for investigation-derived waste. The disposal contractor will use the analytical data results to classify the soil and water generated during field activities to determine the appropriate methods for transporting and disposing of waste.

Data will be reported in a Remedial Design Report.

QAPP Worksheet #12 Table 12.1
Measurement Performance Criteria Table – Soil, Metals by SW-846 Method 6010D

Matrix: Soil
Analytical Group or Method: Metals/SW6010D
Concentration Level: Low

Data Quality Indicator	QC sample or measurement performance activity	Measurement Performance Criteria
Overall Precision	Field Duplicates	RPD ≤ 50% when an analyte is detected in both samples ≥ sample-specific LOQ; field duplicate results are not qualified when analytes are not detected or are detected at concentrations less the LOQ
Analytical Precision (laboratory)	Laboratory Control Sample Duplicates	RPD ≤ 20%
Analytical Accuracy/Bias (laboratory)	Laboratory Control Samples	DoD QSM v. 5.3 control limits (Table C-3)
Analytical Accuracy/Bias (matrix interference)	Matrix Spike/Matrix Spike Duplicates	% Recovery listed in Table C-3 of DoD QSM v. 5.3 RPD < 20%
Overall accuracy/bias (contamination)	Equipment Blanks	No analytes detected >1/2 the LOQ or 1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater
Sensitivity	Lowest calibration standard	Lowest calibration standard ≤ LOQ
Completeness	See Worksheet #34	See Worksheet #34

DoD QSM = Department of Defense Quality Systems Manual
LOD = limit of detection
LOQ = limit of quantitation
QC=quality control
QSM = Quality Systems Manual
RPD = relative percent difference

QAPP Worksheet #12 Table 12.2
Measurement Performance Criteria Table – Soil, Mercury by SW-846 Method 7471B

Matrix:	Soil
Analytical Group or Method:	Mercury/SW7471B
Concentration Level:	Low

Data Quality Indicator	QC sample or measurement performance activity	Measurement Performance Criteria
Overall Precision	Field Duplicates	RPD ≤ 50% when an analyte is detected in both samples ≥ sample-specific LOQ; field duplicate results are not qualified when analytes are not detected or are detected at concentrations less the LOQ
Analytical Precision (laboratory)	Laboratory Control Sample Duplicates	RPD ≤ 20%
Analytical Accuracy/Bias (laboratory)	Laboratory Control Samples	DoD QSM v. 5.3 control limits (See Table C-11)
Analytical Accuracy/Bias (matrix interference)	Matrix Spikes/Matrix Spike Duplicates	% Recovery listed in Table C-11 of DoD QSM v. 5.3 RPD ≤ 20%
Overall accuracy/bias (contamination)	Equipment Blanks	No analytes detected >1/2 the LOQ or 1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater
Sensitivity	Lowest calibration standard	Lowest calibration standard ≤ LOQ
Completeness	See Worksheet #34	See Worksheet #34

DoD QSM = Department of Defense Quality Systems Manual
LOD = limit of detection
LOQ = limit of quantitation
QC = quality control
QSM = Quality Systems Manual
RPD = relative percent difference
VOCs = volatile organic compounds

QAPP Worksheet #12 Table 12.3
Measurement Performance Criteria Table – Soil, VOCs by SW-846 Method 8260C

Matrix:	Soil
Analytical Group or Method:	Volatile Organic Compounds/SW8260C
Concentration Level:	Low

Data Quality Indicator	QC sample or measurement performance activity	Measurement Performance Criteria
Overall Precision	Field Duplicates	RPD ≤ 50% when an analyte is detected in both samples ≥ sample-specific LOQ; field duplicate results are not qualified when analytes are not detected or are detected at concentrations less the LOQ
Analytical Precision (laboratory)	Laboratory Control Sample Duplicates	RPD ≤ 20%
Analytical Accuracy/Bias (laboratory)	Laboratory Control Samples	DoD QSM v. 5.3 control limits (Table C-23)
Analytical Accuracy/Bias (matrix interference)	Matrix Spike/Matrix Spike Duplicates	% Recovery listed in Table C-23 of DoD QSM v. 5.3 RPD ≤ 20%
Overall accuracy/bias (contamination)	Equipment Blanks	No analytes detected >1/2 the LOQ or 1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater
Sensitivity	Lowest calibration standard	Lowest calibration standard ≤ LOQ
Completeness	See Worksheet #34	See Worksheet #34

DoD QSM = Department of Defense Quality Systems Manual
LOD = limit of detection
LOQ = limit of quantitation
QC = quality control
QSM = Quality Systems Manual
RPD = relative percent difference
VOCs = volatile organic compounds

QAPP Worksheet #12 Table 12.4
Measurement Performance Criteria Table – Soil, PAHs by SW-846 Method 8270D-SIM

Matrix:	Soil
Analytical Group or Method:	PAHs/SW8270D SIM
Concentration Level:	Low

Data Quality Indicator	QC sample or measurement performance activity	Measurement Performance Criteria
Overall Precision	Field Duplicates	RPD ≤ 40% when an analyte is detected in both samples ≥ sample-specific LOQ; field duplicate results are not qualified when analytes are not detected or are detected at concentrations less the LOQ
Analytical Precision (laboratory)	Laboratory Control Sample Duplicates	RPD ≤ 20%
Analytical Accuracy/Bias (laboratory)	Laboratory Control Samples	DoD QSM v. 5.3 control limits (See Table C-27)
Analytical Accuracy/Bias (matrix interference)	Matrix Spike/Matrix Spike Duplicates	% Recovery listed in Table C-27 of DoD QSM v. 5.3 RPD ≤ 20%
Overall accuracy/bias (contamination)	Equipment Blanks	No analytes detected >1/2 the LOQ or 1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater
Sensitivity	Lowest calibration standard	Lowest calibration standard ≤ LOQ
Completeness	See Worksheet #34	See Worksheet #34

DoD QSM = Department of Defense Quality Systems Manual
LOD = limit of detection
LOQ = limit of quantitation
PAH = polynuclear aromatic hydrocarbon
QC = quality control
QSM = Quality Systems Manual
RPD = relative percent difference

QAPP Worksheet #12 Table 12.5
Measurement Performance Criteria Table – Soil, Explosives by SW-846 Method 8330B

Matrix:	Soil
Analytical Group or Method:	Explosives/SW8330B
Concentration Level:	Low

Data Quality Indicator	QC sample or measurement performance activity	Measurement Performance Criteria
Overall Precision	Field Duplicates	RPD ≤ 50% when an analyte is detected in both samples ≥ sample-specific LOQ; field duplicate results are not qualified when analytes are not detected or are detected at concentrations less the LOQ
Analytical Precision (laboratory)	Laboratory Control Sample Duplicates	RPD ≤ 20%
Analytical Accuracy/Bias (laboratory)	Laboratory Control Samples	DoD QSM v. 5.3 control limits (See Table C-37)
Analytical Accuracy/Bias (matrix interference)	Matrix Spike/Matrix Spike Duplicates	% Recovery listed in Table C-37 of DoD QSM v. 5.3 RPD ≤ 20%
Overall accuracy/bias (contamination)	Equipment Blanks	No analytes detected >1/2 the LOQ or 1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater
Sensitivity	Lowest calibration standard	Lowest calibration standard ≤ LOQ
Completeness	See Worksheet #34	See Worksheet #34

DoD QSM = Department of Defense Quality Systems Manual
LOD = limit of detection
LOQ = limit of quantitation
QC = quality control
QSM = Quality Systems Manual
RPD = relative percent difference

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QAPP Worksheet #13
Secondary Data Uses and Limitations

Data Type	Data Source	How Data Will Be Used	Limitations on Data Use
Site Background and Physical Characteristics, Past Site Uses	Previous site reports	Potential contaminant source identification; site history, potential contaminants in former building areas, building use, building construction	None.
Removal Action Reports	Previous removal action reports	Potential contaminants in former building areas	None
Analytical data	Previous site reports (PA/SI, RI, RACR)	To support selection of locations for sample locations; support investigation of building footprint.	None
Geographic information system mapping layers and coordinates	Previous site reports, geographic information system data files	Locate building footprints, select optimum placement of boring locations, identify likely contaminants, if any.	None

For reference documents, see Worksheets #1 and #2, which lists reports and identifies generators of data for previous investigations relevant to this project. The RIs and RACRs for OU-1 were completed under approved UFP-QAPPs, and available analytical data were used qualitatively to identify potential contaminants of concern. Available analytical data were used qualitatively to identify potential contaminants (identified in the approved ROD for each of the Lines) for the former buildings within these Lines.

QAPP Worksheets #14 and #16
Project Tasks and Schedule

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s)	Deliverable Due Date
Mobilization/Demobilization	TAC JV	September 30, 2022	January 26, 2022	Field Notes	January 26, 2022
Stake Soil Boring Locations	TAC JV	September 30, 2022	October 13, 2022	Field Notes	October 13, 2022
Drilling and Soil Sampling	TAC JV	October 13, 2022	December 17, 2022	Field Notes	December 17, 2022
Soil Sample Analyses	Eurofins/TestAmerica Laboratories	October 14, 2022	January 17, 2022	Laboratory Analytical Reports	January 17, 2022
Optional Task Drilling and Soil Sampling	TAC JV	January 5, 2022	January 11, 2022	Field Notes	January 11, 2022
Optional Task Soil Sample Analyses	TAC JV	January 6, 2022	February 8, 2022	Field Notes	February 8, 2022
Data Validation	TAC JV Chemist	January 15, 2022	February 8, 2022	Validation Summary Report	February 8, 2022
Usability Assessment	Project Team	February 2022	March 2022	Usability Assessment Summary Report	March 2022
Data Analysis	TAC JV	January 2022	February 2022	Meeting Minutes	February 2022
Remedial Design	TAC JV	January 2022	May 3, 2022	RD Report	May 3, 2022

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QAPP Worksheet #15
Reference Limits and Evaluation Tables

Samples will be collected and analyzed to delineate the extent of VOC, PAH, explosives, and metals-contamination in vadose zone soil beneath former buildings. Analytical data for VOCs, PAHs, explosives, and/or metals in soil samples will be compared to Project Action Limits (PALs) provided in Tables 15.1 through 15.5. The PALs for soil are the RGs provided in the OU1 ROD, where available, and RSLs for a commercial/industrial scenario where RGs are not provided in the OU1 ROD.

The RGs provided in the ROD (included in Tables 15.1, 15.2, 15.4, and 15.5) were based on ingestion/dermal contact at 10^{-6} risk level to the reasonably maximum exposed individual considering an industrial setting. The ROD stipulates that RGs for other constituents which may be detected at the site and which are not specified in the ROD will be established under similar criteria. RGs for RDX and TNT, explosives which were historically found in on- and off-site groundwater (evaluated under OU3), were developed using the Summers' model (Summers et al., 1980) to satisfy remedial action objectives for the protection of human health and the protection of groundwater, and supersede the ingestion/dermal contact RGs for these two constituents. The Summers' model assumes that a percentage of rainfall at the site will infiltrate the surface and desorb contaminants from soils, based on an equilibrium of soil and water partitioning. It is further assumed that this contaminated infiltration will mix completely with the groundwater below the site, resulting in an equilibrium groundwater concentration with all contaminants in the final mixture from the infiltration (USAEC, 1997).

Remediation of contaminated soil under OU1 will be completed to meet the RGs, which are protective in the short-term; this investigation evaluates only subsurface soil which does not pose an ecological risk. In order for the remedy to be protective in the long term, land use controls will be required to maintain protectiveness under an industrial land use scenario, in accordance with the 2018 ESD (CH2M HILL, 2018).

Tables 15.1 through 15.5 provide the comprehensive analyte lists for the analytical methods that will be used for the sites that will be addressed by this project. The associated limits for sensitivity and accuracy are also included in each table. The accuracy control limits presented in the Worksheet #15 tables are based on those presented in the DoD QSM for Environmental Laboratories, Version 5.3 (DoD, 2019). Where the control limits are not specified in the QSM, the site-specific laboratory's internally derived control limits will be used.

QAPP Worksheet #15 Table 15.1
Reference Limits and Evaluation Tables –Metals in Soil by 6010D/3050B

Matrix: Soil
Analytical Method: SW6010D/SW3050B
Concentration level (if applicable): Low

Analyte	CAS Number	Project Action Limit (mg/kg)	PQLG[3] (mg/kg)	LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)
Aluminum	7429-90-5	1,100,000[1]	367,000	50.0	6.00	1.55
Antimony	7440-36-0	816[2]	157	2.00	1.50	0.733
Arsenic	7440-38-2	30[2]	10.0	2.50	2.00	0.665
Barium	7440-39-3	220,000[1]	16,300	2.00	0.900	0.296
Beryllium	7440-41-7	5[2]	1.67	0.500	0.120	0.0330
Cadmium	7440-43-9	1,000[2]	327	0.500	0.150	0.0410
Chromium, Total	7440-47-3	1,800,000[5]	600,000	3.50	0.400	0.123
Cobalt	7440-48-4	350[1]	117	1.00	0.200	0.0679
Copper	7440-50-8	47,000[1]	15,700	5.00	0.800	0.217
Iron	7439-89-6	820,000[1]	273,000	80.0	20.0	8.27
Lead	7439-92-1	1,000[2]	267	0.900	0.800	0.310
Manganese	7439-96-5	26,000[1]	8,670	4.50	0.400	0.100
Nickel	7440-02-0	22,000[1]	7,330	4.00	0.450	0.132
Selenium	7782-49-2	5,800[1]	1,930	3.00	1.75	0.860
Silver	7440-22-4	5,800[1]	1,930	1.50	0.600	0.160
Thallium	7440-28-0	143[2]	4.0	3.00	1.30	0.650
Vanadium	7440-62-2	5,800[1]	1,933	2.00	0.350	0.0940
Zinc	7440-66-6	350,000[1]	117,000	8.00	1.50	0.398

QAPP Worksheet #15 Table 15.2
Reference Limits and Evaluation Tables –Mercury in Soil by 7471B

Matrix: Soil
Analytical Method: SW7471B
Concentration level (if applicable): Low

Analyte	CAS Number	Project Action Limit (µg/kg)	PQLG[3] (µg/kg)	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)
Mercury	7439-97-6	46,000[1]	15,333	33.0	17.0	13.3

QAPP Worksheet #15 Table 15.3
Reference Limits and Evaluation Tables –VOCs in Soil by 8260C/5035A

Matrix: Soil
Analytical Method: SW8260C/SW5035A
Concentration level (if applicable): Low

Analyte	CAS Number	PAL EPA RSL[1] Industrial Soil (µg/kg)	PQLG[3] (µg/kg)	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)
1,1,1,2-Tetrachloroethane	630-20-6	8,800	2,930	5.00	5.00	2.22
1,1,1-Trichloroethane	71-55-6	36,000,000	12,000,000	5.00	5.00	1.98
1,1,2,2-Tetrachloroethane	79-34-5	2,700	900	5.00	0.800	0.285
1,1,2-Trichloroethane	79-00-5	5,000	1,670	5.00	3.20	0.880
1,1-Dichloroethane	75-34-3	16,000	5,330	5.00	0.800	0.210
1,1-Dichloroethene	75-35-4	1,000,000	33,000	5.00	1.60	0.590
1,2,3-Trichlorobenzene	87-61-6	930,000	310,000	5.00	3.20	0.810
1,2,3-Trichloropropane	96-18-4	110.0	36.7	5.00	0.800	0.218
1,2,4-Trichlorobenzene	120-82-1	110,000	36,700	5.00	1.60	0.730
1,2,4-Trimethylbenzene	95-63-6	1,800,000	600,000	5.00	5.00	2.31
1,2-Dibromo-3-Chloropropane	96-12-8	64.0	3,100,000	10.0	10.0	3.66
1,2-Dichlorobenzene	95-50-1	9,300,000	667	5.00	5.00	1.87
1,2-Dichloroethane	107-06-2	2,000	870,000	5.00	1.60	0.700
1,2-Dichloropropane	78-87-5	11,000	500,000	5.00	1.60	0.550
1,3,5-Trimethylbenzene	108-67-8	1,500,000	3,100,000	5.00	5.00	2.42
1,3-Dichloropropane	142-28-9	23,000,000	7,670,000	5.00	0.400	0.173
1,4-Dichlorobenzene	106-46-7	11,000	3,670	5.00	0.800	0.245
2-Butanone (MEK)	78-93-3	190,000,000	63,300,000	20.0	12.8	3.89
2-Chlorotoluene	95-49-8	23,000,000	7,670,000	5.00	1.60	0.510
2-Hexanone	591-78-6	1,300,000	433,000	20.0	12.8	4.89
4-Chlorotoluene	106-43-4	23,000,000	7,670,000	5.00	0.800	0.361

Matrix: Soil
Analytical Method: SW8260C/SW5035A
Concentration level (if applicable): Low

Analyte	CAS Number	PAL EPA RSL[1] Industrial Soil (µg/kg)	PQLG[3] (µg/kg)	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)
4-Methyl-2-pentanone	108-10-1	140,000,000	46,700,000	20.0	12.8	4.36
Acetone	67-64-1	1,100,000,000	36,666,667	72.0	72.0	35.6
Benzene	71-43-2	5,100	1,700	5.00	0.400	0.151
Bromobenzene	108-86-1	1,800,000	600,000	5.00	1.60	0.490
Bromochloromethane	74-97-5	630,000	210,000	5.00	5.00	2.46
Bromodichloromethane	75-27-4	1,300	433	5.00	5.00	2.13
Bromoform	75-25-2	86,000	28,700	5.10	5.10	2.55
Bromomethane	74-83-9	30,000	10,000	10.0	3.20	1.35
Carbon disulfide	75-15-0	3,500,000	1,170,000	5.00	5.00	1.66
Carbon tetrachloride	56-23-5	2,900	957	5.00	5.00	2.01
Chlorobenzene	108-90-7	1,300,000	433,000	5.00	5.00	2.06
Chloroethane	75-00-3	23,000,000	7,666,667	10.0	6.40	1.99
Chloroform	67-66-3	1,400	467	10.0	0.800	0.290
Chloromethane	74-87-3	460,000	153,333	10.0	1.60	0.770
cis-1,2-Dichloroethene	156-59-2	2,300,000	767,000	5.00	0.800	0.201
Dibromochloromethane	124-48-1	39,000	13,000	5.00	5.00	2.27
Dibromomethane	74-95-3	99,000	33,000	5.00	0.800	0.317
Dichlorodifluoromethane	75-71-8	370,000	123,000	10.0	6.40	2.74
Ethylbenzene	100-41-4	25,000	8,330	5.00	0.800	0.305
Ethylene Dibromide	106-93-4	160	53.3	5.00	1.60	0.520
Hexachlorobutadiene	87-68-3	5,300	1,770	5.00	5.00	2.17
Isopropylbenzene	98-82-8	9,900,000	3,300,000	5.00	5.00	2.41
Methyl tert-butyl ether	1634-04-4	210,000	70,000	20.0	6.40	2.11

Matrix: Soil
Analytical Method: SW8260C/SW5035A
Concentration level (if applicable): Low

Analyte	CAS Number	PAL EPA RSL[1] Industrial Soil (µg/kg)	PQLG[3] (µg/kg)	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)
Methylene Chloride	75-09-2	1,000,000	333,000	5.00	3.20	1.60
m-Xylene & p-Xylene	179601-23-1	4,800,000	1,600,000	3.20	3.20	1.04
Naphthalene	91-20-3	8,600	2,870	6.70	6.70	3.31
n-Butylbenzene	104-51-8	58,000,000	19,300,000	5.00	1.60	0.560
N-Propylbenzene	103-65-1	24,000,000	8,000,000	5.00	1.60	0.580
o-Xylene	95-47-6	2,800,000	933,000	5.00	0.800	0.266
sec-Butylbenzene	135-98-8	120,000,000	40,000,000	5.00	1.60	0.770
Styrene	100-42-5	35,000,000	11,700,000	5.00	0.800	0.280
tert-Butylbenzene	98-06-6	120,000,000	40,000,000	5.00	1.60	0.500
Tetrachloroethene	127-18-4	100,000	33,300	5.00	5.00	1.91
Toluene	108-88-3	47,000,000	15,700,000	5.00	0.800	0.227
trans-1,2-Dichloroethene	156-60-5	300,000	100,000	5.00	0.800	0.390
trans-1,3-Dichloropropene	10061-02-6	8,200	2,730	5.00	0.200	0.0830
Trichloroethene	79-01-6	6,000	2,000	5.00	4.00	1.91
Trichlorofluoromethane	75-69-4	350,000,000	117,000,000	10.0	10.0	3.20
Vinyl chloride	75-01-4	1,700	567	5.00	3.20	1.34
1,2-Dichloroethane-d4 (Surr)	17060-07-0	-	-	2.00	1.60	0.500
4-Bromofluorobenzene (Surr)	460-00-4	-	-	2.00	1.00	0.500
Dibromofluoromethane (Surr)	1868-53-7	-	-	2.00	1.00	0.500
Toluene-d8 (Surr)	2037-26-5	-	-	2.00	0.200	0.100

QAPP Worksheet #15 Table 15.4
Reference Limits and Evaluation Tables –PAHs in Soil by 8270D/3550C

Matrix: Soil
Analytical Method: SW8270D/SW3550C
Concentration level (if applicable): Low

Analyte	CAS Number	Project Action Limit (µg/kg)	PQLG[4] (µg/kg)	LOQ (µg/kg)	LOD (µg/kg)	DL (µg/kg)
1-Methylnaphthalene	90-12-0	73,000[1]	24,300	10.0	2.00	0.520
2-Methylnaphthalene	91-57-6	3,000,000[1]	1,000,000	10.0	2.00	0.618
Acenaphthene	83-32-9	45,000,000[1]	15,000,000	10.0	1.07	0.320
Anthracene	120-12-7	230,000,000[1]	76,700,000	10.0	4.33	1.44
Benzo[a]anthracene	56-55-3	8,100[2]	2,700	10.0	4.33	1.80
Benzo[a]pyrene	50-32-8	810[2]	270	10.0	4.33	1.48
Benzo[b]fluoranthene	205-99-2	8,100[2]	2,700	10.0	6.67	2.40
Benzo[k]fluoranthene	207-08-9	210,000[1]	70,000	10.0	4.33	2.00
Chrysene	218-01-9	2,100,000[1]	700,000	10.0	4.33	2.00
Dibenz(a,h)anthracene	53-70-3	810[2]	270	10.0	6.67	2.60
Fluoranthene	206-44-0	30,000,000[1]	10,000,000	10.0	4.33	2.00
Fluorene	86-73-7	30,000,000[1]	10,000,000	10.0	2.67	0.940
Indeno[1,2,3-cd]pyrene	193-39-5	21,000[1]	7,000	10.0	6.67	2.20
Naphthalene	91-20-3	8,600[1]	2,867	10.0	2.00	0.652
Pyrene	129-00-0	23,000,000[1]	7,670,000	10.0	6.67	2.20
2-Fluorobiphenyl (Surr)	321-60-8	-	-	5.50	5.33	1.00
2-Methylnaphthalene-d10 (Surr)	7297-45-2	-	-	5.00	2.00	1.00
Fluoranthene-d10 (Surr)	93951-69-0	-	-	5.00	2.00	1.00
Nitrobenzene-d5 (Surr)	4165-60-0	-	-	6.00	5.33	1.00
Terphenyl-d14 (Surr)	1718-51-0	-	-	10.0	10.0	3.20

QAPP Worksheet #15 Table 15.5
Reference Limits and Evaluation Tables –Explosives in Soil by 8330B

Matrix: Soil
Analytical Method: SW8330B
Concentration level (if applicable): Low

Analyte	**CAS Number**	**PAL (mg/kg)**	**PQLG^3 (mg/kg)**	**LOQ (mg/kg)**	**LOD (mg/kg)**	**DL (mg/kg)**
1,3,5-Trinitrobenzene	99-35-4	102^2	34.0	0.100	0.0400	0.0138
1,3-Dinitrobenzene	99-65-0	82.0^1	27.3	0.100	0.0400	0.0166
2,4,6-Trinitrotoluene	118-96-7	$196^2/47^4$	32.0	0.100	0.100	0.0307
2,4-Dinitrotoluene	121-14-2	8.7^2	2.47	0.100	0.0400	0.0147
2,6-Dinitrotoluene	606-20-2	1.50^1	0.500	0.100	0.0400	0.0191
2-Amino-4,6-dinitrotoluene	35572-78-2	110^1	36.7	0.100	0.100	0.0329
4-Amino-2,6-dinitrotoluene	19406-51-0	110^1	36.7	0.100	0.100	0.0299
HMX	2691-41-0	$51{,}000^2$	17,000	0.100	0.0700	0.0227
m-Nitrotoluene	99-08-1	82.0^1	27.3	0.200	0.200	0.0640
Nitrobenzene	98-95-3	22.0^1	7.33	0.300	0.200	0.0850
Nitroglycerin	55-63-0	82.0^1	27.3	2.00	0.700	0.215
o-Nitrotoluene	88-72-2	15.0^1	5.00	0.200	0.100	0.0472
PETN	78-11-5	530^1	177	2.00	1.00	0.493
p-Nitrotoluene	99-99-0	140^1	46.7	0.200	0.100	0.0365
RDX	121-82-4	$53.0^2/1.00^4$	12.7	0.200	0.100	0.0430
Tetryl	479-45-8	$2{,}300^1$	767	0.200	0.100	0.0439
1,2-Dinitrobenzene	528-29-0	82.0^1	27.3	0.100	0.0400	0.0190

Worksheet #15 Table footnotes:

[1] EPA Industrial Soil (TR = 1E-06, THQ=1.0), November 2021

[2] Soil Remediation Goals: Human Health, ROD Operable Unit 1, Iowa Army Ammunition Plant IAAAP (Harza, 1998)

[3] PQLG is set at 1/3 the PAL.

[4] Soil Remediation Goals: Leaching, ROD Operable Unit OU-1, Iowa Army Ammunition Plant IAAAP (Harza, 1998)

[5] There is no listed regional screening level for total chromium; the listed value is for trivalent chromium.

Bold type indicates PQLG less than LOQ

µg/kg	microgram per kilogram
CAS	chemical abstract service
DL	detection limit
EPA	United States Environmental Protection Agency
LOD	limit of detection
LOQ	limit of quantitation
mg/kg	milligram per kilogram
PAL	Project Action Limit
PQLG	project quantitation limit goal
ROD	record of decision
SIM	selected ion monitoring
Surr	surrogate
THQ	target hazard quotient
TR	target risk

QAPP Worksheet #17
Sampling Design and Rationale

Subsurface soil samples will be collected and screened during the fieldwork to determine if contaminated soil exists beneath former buildings listed in Table 17.1. Contaminants in soil that are associated with activities performed at the different IAAAP Lines and were identified in the OU1 IROD and/or previous investigations and removal actions include PAHs, explosives and/or metals. Contaminants within these chemical groups that have established RGs identified in the OU1 ROD are provided in Tables 17.2 and 17.3. The ROD stipulates that RGs for other constituents which may be detected at the site and which are not specified in the ROD will be established using similar criteria. Soil samples will be analyzed for the chemical groups identified for the associated Line to delineate contamination that exceeds RGs and/or PALs shown in Worksheet #15. The objective of the soil sampling is to collect data for delineation of contaminated soil in support of a removal action, as necessary, in the Remedial Design.

Table 17.1
Proposed Borings Summary

Area	Area Description	Previous Building	Building Number	Area (sf)	Number of Proposed Borings*
Line 2	Line 2 was constructed in 1941 for LAP of ammunition items. Explosives were shipped by rail to Line 2 and then melted and packed into metal ammunition cases. The line was cleaned and placed into storage from 1945 to the early 1950s when it was reactivated for ammunition production. Chemicals of concern are PAHs, explosives, and metals.	Explosives Magazine	2-06-1	1440	6
		Explosives Magazine	2-06-2	1440	6
		Explosives Magazine	2-08-1	1440	6
		Explosives Magazine	2-08-2	1440	6
		Explosives Treatment	2-50	2662	6
		Vacuum House	2-99-1	100	1
		Vacuum House	2-99-2	100	1
		Vacuum House	2-99-3	100	1
		Vacuum House	2-99-4	100	1
		Vacuum House	2-99-5	100	1
		Vacuum House	2-99-6	100	1
		Vacuum House	2-99-7	100	1
		Vacuum House	2-99-8	100	1
		Ammo Wash Facility	2-140-2	82	1
		Ammo Wash Facility	2-140-7	96	1

QAPP Worksheet #17, Cont'd

Table 17.1
Proposed Borings Summary

Area	Area Description	Previous Building	Building Number	Area (sf)	Number of Proposed Borings*
		Ammo Wash Facility	2-140-8	96	1
		Ammo Wash Facility	2-140-10	325	1
		Ammo Wash Facility	2-140-11	203	1
		Transformer on Platform (part of Electrical Distribution	2-169-7	100	1
Line 3	Line 3 began operation in the early 1940s and operated continuously with the exception of a temporary shutdown from 1945 to 1949. The line produced heavy artillery and projectiles. Explosives were shipped by rail to the line, then melted and packed into metal cases. Chemicals of concern are PAHs, explosives, and metals.	Melt Loading	3-05-2	27372	15
		Ind Waste Treatment (Carbon Col)	3-70-3	1068	6
		Ind Waste Treatment	3-163-1	66.9	1
		Ind Waste Treatment	3-163-2	285.6	1
		Vacuum House	3-99-1	100	1
		Vacuum House	3-99-2	100	1
		Vacuum House	3-99-5	100	1
		Vacuum House	3-99-6	100	1
Line 3A	Line 3A began operation as a LAP production line for artillery in 1943. Explosives were shipped into the plant, melted, then packed into 155-millimeter artillery rounds. The line was shut down from 1945 to 1949, resuming operations until 1989. Metal cleaning operations were conducted	Solvent Storage	3A-03-1	983	5
		Explosives Storage	3A-03-2	983	5
		Melt Loading	3A-05-1	19269	13
		Melt Loading	3A-05-2	18629	13
		High Explosives Magazine	3A-06	981	5
		Explosives Magazine	3A-08-1	981	5
		Explosives Magazine	3A-08-2	981	5

QAPP Worksheet #17, Cont'd

Table 17.1
Proposed Borings Summary

Area	Area Description	Previous Building	Building Number	Area (sf)	Number of Proposed Borings*
	from 1977 to 1985. Chemicals of concern are explosives and metals.	Explosives Drilling Bldg	3A-10-5	1420	6
		Assy Bldg	3A-20-1	10774	10
		Assy Bldg	3A-20-2	10354	10
		Explosives Screening	3A-50-1	3315	6
		Vacuum House	3A-99-1	100	1
		Vacuum House	3A-99-2	100	1
		Vacuum House	3A-99-7	100	1
		Vacuum House	3A-99-8	672	5
		Xray Bldg	3A-100	4231	6
		Ammo Wash Facility	3A-140-2	100	1
		Sump House	3A-140-3	54	1
		Ammo Wash Facility (only Concrete Remains)	3A-140-4	54	1
Lines 5A	Lines 5A/5B operated from 1942 to 1945 as booster and grenade lines. In 1949 production resumed, intensifying in 1961, then were placed in caretaker status. Line 5A was torn down in 2010. Principal explosives used were TNT, RDX, and tetryl. Chemicals of concern are explosives and metals.	Ready Magazine	5A-21	120	1
		Ready Magazine	5A-25	120	1
		Pressing Area	5A-28	4017	6
		Assembly	5A-29	13986	10
		Vacuum House	5A-99-1	100	1
		Vacuum House	5A-99-2	100	1
		Ammo Wash Facility	5A-140-2	141	1
		Ammo Wash Facility	5A-140-3	944	5
Lines 5B	Lines 5A/5B operated from 1942 to 1945 as booster and grenade lines. In 1949 production resumed,	Solvent Storage	5B-03-3	69	1
		Ready Magazine	5B-26	960	5
		Ready Magazine	5B-56	120	1
		Vacuum House	5B-99-1	100	1

QAPP Worksheet #17, Cont'd

Table 17.1
Proposed Borings Summary

Area	Area Description	Previous Building	Building Number	Area (sf)	Number of Proposed Borings*
	intensifying in 1961, then were placed in caretaker status. Line 5A was torn down in 2010. Principal explosives used were TNT, RDX, and tetryl. Chemicals of concern are explosives and metals.	Vacuum House	5B-99-2	100	1
		Ammo Wash Facility	5B-140-1	141	1
		Ammo Wash Facility	5B-140-2	107	1
		Ammo Wash Facility	5B-140-3	944	5
Line 6	Line 6 is a detonator production area constructed in 1941 and operating until 1981. Treatment of black powder was performed in Building 6-68 as a RCRA permitted unit. RCRA closure was completed for this unit I 1994 and the building was placed in modified caretaker status. Chemicals of concern are explosives and metals.	Ready Magazine	6-11	519	5
		Insp Powder	6-18-1	127	1
		Pressing & Assy	6-19	330	3
		Ready Magazine	6-25	120	1
		M2A2 Assy	6-34-2	12820	10
		Assy & Line Office	6-34-3	13060	10
		Ammo Quality Facility	6-35	1291	6
		General Purpose Magazine	6-68	596	5
		Lead Azide or Nol PLT	6-87	946	5
		Lead Azide Processing	6-88	1819	6
		Lead Azide or Nol PLT	6-90	963	5
		Ammo Quality Facility	6-94	337	3
		Pellet Storage	6-96	120	1
		Test Fire	6-97	1995	6
		Dry M61	6-98	230	1
Line 9	Line 9 was built as a production facility in 1942 and produced mine and mine fuzes during the Vietnam Conflict. The line operated	Magazine	9-62	120	1
		Flamm Material Bldg	9-64	204	1

Table 17.1
Proposed Borings Summary

Area	Area Description	Previous Building	Building Number	Area (sf)	Number of Proposed Borings*
	as a LAP facility. The Line was moved into modified caretaker status before being torn down in 2010. Chemicals of concern are metals.				
Line 800	Line 800 operated from 1943 to 1955 in ammunition renovation. The line operated from 1943 to 1955. Subsequently the line was used as a small detonator assembly facility. Chemicals of concern are explosives and metals.	Solvent Storage	800-03	120	1
		Solvent Storage	800-03-2	373	3
		Ready Magazine	800-08	288	1
		Ready Magazine	800-16	120	1
		Ind Waste Treatment	800-70-1	115	1
		Ind Waste Treatment	800-70-2	2000	6
		Blank Assy	800-192	6140	7
		Rec Platform F/Explo	800-193	800	5
Other		Ready Magazine (after RCRA closure received)	BG-12	440	5
		Ammo Demolition Facility (EWI)	BG-199-1	1133	6
		Contaminated Waste Processor	BG-199-2	4000	6
		Ammunition Storage	H-6	192	1
		Ammunition Storage	H-7	192	1
		Ammunition Storage	H-8	192	1
		Ammunition Storage	H-9	192	1
		Solvent Storage	L-03-1	400	5
		Ready Magazine	5B-21	120	1

QAPP Worksheet #17, Cont'd

Table 17.1
Proposed Borings Summary

Area	Area Description	Previous Building	Building Number	Area (sf)	Number of Proposed Borings*
		Bottle Gas Storage	500-143-2	253	1
		Gas Storage Shelter	500-143-3	152	1
		Acid Storage	500-143-4	271	1
		Bottle Gas Storage	500-206-1	88	1
		Central Test Facility (AET Tenants)	600-84	5014	7
		Filter Plant Facility	700-186-1	2000	6
		Explosive Storage Magazine	800-68	575	5
		Ammo Demo Facility	900-194-8	537	5
		Billet Splitter Bldg	900-198-2	100	1
		Ammo Demolition Facility	900-199-2	528	5

*Two subsurface soil samples will be collected from each boring; one between 2 and 5 feet below the building foundation and one between 4 and 10 feet below the building foundation, if groundwater is not encountered. Soil samples will only be collected within the vadose zone beneath the buildings.

Buildings in Area 3A are included under Optional Task 3A, and buildings listed under "Other Location" are included under Optional Task 3B.

cy = cubic yards
LAP = load, assemble, and pack
mg/kg = milligrams per kilogram
PAH = polynuclear aromatic hydrocarbon
RCRA = Resource Conservation and Recovery Act

QAPP Worksheet #17, Cont'd

Table 17.2
Soil Remediation Goals Based on Ingestion/Dermal Contact

Contaminant Type	Chemical of Concern	OU-1 ROD RG at 10^{-6} Risk Level Based on Ingestion/Dermal Contact (mg/kg)
PAH	Benzo(a)anthracene	8.1
	Benzo(a)pyrene	0.81
	Benzo(b)fluoranthene	8.1
	Dibenzo(a,h)anthracene	0.81
Explosive	1,3,5-Trinitrobenzene	102
	2,4-Dinitrotoluene	8.7
	2,4,6-Trinitrotoluene	196[3]
	RDX	53[3]
	HMX	51,000
Metal	Antimony	816
	Arsenic	30
	Beryllium	5
	Cadmium	1,000
	Chromium VI	10,000
	Lead[1]	1,000
	Thallium	143
PCB	Total PCBs[2]	10

[1] RG for lead is determined based on the PRG Screen Model rather than carcinogenic risk.

[2] RG for PCB is based on USEPA OSWER Directive 9355.4-01, "Guidance on Remedial Actions for Superfund Sites with PCB Contamination." PCBs were not identified as potential chemicals of concern in soil for the demolished buildings of this project.

[3] See Table 17.3

mg/kg - milligrams per kilogram
PAH - polynuclear aromatic hydrocarbon
PCB - polychlorinated biphenyl
RG - Remediation Goal

In addition to risk-based soil RGs for protection of human health, impact to groundwater from residual soil contamination was evaluated using the Summer's model to determine acceptable levels for explosives COCs in soils (RDX and TNT), major contributing explosives which were found in on- and off-site groundwater. The model was not used for metals because metals are relatively immobile in the clay soils found at the IAAAP, and there are also no Summers' model limits for SVOCs.

Table 17.3
Soil Remediation Goals Based on Soil Leaching

Contaminant Type	Chemical of Concern	OU-1 ROD RG at 10-6 Risk Level Based on Ingestion/Dermal Contact (mg/kg)
Explosive	RDX	1.3
	2,4,6-Trinitrotoluene	47.6

In accordance with the OU1 ROD, subsurface contaminants will be delineated using the RGs listed in Tables 17.2 and 17.3, and using industrial RSLs with a target risk of 1^{-6}, for constituents which are not specified in the tables. Samples will not be evaluated for ecological risk because the depth of exposure for the Indiana Bat is one ft and all subsurface soil samples will be collected from below this depth. The IAAAP is a military installation with industrial land use where groundwater is not being used as a potable source by workers nor is it expected to be used for such purposes in the foreseeable future. Potential direct contact with soil is the more plausible exposure scenario for a worker (USACE, 2019).

Boring Installation and Soil Sampling

Borings will be advanced to collect subsurface soil samples that are representative of the subsurface beneath former buildings, and biased toward historically detected contaminants or observed potential contamination in soil cores. Actual boring locations and sample depths will be selected in the field, based on boring logs and site observations (e.g., actual building footer depth; observed staining or odor to soil; actual footprint boundary). Where no known contamination adjacent to the building has been identified, borings will be advanced in the center of the former building footprint (for buildings with footprints less than 300 square ft) or evenly spaced within the building footprint (each boring representing approximately 20 % of the footprint area of buildings with footprints greater than 300 square ft).

Building footprint locations are shown on Figures 3 through 9. The area of each structure (in square ft) and proposed number of borings per building is summarized with building history in Table 17.1. For structures that were not shown on available maps or provided in available documentation, USACE historical files were viewed to identify approximate locations. Two soil samples will be collected from each boring. Sample depths are anticipated to be within the 10 ft below the base of each building foundation, and will be based on available information and the observed interface between backfill and native soil. Available information indicates that the average building foundation depth at IAAAP is 15 ft bgs, and that some building foundations are approximately 30 ft bgs. It is expected that the smaller buildings (e.g., vacuum houses, wash facilities) extended to approximately 4 ft bgs. This information will be used with drilling observations to confirm the former foundation depth of each structure and to evaluate native soil beneath the former structure.

A global positioning system unit will be used to locate and stake each building footprint and the proposed boring location(s) within the footprint. A hydraulic probe drilling rig will be used to blind drill to the approximate depth of foundation. The boring will then be advanced with continuous sampling to log and screen soils using a PID for collection of two soil samples, one at the depth most likely to be contaminated (e.g., elevated PID readings [sustained readings above background], noticeable staining, noticeable odor, unusual/transmissive grain pattern), and one approximately 2 to 5 ft below this depth. If there is no evidence of impacted soil, the first sample will be collected within the 2 ft below the base of the former building foundation, and the second sample will be collected 2 to 5 ft below the first sample. The actual depth of each sample will be determined in the field. Estimated sample depths and quantities are included in Worksheet #18. After soil samples have been collected, the boring will be backfilled using a bentonite/grout slurry.

Table 18-1 provides the sample Quality Assurance (QA)/QC, matrix, number of samples to be collected, and the sampling SOP reference, as applicable. Soil results will be compared to RGs and industrial RSLs for constituents not specified in the ROD for contaminant delineation.

Sample collection will begin at the smaller buildings (less than 300 square ft), where no known contamination was historically established and one boring is initially proposed. As fieldwork continues and data become available, additional borings may be advanced within the smaller building footprints to delineate identified contamination, as necessary.

Historical information relative to previous sampling and excavation is summarized below, with a rationale for the proposed sampling approach at each building. VOCs were not identified as contaminants of concern at any of the IAAAP Lines. However, soil will be screened using a PID, and if elevated readings (sustained readings above background) are recorded, then the sample will also be analyzed for VOCs.

Sampling Rationale

Line 2:

Subsurface soil samples will be collected for PAH, explosives, and metals analysis. These contaminants were identified in the OU1 IROD and in investigations and removal actions at Line 2. Samples will be analyzed for VOCs if elevated PID readings (sustained readings above background), staining, or odors are observed during collection of soil samples. Borings will be advanced to approximately 10 ft below the base of each former structure, and two soil samples will be collected from each boring. Sampling will be conducted to delineate vertical and horizontal extent of contaminated soil, if present.

MAGAZINES - EXPLOSIVES STORAGE

- **2-06-1:** Explosives magazine occupying approximately 1,440 square ft.
- **2-06-2:** Explosives magazine occupying approximately 1,440 square ft.
- **2-08-1:** Explosives magazine occupying approximately 1,440 square ft.
- **2-08-2:** Explosives magazine occupying approximately 1,440 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Buildings 2-06-1, 2-06-2, 2-08-1, and 2-08-2 as explosives magazines, and because PAHs, explosives and/or metals have been detected in soil sampled around the buildings, 12 borings will be advanced within each of these building footprint with subsurface soil samples collected and analyzed for the potential presence of PAH, explosives, and metals contamination. The borings will be evenly spaced within the building footprints because outside contaminants were identified only to depths of 2 ft bgs, and the footers of the buildings are expected to be deeper than 2 ft bgs.

EXPLOSIVES TREATMENT

- **2-50:** Explosives treatment area occupying approximately 2,662 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Building 2-50 for explosives treatment, and because PAHs, explosives and/or metals have been detected in soil sampled around the buildings, 12 borings will be advanced within each of these building footprint with subsurface soil samples collected and analyzed for the potential presence of PAH, explosives, and metals contamination. The borings will be evenly spaced within the building footprints because outside contaminants were identified only to a depth of 2 ft bgs, and the footer of the building is expected to be deeper than 2 ft bgs.

VACUUM HOUSES

- **2-99-1 through 2-99-8:** Vacuum houses occupying approximately 100 square ft each.

Because there may have been leaks and/or spills to the subsurface during past use of Buildings 2-99-1 through 2-99-8 for vacuum houses, but no known contamination was identified immediately outside the buildings during historical investigations, one boring will be advanced within the central portion of each of the building footprints with soil samples collected and analyzed for the potential presence of PAHs, explosives, and metals (contaminants identified in Line 2 soils). If data indicate subsurface contamination is present, borings may be advanced to collect additional samples as needed to delineate the identified contamination.

AMMUNITIONS WASH FACILITIES

- **2-140-2:** Ammunitions wash facility occupying approximately 82 square ft.
- **2-140-7 and 2-140-8:** Ammunitions wash facility occupying approximately 96 square ft.
- **2-140-8:** Ammunitions wash facility occupying approximately 96 square ft.
- **2-140-10:** Ammunitions wash facility occupying approximately 325 square ft.
- **2-140-11:** Ammunitions wash facility occupying approximately 203 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Buildings 2-140-2, 2-140-7 and 2-140-8, and 2-140-10 and 2-140-11, but no known contamination was identified immediately outside the buildings during historical investigations, one boring will be advanced within the central portion of each of the building footprints with soil samples collected and analyzed for the potential presence of PAHs, explosives, and metals (contaminants identified in Line 2 soils). Stepout samples may be collected dependent on analytical results.

OTHER

2-169-7: Transformer on platform occupying approximately 100 square ft. This structure was not located on figures provided, but two former transformer locations were identified on historic maps and are shown on Figure 2. Borings will be advanced at both former transformer locations unless additional information becomes available.

Because there may have been leaks and/or spills to the subsurface during past use of Building 2-169-7, but no known contamination was identified during historical investigations, one boring will be advanced within the central portion of the transformer pad location with soil samples collected and analyzed for the potential presence of PAHs, explosives, and metals. Stepout samples may be collected dependent on analytical results.

Line 3:

Subsurface soil samples will be collected for PAH, explosives, and metals analysis. These contaminants were identified in the OU1 IROD and in investigations and removal actions at Line 3. Samples will be analyzed for VOCs if elevated PID readings (sustained readings above background), staining, or odors are observed during collection of soil samples. Borings will be advanced to approximately 10 ft below the base of each former structure, and two soil samples will be collected from each boring. Sampling will be conducted to delineate vertical and horizontal extent of contaminated soil, if present.

MELT LOAD

- **3-05-2:** Melt loading area occupying approximately 27,372 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Building 3-05-2 for melt loading, and explosives and metals contamination was identified outside the building, 15 borings will be advanced within the building footprint with soil samples collected and analyzed for the potential presence of PAHs, explosives, and metals (contaminants identified in Line 3 soils). Borings will be placed evenly within the building footprint to fully evaluate the subsurface.

WASTE TREATMENT

- **3-70-3:** Industrial waste treatment (carbon column) area occupying approximately 1,068 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Building 3-70-3 for waste treatment, and explosives and metals contamination was identified outside the building, 6 borings will be advanced within the building footprint with soil samples collected and analyzed for the potential presence of PAHs, explosives, and metals (contaminants identified in Line 3 soils). Borings will be placed evenly within the building footprint to fully evaluate the subsurface.

- **3-163-1:** Industrial waste treatment area occupying approximately 66.9 square ft.

- **3-163-2:** Industrial waste treatment area occupying approximately 285.6 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Buildings 3-163-1 and 3-163-2, but only copper detected on samples at concentrations exceeding ecological screening levels was identified as a contaminant in removed soil, one boring will be advanced within the central portion of each of the building footprints with soil samples collected and analyzed for the potential presence of PAHs, explosives, and metals (contaminants identified in Line 3 soils). Stepout samples may be collected dependent on analytical results.

VACUUM HOUSES

- **3-99-1:** Vacuum house occupying approximately 100 square ft.
- **3-99-2:** Vacuum house occupying approximately 100 square ft.
- **3-99-5:** Vacuum house occupying approximately 100 square ft.
- **3-99-6:** Vacuum house occupying approximately 100 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Buildings 3-99-1, 3-99-2, 3-99-5, and 3-99-6, but contaminated soil (since removed) was identified only to 1.5 ft bgs around two of the vacuum buildings, one boring will be advanced within the central portion of each of the building footprints with soil samples collected and analyzed for the potential presence of PAHs, explosives, and metals (contaminants identified in Line 3 soils). Stepout samples may be collected dependent on analytical results.

Line 3A

Subsurface soil samples will be collected for explosives and metals analysis. These contaminants were identified in the OU1 IROD and in investigations and removal actions at Line 3A. Samples will be analyzed for VOCs if elevated PID readings (sustained readings above background), staining, or odors are observed during collection of soil samples. Borings will be advanced to approximately 10 ft below the base of each former structure, and two soil samples will be collected from each boring. Sampling will be conducted to delineate vertical and horizontal extent of contaminated soil, if present.

SOLVENTS/EXPLOSIVES STORAGE

- **3A-03-1:** Solvent storage area occupying approximately 983 square ft.
- **3A-03-2:** Explosives storage area occupying approximately 983 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of the buildings for storage, but no known contamination was identified immediately outside the building during historical investigations, 5 borings will be advanced at evenly spaced locations throughout the building footprints with soil samples collected and analyzed for the potential presence of explosives and metals (contaminants identified in Line 3A soils).

MELT LOAD

- **3A-05-1:** Melt loading area occupying approximately 19,269 square ft.

- **3A-05-2:** Melt loading area occupying approximately 18,629 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Buildings 3A-05-1 and 3A-05-2 for melt loading, but no known contamination was identified immediately outside the buildings during historical investigations, 5 borings will be advanced at evenly spaced locations within the building footprints with soil samples collected and analyzed for the potential presence of explosives and metals (contaminants identified in Line 3A soils).

MAGAZINES

- **3A-06:** High explosives magazine occupying approximately 981 square ft.
- **3A-08-1:** Explosives magazine occupying approximately 981 square ft.
- **3A-08-2:** Explosives magazine occupying approximately 981 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Buildings 3A-05-1 and 3A-05-2 for melt loading, but no known contamination was identified immediately outside the buildings during historical investigations. Five borings will be advanced at evenly spaced locations within the building footprints with soil samples collected and analyzed for potential presence of explosives and metals (contaminants identified in Line 3A soils).

EXPLOSIVES DRILLING

- **3A-10-5:** Explosives drilling building occupying approximately 1,420 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of the Building 3A-10-5 explosives drilling, but no known contamination was identified immediately outside the building during historical investigations, 6 borings will be advanced at evenly spaced locations throughout the building footprints with soil samples collected and analyzed for the potential presence of explosives and metals (contaminants identified in Line 3A soils).

EXPLOSIVES ASSEMBLY

- **3A-20-1:** Assembly building occupying approximately 10,774 square ft.
- **3A-20-2:** Assembly building occupying approximately 10,354 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Buildings 3A-20-1 and 3A-20-2 for explosives drilling, assembly, and screening, but no known contamination was identified immediately outside the buildings during historical investigations, 5 borings will be advanced at evenly spaced locations within the building footprints with soil samples collected and analyzed for the potential presence of explosives and metals (contaminants identified in Line 3A soils).

EXPLOSIVES SCREENING

- **3A-50-1: Explosives screening area occupying approximately 3,315 square ft**.

Because there may have been leaks and/or spills to the subsurface during past use of Buildings 3A-50-1 for explosives screening but no known contamination was identified immediately outside the building during historical investigations, 6 borings will be advanced at evenly spaced locations within the building footprints with soil samples collected and analyzed for the potential presence of explosives and metals (contaminants identified in Line 3A soils).

VACUUM HOUSES

- **3A-99-1:** Vacuum House occupying approximately 100 square ft.
- **3A-99-2:** Vacuum House occupying approximately 100 square ft.
- **3A-99-7:** Vacuum House occupying approximately 100 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Buildings 3A-99-1, 3A-99-2, and 3A-99-7, but no known contamination was identified immediately outside the buildings during historical investigations, one boring will be advanced within the central portion of each of the building footprints with soil samples collected and analyzed for the potential presence of explosives and metals (contaminants identified in Line 3A soils). Stepout samples may be collected dependent on analytical results.

- **3A-99-8:** Vacuum House occupying approximately 672 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Buildings 3A-99-8 as a vacuum house, but no known contamination was identified immediately outside the building, 5 borings will be advanced at evenly spaced locations within the building footprints with soil samples collected and analyzed for the potential presence of explosives and metals (contaminants identified in Line 3A soils).

AMMUNITION WASH FACILITIES/SUMPS

- **3A-140-2:** Ammunitions wash facility occupying approximately 100 square ft.
- **3A-140-3:** Sump house occupying approximately 54 square ft.
- **3A-140-4:** Ammunitions wash facility (only concrete remains) occupying approximately 54 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Buildings 3A-140-2, 3A-140-3, and 3A-140-4, but the footprints are relatively small and known contamination around the buildings has been removed, one boring will be advanced within the central portion of each of the building footprints with soil samples collected and analyzed for the potential presence of explosives and metals (contaminants identified in Line 3A soils). Stepout samples may be collected dependent on analytical results.

OTHER:

- **3A-100**: X-ray building occupying approximately 4,231 square ft. Sample information is not available for this x-ray building.

Because there may have been leaks and/or spills to the subsurface during past use of Building 3A-100, but no known contamination was identified immediately outside the buildings during historical investigations, 12 borings will be advanced within the building footprint with subsurface soil samples collected and analyzed for the potential presence of explosives and metals contamination.

Lines 5A/5B

Subsurface soil samples will be collected for explosives and metals analysis. These contaminants were identified in the OU1 IROD and in investigations and removal actions at Lines 5A/5B. Samples will be analyzed for VOCs if elevated PID readings (sustained readings above background), staining, or odors are observed during collection of soil samples. Borings will be advanced to approximately 10 ft below the base of each former structure, and two soil samples will be collected from each boring. Sampling will be conducted to delineate vertical and horizontal extent of contaminated soil, if present.

MATERIALS STORAGE/SCREENING/ASSEMBLY

- **5A-21:** Solvent storage area occupying approximately 120 square ft.
- **5A-25:** Explosives storage area occupying approximately 120 square ft.
- **5A-99-1:** High explosives magazine occupying approximately 100 square ft.
- **5A-99-2:** Explosives magazine occupying approximately 100 square ft.
- **5A-140-2:** Explosives magazine occupying approximately 141 square ft.
- **5B-03-3:** Assembly building occupying approximately 69 square ft.
- **5B-99-1:** Explosives screening area occupying approximately 100 square ft.
- **5B-99-2:** Explosives screening area occupying approximately 100 square ft.
- **5B-140-1:** Explosives screening area occupying approximately 141 square ft.
- **5B-140-2:** Explosives screening area occupying approximately 107 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of these storage/screening/assembly units, and contaminated soils at this line were not detected below 2 ft bgs (metals) and 4 ft bgs (metals), one boring will be advanced within the central portion of the building footprints with soil samples collected and analyzed for the potential presence explosives and metals (contaminants identified in Lines 5A and5B soils). Stepout samples may be collected dependent on analytical results.

- **5A-28:** Melt loading area occupying approximately 4,017 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Building 5A-28 for melt loading, 6 borings will be advanced within the building footprint with soil samples collected and analyzed for the potential presence of explosives and metals (contaminants identified in Lines 5A and 5B soils). Borings will be placed evenly within the building footprint to fully evaluate the subsurface.

- **5A-29:** Melt loading area occupying approximately 13,986 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Building 5A-29 for melt loading, 10 borings will be advanced within the building footprint with soil samples collected and analyzed for the potential presence of explosives and metals (contaminants identified in Lines 5A and 5B3 soils). Borings will be placed evenly within the building footprint to fully evaluate the subsurface.

- **5A-140-3:** Explosives drilling building occupying approximately 944 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Building 5A-140-3 for explosives drilling, 5 borings will be advanced within the building footprint with soil samples collected and analyzed for the potential presence of explosives and metals (contaminants identified in Lines 5A and 5B soils). Borings will be placed evenly within the building footprint to fully evaluate the subsurface.

- **5B-26:** Assembly building occupying approximately 960 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Building 5B-26 for assembly, 5 borings will be advanced within the building footprint with soil samples collected and analyzed for the potential presence of explosives and metals (contaminants identified in Lines 5A and 5B soils). Borings will be placed evenly within the building footprint to fully evaluate the subsurface

- **5B-140-3:** Explosives screening area occupying approximately 944 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Building 5B-140-3 for explosives screening, 5 borings will be advanced within the building footprint with soil samples collected and analyzed for the potential presence of explosives and metals (contaminants identified in Lines 5A and 5B soils). Borings will be placed evenly within the building footprint to fully evaluate the subsurface.

Line 6:

Subsurface soil samples will be collected for explosives, and metals analysis. These contaminants were identified in the OU1 IROD and in investigations and removal actions at Line 6. Samples will be analyzed for VOCs if elevated PID readings (sustained readings above background), staining, or odors are observed during collection of soil samples. Borings will be advanced to approximately 10 ft below the base of each former structure, and two soil samples will be collected from each boring. Sampling will be conducted to delineate vertical and horizontal extent of contaminated soil, if present.

EXPLOSIVES STORAGE, LOADING, SCREENING

- **6-18-1:** Explosives storage area occupying approximately 127 square ft.
- **6-25:** Melt loading area occupying approximately 120 square ft.
- **6-96:** Explosives screening area occupying approximately 120 square ft.
- **6-98:** Explosives screening area occupying approximately 230 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Buildings 6-18-1, 6-25, 6-96, and 6-98 for explosives storage, loading and/or screening, but only limited lead- and mercury-impacted soil at shallow depths were identified immediately outside the buildings during historical investigations, one boring will be advanced within the central portion of the building footprints, and soil samples will be collected and analyzed for the potential presence of explosives and metals (contaminants identified in Line 6 soils). Stepout samples may be collected dependent on analytical results.

- **6-19:** Melt loading area occupying approximately 330 square ft.
- **6-34-2**: High explosives magazine occupying approximately 12,820 square ft.
- **6-68**: Explosives drilling building occupying approximately 596 square ft.
- **6-11**: Solvent storage area occupying approximately 519 square ft.
- **6-34-3**: Explosives magazine occupying approximately 13,060 square ft.
- **6-35**: Explosives magazine occupying approximately 1,291 square ft.
- **6-87**: Assembly building occupying approximately 946 square ft.
- **6-88**: Assembly building occupying approximately 1,819 square ft.
- **6-90**: Explosives screening area occupying approximately 963 square ft.
- **6-94**: Explosives screening area occupying approximately 337 square ft.
- **6-97**: Explosives screening area occupying approximately 1,995 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of the above listed buildings, but no or limited shallow depth contamination was identified immediately outside the buildings during historical investigations, between three and ten borings will be advanced within the central portion of the building footprints with soil samples collected and analyzed for the potential presence of explosives and metals (contaminants identified in Line 6 soils). The borings will be evenly spaced within the building footprints.

Line 9:

- **9-62:** Magazine area occupying approximately 120 square ft.
- **9-64:** Flammable material building area occupying approximately 204 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of these two storage buildings at Line 9, and only metals contamination has been identified at this Line, one boring will be advanced within the central portion of the building footprints with soil samples collected and analyzed for the potential presence of metals. Stepout samples may be collected dependent on analytical results.

Line 800 (Optional Task 3A):

SOLVENT STORAGE AND MAGAZINES

- **800-03:** Solvent storage area occupying approximately 120 square ft.
- **800-03-2:** Solvent storage area occupying approximately 373 square ft.
- **800-08:** Ready magazine area occupying approximately 288 square ft.
- **800-16:** Ready magazine area occupying approximately 120 square ft.
- **800-70-1:** Industrial waste treatment area occupying approximately 115 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of these storage units, but only limited metals contamination is associated with historical samples collected in these areas, one boring will be advanced within the central portion of the building footprints with soil samples collected and analyzed for the potential presence of explosives and metals (contaminants identified in Line 800 soils). Stepout samples may be collected dependent on analytical results.

MISCELLANEOUS STRUCTURES

- **800-70-2**: Industrial waste treatment area occupying approximately 2,000 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of the building, but no known contamination was identified immediately outside the building during historical investigations, six borings will be advanced at evenly spaced locations throughout the Building 800-70-2 footprint with soil samples collected and analyzed for the potential presence of explosives and metals (contaminants identified in Line 800 soils).

- **800-192:** Blank assay area occupying approximately 6,140 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Building 800-192 for blank assay, and because explosives have been detected in soil sampled around the buildings, 7 borings will be advanced within each the building footprint, with two initial borings placed on the south side of the building where soil was removed to a depth of 3.5 ft bgs to remove RDX-impacted soil. The remaining borings will be evenly spaced throughout the rest of the building footprint. Subsurface soil samples will be collected and analyzed for the potential presence of explosives and metals contamination.

- **800-193:** Receiving platform f/explosives area occupying approximately 800 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of the building, and metals contamination was detected in soil to 3 ft bgs in the building area during historical sampling, five borings will be advanced at evenly spaced locations throughout the Building 800-193 footprint with soil samples collected and analyzed for the potential presence of explosives and metals (contaminants identified in Line 800 soils).

Other Building Footprints (Optional Task 3B):

- **BG-12:** Ready magazine (post-RCRA closure) area occupying approximately 440 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Building BG-12 for a ready magazine, 5 borings will be advanced within the building footprint with soil samples collected and analyzed for the potential presence of explosives and metals analysis. Borings will be placed evenly within the building footprint to fully evaluate the subsurface.

- **BG-199-1:** Ammunition demolition facility (EW1) occupying approximately 1,133 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Building BG-199-1 for a ready magazine, 5 borings will be advanced within the building footprint with soil samples collected and analyzed for the potential presence of explosives and metals analysis. Borings will be placed evenly within the building footprint to fully evaluate the subsurface.

- **BG-199-2:** Contaminated waste processor area occupying approximately 4,000 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Building BG-199-2 for a ready magazine, 6 borings will be advanced within the building footprint with soil samples collected and analyzed for the potential presence of explosives and metals analysis. Borings will be placed evenly within the building footprint to fully evaluate the subsurface.

- **H-6:** Ammunition storage area occupying approximately 192 square ft.
- **H-7:** Ammunition storage area occupying approximately 192 square ft.
- **H-8:** Ammunition storage area occupying approximately 192 square ft.
- **H-9:** Ammunition storage area occupying approximately 192 square ft.
- **L-03-1:** Solvent storage area occupying approximately 400 square ft.
- **5B-21:** Ready magazine located within Line 5B and occupying approximately 120 square ft.
- **500-143-2:** Bottle gas storage area occupying approximately 253 square ft.
- **500-143-3:** Gas storage shelter area occupying approximately 152 square ft.
- **500-143-4:** Acid storage area occupying approximately 271 square ft.
- **500-206-1:** Bottle gas storage area occupying approximately 88 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of these storage units, but no contamination is associated with historical samples collected in these areas, one boring will be advanced within the central portion of the building footprints with soil samples collected and analyzed for the potential presence of explosives and metals. Stepout samples may be collected dependent on analytical results.

- **600-84:** Central test facility (AET tenants) area occupying approximately 5,014 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Building 600-84 for a test facility, 7 borings will be advanced within the building footprint with soil samples collected and analyzed for the potential presence of explosives and metals analysis. Borings will be placed evenly within the building footprint to fully evaluate the subsurface.

- **700-186-1:** Filter plant facility area occupying approximately 2,000 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Building 700-186-1 for a filter plant, 6 borings will be advanced within the building footprint with soil samples collected and analyzed for the potential presence of explosives and metals analysis. Borings will be placed evenly within the building footprint to fully evaluate the subsurface.

- **800-68:** Explosives storage magazine area occupying approximately 575 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Building 800-68 for an explosives storage magazine, 5 borings will be advanced within the building footprint with soil samples collected and analyzed for the potential presence of explosives and metals analysis. Borings will be placed evenly within the building footprint to fully evaluate the subsurface.

- **900-194-8:** Ammunition demolition facility area occupying approximately 537 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Building 900-194-8 for a filter plant, 5 borings will be advanced within the building footprint with soil samples collected and analyzed for the potential presence of explosives and metals analysis. Borings will be placed evenly within the building footprint to fully evaluate the subsurface.

- **900-198-2:** Billet splitter building area occupying approximately 100 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of the above structure, but no contamination is known in the site area, one boring will be advanced within the central portion of the building footprint. Soil samples will be collected and analyzed for the potential presence of explosives and metals. Stepout samples may be collected dependent on analytical results.

- **900-199-2:** Ammunition demolition facility area occupying approximately 528 square ft.

Because there may have been leaks and/or spills to the subsurface during past use of Building 900-199-2, 5 borings will be advanced within the building footprint with soil samples collected and analyzed for the potential presence of explosives and metals analysis. Borings will be placed evenly within the building footprint to fully evaluate the subsurface.

QAPP Worksheet #18
Sampling Locations and Methods/SOP Requirements Table

Soil samples collected from building footprints will be identified by the Site Name (IAAAP), Building identification number (e.g., 2-06-1), soil boring designation (e.g., SB01, SB02, SB03), sample depth (e.g., 16-18 for a sample collected at 16 to 18 ft bgs), and date of collection. The sample identification for a soil sample collected from the first boring advanced at building 2-06-1 at a depth of 3 to 5 ft on August 10, 2022, would be IAAAP-2-06-1-SB01 (3-5)-8/10/22. The sample information will be recorded in a logbook in accordance with SOPs. Initially 726 primary soil samples will be collected from 363 borings. Table 18-1 provides the sample locations, matrix, number of samples to be collected, and the sampling SOP reference, as applicable. Additional stepout samples may be required based on review of the analytical results.

One field duplicate sample will be collected for every 10 soil samples, and matrix spike/matrix spike duplicate samples will be collected for every 20 soil samples. QA/QC samples will include field duplicates and matrix spike/matrix spike duplicate samples, and are detailed in Worksheet #20. The native for the field duplicates will not be identified in the sample identification (blind to the laboratory). Matrix spikes (MSs) will be designated using the sample identification followed by a dash and two letters (-MS for matrix spike, -MSD for matrix spike duplicate).

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Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
2-08-1	IAAAP-2-08-1-SB01-"depth1"-date IAAAP-2-08-1-SB01-"depth2"-date IAAAP-2-08-1-SB02-"depth1"-date IAAAP-2-08-1-SB02-"depth2"-date IAAAP-2-08-1-SB03-"depth1"-date IAAAP-2-08-1-SB03-"depth2"-date IAAAP-2-08-1-SB04-"depth1"-date IAAAP-2-08-1-SB04-"depth2"-date IAAAP-2-08-1-SB05-"depth1"-date IAAAP-2-08-1-SB05-"depth2"-date IAAAP-2-08-1-SB06-"depth1"-date IAAAP-2-08-1-SB06-"depth2"-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	PAHs, explosives, metals	12 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
2-08-2	IAAAP-2-08-2-SB01-"depth1"-date IAAAP-2-08-2-SB01-"depth2"-date IAAAP-2-08-2-SB02-"depth1"-date IAAAP-2-08-2-SB02-"depth2"-date IAAAP-2-08-2-SB03-"depth1"-date IAAAP-2-08-2-SB03-"depth2"-date IAAAP-2-08-2-SB04-"depth1"-date IAAAP-2-08-2-SB04-"depth2"-date IAAAP-2-08-2-SB05-"depth1"-date IAAAP-2-08-2-SB05-"depth2"-date IAAAP-2-08-2-SB06-"depth1"-date IAAAP-2-08-2-SB06-"depth2"-date				12 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
2-50	IAAAP-2-50-SB01-“depth1”-date IAAAP-2-50-SB01-“depth2”-date IAAAP-2-50-SB02-“depth1”-date IAAAP-2-50-SB02-“depth2”-date IAAAP-2-50-SB03-“depth1”-date IAAAP-2-50-SB03-“depth2”-date IAAAP-2-50-SB04-“depth1”-date IAAAP-2-50-SB04-“depth2”-date IAAAP-2-50-SB05-“depth1”-date IAAAP-2-50-SB05-“depth2”-date IAAAP-2-50-SB06-“depth1”-date IAAAP-2-50-SB06-“depth2”-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	PAHs, explosives, metals	12 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
2-99-1	IAAAP-2-99-1-SB01-“depth1”-date IAAAP-2-99-1-SB01-“depth2”-date				2 - soil samples		
2-99-2	IAAAP-2-99-2-SB01-“depth1”-date IAAAP-2-99-2-SB01-“depth2”-date				2- soil samples		
2-99-3	IAAAP-2-99-3-SB01-“depth1”-date IAAAP-2-99-3-SB01-“depth2”-date				2 - soil samples		
2-99-4	IAAAP-2-99-4-SB01-“depth1”-date IAAAP-2-99-4-SB01-“depth2”-date				2 - soil samples		
2-99-5	IAAAP-2-99-5-SB01-“depth1”-date IAAAP-2-99-5-SB01-“depth2”-date				2 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
2-99-6	IAAAP-2-99-6-SB01-"depth1"-date IAAAP-2-99-6-SB01-"depth2"-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	PAHs, explosives, metals	2 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
2-99-7	IAAAP-2-99-7-SB01-"depth1"-date IAAAP-2-99-7-SB01-"depth2"-date				2 - soil samples		
2-99-8	IAAAP-2-99-8-SB01-"depth1"-date IAAAP-2-99-8-SB01-"depth2"-date				2 - soil samples		
2-140-2	IAAAP-2-140-2-SB01-"depth1"-date IAAAP-2-140-2-SB01-"depth2"-date				2 - soil samples		
2-140-7	IAAAP-2-140-7-SB01-"depth1"-date IAAAP-2-140-7-SB01-"depth2"-date				2 - soil samples		
2-140-8	IAAAP-2-140-8-SB01-"depth1"-date IAAAP-2-140-8-SB01-"depth2"-date				2 - soil samples		
2-140-10	IAAAP-2-140-10-SB01-"depth1"-date IAAAP-2-140-10-SB01-"depth2"-date				2 - soil samples		
2-140-11	IAAAP-2-140-11-SB01-"depth1"-date IAAAP-2-140-11-SB01-"depth2"-date				2 - soil samples		
2-169-7	IAAAP-2-169-7-SB01-"depth1"-date IAAAP-2-169-7-SB01-"depth2"-date				2 - soil samples (note: 1 boring may be advanced at 2 potential locations and 4 samples collected if additional information does not become available.		
3-163-1	IAAAP-3-163-1-SB01-"depth1"-date IAAAP-3-163-1-SB01-"depth2"-date				2 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
3-05-2	IAAAP-3-05-2-SB01-“depth1”-date IAAAP-3-05-2-SB01-“depth2”-date IAAAP-3-05-2-SB02-“depth1”-date IAAAP-3-05-2-SB02-“depth2”-date IAAAP-3-05-2-SB03-“depth1”-date IAAAP-3-05-2-SB03-“depth2”-date IAAAP-3-05-2-SB04-“depth1”-date IAAAP-3-05-2-SB04-“depth2”-date IAAAP-3-05-2-SB05-“depth1”-date IAAAP-3-05-2-SB05-“depth2”-date IAAAP-3-05-2-SB06-“depth1”-date IAAAP-3-05-2-SB06-“depth2”-date IAAAP-3-05-2-SB07-“depth1”-date IAAAP-3-05-2-SB07-“depth2”-date IAAAP-3-05-2-SB08-“depth1”-date IAAAP-3-05-2-SB08-“depth2”-date IAAAP-3-05-2-SB09-“depth1”-date IAAAP-3-05-2-SB09-“depth2”-date IAAAP-3-05-2-SB10-“depth1”-date IAAAP-3-05-2-SB10-“depth2”-date IAAAP-3-05-2-SB11-“depth1”-date IAAAP-3-05-2-SB11-“depth2”-date IAAAP-3-05-2-SB12-“depth1”-date IAAAP-3-05-2-SB12-“depth2”-date IAAAP-3-05-2-SB13-“depth1”-date IAAAP-3-05-2-SB13-“depth2”-date IAAAP-3-05-2-SB14-“depth1”-date IAAAP-3-05-2-SB14-“depth2”-date IAAAP-3-05-2-SB15-“depth1”-date IAAAP-3-05-2-SB15-“depth2”-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	PAHs, explosives, metals	30 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
3-70-3	IAAAP-3-70-3-SB01-“depth1”-date IAAAP-3-70-3-SB01-“depth2”-date IAAAP-3-70-3-SB02-“depth1”-date IAAAP-3-70-3-SB02-“depth2”-date IAAAP-3-70-3-SB03-“depth1”-date IAAAP-3-70-3-SB03-“depth2”-date IAAAP-3-70-3-SB04-“depth1”-date IAAAP-3-70-3-SB04-“depth2”-date IAAAP-3-70-3-SB05-“depth1”-date IAAAP-3-70-3-SB05-“depth2”-date IAAAP-3-70-3-SB06-“depth1”-date IAAAP-3-70-3-SB06-“depth2”-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	PAHs, explosives, metals	12 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
3-163-2	IAAAP-3-163-2-SB01-“depth1”-date IAAAP-3-163-2-SB01-“depth2”-date				2 - soil samples		
3-99-1	IAAAP-3-99-1-SB01-“depth1”-date IAAAP-3-99-1-SB01-“depth2				2- soil samples		
3-99-2	IAAAP-3-99-2-SB01-“depth1”-date IAAAP-3-99-2-SB01-“depth2”-date				2 - soil samples		
3-99-5	IAAAP-3-99-5-SB01-“depth1”-date IAAAP-3-99-5-SB01-“depth2”-date				2 - soil samples		
3-99-6	IAAAP-3-99-6-SB01-“depth1”-date IAAAP-3-99-6-SB01-“depth2”-date				2 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
3A-20-1	IAAAP-3A-20-1-SB01-“depth1”-date IAAAP-3A-20-1-SB01-“depth2”-date IAAAP-3A-20-1-SB02-“depth1”-date IAAAP-3A-20-1-SB02-“depth2”-date IAAAP-3A-20-1-SB03-“depth1”-date IAAAP-3A-20-1-SB03-“depth2”-date IAAAP-3A-20-1-SB04-“depth1”-date IAAAP-3A-20-1-SB04-“depth2”-date IAAAP-3A-20-1-SB05-“depth1”-date IAAAP-3A-20-1-SB05-“depth2”-date IAAAP-3A-20-1-SB06-“depth1”-date IAAAP-3A-20-1-SB06-“depth2”-date IAAAP-3A-20-1-SB07-“depth1”-date IAAAP-3A-20-1-SB07-“depth2”-date IAAAP-3A-20-1-SB08-“depth1”-date IAAAP-3A-20-1-SB08-“depth2”-date IAAAP-3A-20-1-SB09-“depth1”-date IAAAP-3A-20-1-SB09-“depth2”-date IAAAP-3A-20-1-SB10-“depth1 IAAAP-3A-20-1-SB10-“depth2”-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	explosives, metals	20 samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
3A-20-2	IAAAP-3A-20-2-SB01-“depth1”-date IAAAP-3A-20-2-SB01-“depth2”-date IAAAP-3A-20-2-SB02-“depth1”-date IAAAP-3A-20-2-SB02-“depth2”-date IAAAP-3A-20-2-SB03-“depth1”-date IAAAP-3A-20-2-SB03-“depth2”-date IAAAP-3A-20-2-SB04-“depth1”-date IAAAP-3A-20-2-SB04-“depth2”-date IAAAP-3A-20-2-SB05-“depth1”-date IAAAP-3A-20-2-SB05-“depth2”-date IAAAP-3A-20-2-SB06-“depth1”-date IAAAP-3A-20-2-SB06-“depth2”-date IAAAP-3A-20-2-SB07-“depth1”-date IAAAP-3A-20-2-SB07-“depth2”-date IAAAP-3A-20-2-SB08-“depth1”-date IAAAP-3A-20-2-SB08-“depth2”-date IAAAP-3A-20-2-SB09-“depth1”-date IAAAP-3A-20-2-SB09-“depth2”-date IAAAP-3A-20-2-SB10-“depth1”-date IAAAP-3A-20-2-SB10-“depth2”-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	explosives, metals	20 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
3A-03-1	IAAAP-3A-03-1-SB01-“depth1”-date IAAAP-3A-03-1-SB01-“depth2”-date IAAAP-3A-03-1-SB02-“depth1”-date IAAAP-3A-03-1-SB02-“depth2”-date IAAAP-3A-03-1-SB03-“depth1”-date IAAAP-3A-03-1-SB03-“depth2”-date IAAAP-3A-03-1-SB04-“depth1”-date IAAAP-3A-03-1-SB04-“depth2”-date IAAAP-3A-03-1-SB05-“depth1”-date IAAAP-3A-03-1-SB05-“depth2”-date				10 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
3A-03-2	IAAAP-3A-03-2-SB01-“depth1”-date IAAAP-3A-03-2-SB01-“depth2”-date IAAAP-3A-03-2-SB02-“depth1”-date IAAAP-3A-03-2-SB02-“depth2”-date IAAAP-3A-03-2-SB03-“depth1”-date IAAAP-3A-03-2-SB03-“depth2”-date IAAAP-3A-03-2-SB04-“depth1”-date IAAAP-3A-03-2-SB04-“depth2”-date IAAAP-3A-03-2-SB05-“depth1”-date IAAAP-3A-03-2-SB05-“depth2”-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	explosives, metals	10 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
3A-06	IAAAP-3A-06-SB01-“depth1”-date IAAAP-3A-06-SB01-“depth2”-date IAAAP-3A-06-SB02-“depth1”-date IAAAP-3A-06-SB02-“depth2”-date IAAAP-3A-06-SB03-“depth1”-date IAAAP-3A-06-SB03-“depth2”-date IAAAP-3A-06-SB04-“depth1”-date IAAAP-3A-06-SB04-“depth2”-date IAAAP-3A-06-SB05-“depth1”-date IAAAP-3A-06-SB05-“depth2”-date				10 - soil samples		
3A-08-1	IAAAP-3A-08-1-SB01-“depth1”-date IAAAP-3A-08-1-SB01-“depth2”-date IAAAP-3A-08-1-SB02-“depth1”-date IAAAP-3A-08-1-SB02-“depth2”-date IAAAP-3A-08-1-SB03-“depth1”-date IAAAP-3A-08-1-SB03-“depth2”-date IAAAP-3A-08-1-SB04-“depth1”-date IAAAP-3A-08-1-SB04-“depth2”-date IAAAP-3A-08-1-SB05-“depth1”-date IAAAP-3A-08-1-SB05-“depth2”-date				10 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
3A-05-1	IAAAP-3A-05-1-SB01-“depth1”-date IAAAP-3A-05-1-SB01-“depth2”-date IAAAP-3A-05-1-SB02-“depth1”-date IAAAP-3A-05-1-SB02-“depth2”-date IAAAP-3A-05-1-SB03-“depth1”-date IAAAP-3A-05-1-SB03-“depth2”-date IAAAP-3A-05-1-SB04-“depth1”-date IAAAP-3A-05-1-SB04-“depth2”-date IAAAP-3A-05-1-SB05-“depth1”-date IAAAP-3A-05-1-SB05-“depth2”-date IAAAP-3A-05-1-SB06-“depth1”-date IAAAP-3A-05-1-SB06-“depth2”-date IAAAP-3A-05-1-SB07-“depth1”-date IAAAP-3A-05-1-SB07-“depth2”-date IAAAP-3A-05-1-SB08-“depth1”-date IAAAP-3A-05-1-SB08-“depth2”-date IAAAP-3A-05-1-SB09-“depth1”-date IAAAP-3A-05-1-SB09-“depth2”-date IAAAP-3A-05-1-SB10-“depth1”-date IAAAP-3A-05-1-SB10-“depth2”-date IAAAP-3A-05-1-SB11-“depth1”-date IAAAP-3A-05-1-SB11-“depth2”-date IAAAP-3A-05-1-SB12-“depth1”-date IAAAP-3A-05-1-SB12-“depth2”-date IAAAP-3A-05-1-SB13-“depth1”-date IAAAP-3A-05-1-SB13-“depth2	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	explosives, metals	26 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
3A-05-2	IAAAP-3A-05-2-SB01-“depth1”-date IAAAP-3A-05-2-SB01-“depth2”-date IAAAP-3A-05-2-SB02-“depth1”-date IAAAP-3A-05-2-SB02-“depth2”-date IAAAP-3A-05-2-SB03-“depth1”-date IAAAP-3A-05-2-SB03-“depth2”-date IAAAP-3A-05-2-SB04-“depth1”-date IAAAP-3A-05-2-SB04-“depth2”-date IAAAP-3A-05-2-SB05-“depth1”-date IAAAP-3A-05-2-SB05-“depth2”-date IAAAP-3A-05-2-SB06-“depth1”-date IAAAP-3A-05-2-SB06-“depth2”-date IAAAP-3A-05-2-SB07-“depth1”-date IAAAP-3A-05-2-SB07-“depth2”-date IAAAP-3A-05-2-SB08-“depth1”-date IAAAP-3A-05-2-SB08-“depth2”-date IAAAP-3A-05-2-SB09-“depth1”-date IAAAP-3A-05-2-SB09-“depth2”-date IAAAP-3A-05-2-SB10-“depth1”-date IAAAP-3A-05-2-SB10-“depth2”-date IAAAP-3A-05-2-SB11-“depth1”-date IAAAP-3A-05-2-SB11-“depth2”-date IAAAP-3A-05-2-SB12-“depth1”-date IAAAP-3A-05-2-SB12-“depth2”-date IAAAP-3A-05-2-SB13-“depth1”-date IAAAP-3A-05-2-SB13-“depth2	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	explosives, metals	26- soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
3A-99-1	IAAAP-3A-99-1-SB01-“depth1”-date IAAAP-3A-99-1-SB01-“depth2”-date				2 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
3A-08-2	IAAAP-3A-08-2-SB01-“depth1”-date IAAAP-3A-08-2-SB01-“depth2”-date IAAAP-3A-08-2-SB02-“depth1”-date IAAAP-3A-08-2-SB02-“depth2”-date IAAAP-3A-08-2-SB03-“depth1”-date IAAAP-3A-08-2-SB03-“depth2”-date IAAAP-3A-08-2-SB04-“depth1”-date IAAAP-3A-08-2-SB04-“depth2”-date IAAAP-3A-08-2-SB05-“depth1”-date IAAAP-3A-08-2-SB05-“depth2”-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	explosives, metals	10 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
3A-10-5	IAAAP-3A-10-5-SB01-“depth1”-date IAAAP-3A-10-5-SB01-“depth2”-date IAAAP-3A-10-5-SB02-“depth1”-date IAAAP-3A-10-5-SB02-“depth2”-date IAAAP-3A-10-5-SB03-“depth1”-date IAAAP-3A-10-5-SB03-“depth2”-date IAAAP-3A-10-5-SB04-“depth1”-date IAAAP-3A-10-5-SB04-“depth2”-date IAAAP-3A-10-5-SB05-“depth1”-date IAAAP-3A-10-5-SB05-“depth2”-date IAAAP-3A-10-5-SB06-“depth1”-date IAAAP-3A-10-5-SB06-“depth2”-date				12 - soil samples		
3A-99-2	IAAAP-3A-99-2-SB01-“depth1”-date IAAAP-3A-99-2-SB01-“depth2”-date				2 - soil samples		
3A-99-7	IAAAP-3A-99-7-SB01-“depth1”-date IAAAP-3A-99-7-SB01-“depth2”-date				2 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
3A-50-1	IAAAP-3A-50-1-SB01-"depth1"-date IAAAP-3A-50-1-SB01-"depth2"-date IAAAP-3A-50-1-SB02-"depth1"-date IAAAP-3A-50-1-SB02-"depth2"-date IAAAP-3A-50-1-SB03-"depth1"-date IAAAP-3A-50-1-SB03-"depth2"-date IAAAP-3A-50-1-SB04-"depth1"-date IAAAP-3A-50-1-SB04-"depth2"-date IAAAP-3A-50-1-SB05-"depth1"-date IAAAP-3A-50-1-SB05-"depth2"-date IAAAP-3A-50-1-SB06-"depth1"-date IAAAP-3A-50-1-SB06-"depth2"-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	explosives, metals	12 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
3A-99-8	IAAAP-3A-99-8-SB01-"depth1"-date IAAAP-3A-99-8-SB01-"depth2"-date IAAAP-3A-99-8-SB02-"depth1"-date IAAAP-3A-99-8-SB02-"depth2"-date IAAAP-3A-99-8-SB03-"depth1"-date IAAAP-3A-99-8-SB03-"depth2"-date IAAAP-3A-99-8-SB04-"depth1"-date IAAAP-3A-99-8-SB04-"depth2"-date IAAAP-3A-99-8-SB05-"depth1"-date IAAAP-3A-99-8-SB05-"depth2"-date				10 - soil samples		
3A-140-2	IAAAP-3A-140-2-SB01-"depth1"-date IAAAP-3A-140-2-SB01-"depth2"-date				2 - soil samples		
3A-140-3	IAAAP-3A-140-3-SB01-"depth1"-date IAAAP-3A-140-3-SB01-"depth2"-date				2 - soil samples		
3A-140-4	IAAAP-3A-140-4-SB01-"depth1"-date IAAAP-3A-140-4-SB01-"depth2"-date				2 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
3A-100	IAAAP-3A-100-SB01-“depth1”-date IAAAP-3A-100-SB01-“depth2”-date IAAAP-3A-100-SB02-“depth1”-date IAAAP-3A-100-SB02-“depth2”-date IAAAP-3A-100-SB03-“depth1”-date IAAAP-3A-100-SB03-“depth2”-date IAAAP-3A-100-SB04-“depth1”-date IAAAP-3A-100-SB04-“depth2”-date IAAAP-3A-100-SB05-“depth1”-date IAAAP-3A-100-SB05-“depth2”-date IAAAP-3A-100-SB06-“depth1”-date IAAAP-3A-100-SB06-“depth2”-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	explosives, metals	12 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
5A-21	IAAAP-5A-21-SB01-“depth1”-date IAAAP-5A-21-SB01-“depth2”-date				2 - soil samples		
5A-25	IAAAP-5A-25-SB01-“depth1”-date IAAAP-5A-25-SB01-“depth2”-date				2 - soil samples		
5A-28	IAAAP-5A-28-SB01-“depth1”-date IAAAP-5A-28-SB01-“depth2”-date IAAAP-5A-28-SB02-“depth1”-date IAAAP-5A-28-SB02-“depth2”-date IAAAP-5A-28-SB03-“depth1”-date IAAAP-5A-28-SB03-“depth2”-date IAAAP-5A-28-SB04-“depth1”-date IAAAP-5A-28-SB04-“depth2”-date IAAAP-5A-28-SB05-“depth1”-date IAAAP-5A-28-SB05-“depth2”-date IAAAP-5A-28-SB06-“depth1”-date IAAAP-5A-28-SB06-“depth2”-date				12 - soil samples		
5A-99-1	IAAAP-5A-99-1-SB01-“depth1”-date IAAAP-5A-99-1-SB01-“depth2”-date				2 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
5A-140-3	IAAAP-5A-140-3-SB01-“depth1”-date IAAAP-5A-140-3-SB01-“depth2”-date IAAAP-5A-140-3-SB02-“depth1”-date IAAAP-5A-140-3-SB02-“depth2”-date IAAAP-5A-140-3-SB03-“depth1”-date IAAAP-5A-140-3-SB03-“depth2”-date IAAAP-5A-140-3-SB04-“depth1”-date IAAAP-5A-140-3-SB04-“depth2”-date IAAAP-5A-140-3-SB05-“depth1”-date IAAAP-5A-140-3-SB05-“depth2”-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	explosives, metals	10 soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
5A-29	IAAAP-5A-29-SB01-“depth1”-date IAAAP-5A-29-SB01-“depth2”-date IAAAP-5A-29-SB02-“depth1”-date IAAAP-5A-29-SB02-“depth2”-date IAAAP-5A-29-SB03-“depth1”-date IAAAP-5A-29-SB03-“depth2”-date IAAAP-5A-29-SB04-“depth1”-date IAAAP-5A-29-SB04-“depth2”-date IAAAP-5A-29-SB05-“depth1”-date IAAAP-5A-29-SB05-“depth2”-date IAAAP-5A-29-SB06-“depth1”-date IAAAP-5A-29-SB06-“depth2”-date IAAAP-5A-29-SB07-“depth1”-date IAAAP-5A-29-SB07-“depth2”-date IAAAP-5A-29-SB08-“depth1”-date IAAAP-5A-29-SB08-“depth2”-date IAAAP-5A-29-SB09-“depth1”-date IAAAP-5A-29-SB09-“depth2”-date IAAAP-5A-29-SB10-“depth1”-date IAAAP-5A-29-SB10-“depth2”-date				20 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
5A-99-2	IAAAP-5A-99-2-SB01-"depth1"-date IAAAP-5A-99-2-SB01-"depth2"-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	explosives, metals	2 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
5A-140-2	IAAAP-5A-140-2-SB01-"depth1"-date IAAAP-5A-140-2-SB01-"depth2"-date				2 - soil samples		
5B-03-3	IAAAP-5B-03-3-SB01-"depth1"-date IAAAP-5B-03-3-SB01-"depth2"-date				2 - soil samples		
5B-5B-56	IAAAP-5B-56-SB01-"depth1"-date IAAAP-5B-56-SB01-"depth2"-date				2 - soil samples		
5B-26	IAAAP-5B-26-SB01-"depth1"-date IAAAP-5B-26-SB01-"depth2"-date IAAAP-5B-26-SB02-"depth1"-date IAAAP-5B-26-SB02-"depth2"-date IAAAP-5B-26-SB03-"depth1"-date IAAAP-5B-26-SB03-"depth2"-date IAAAP-5B-26-SB04-"depth1"-date IAAAP-5B-26-SB04-"depth2"-date IAAAP-5B-26-SB05-"depth1 & 2"-date				10 - soil samples		
5B-56	IAAAP-5B-56-SB01-"depth1"-date IAAAP-5B-56-SB01-"depth2"-date				2 - soil samples		
5B-99-1	IAAAP-5B-99-1-SB01-"depth1"-date IAAAP-5B-99-1-SB01-"depth2"-date				2 - soil samples		
5B-99-2	IAAAP-5B-99-2-SB01-"depth1"-date IAAAP-5B-99-2-SB01-"depth2"-date				2 - soil samples		
5B-140-1	IAAAP-5B-140-1-SB01-"depth1"-date IAAAP-5B-140-1-SB01-"depth2"-date				2 - soil samples		
5B-140-2	IAAAP-5B-140-2-SB01-"depth1"-date IAAAP-5B-140-2-SB01-"depth2"-date				2 - soil samples		
6-18-1	IAAAP-6-18-1-SB01-"depth1"-date IAAAP-6-18-1-SB01-"depth2"-date				2 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
5B-140-3	IAAAP-5B-140-3-SB01-"depth1"-date IAAAP-5B-140-3-SB01-"depth2"-date IAAAP-5B-140-3-SB02-"depth1"-date IAAAP-5B-140-3-SB02-"depth2"-date IAAAP-5B-140-3-SB03-"depth1"-date IAAAP-5B-140-3-SB03-"depth2"-date IAAAP-5B-140-3-SB04-"depth1"-date IAAAP-5B-140-3-SB04-"depth2"-date IAAAP-5B-140-3-SB05-"depth1"-date IAAAP-5B-140-3-SB05-"depth2"-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	explosives, metals	10 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
6-11	IAAAP-6-11-SB01-"depth1"-date IAAAP-6-11-SB01-"depth2"-date IAAAP-6-11-SB02-"depth1"-date IAAAP-6-11-SB02-"depth2"-date IAAAP-6-11-SB03-"depth1"-date IAAAP-6-11-SB03-"depth2"-date IAAAP-6-11-SB04-"depth1"-date IAAAP-6-11-SB04-"depth2"-date IAAAP-6-11-SB05-"depth1"-date IAAAP-6-11-SB05-"depth2"-date				10 - soil samples		
6-19	IAAAP-6-19-SB01-"depth1"-date IAAAP-6-19-SB01-"depth2"-date IAAAP-6-19-SB02-"depth1"-date IAAAP-6-19-SB02-"depth2"-date IAAAP-6-19-SB03-"depth1"-date IAAAP-6-19-SB03-"depth2"-date				6 - soil samples		
6-25	IAAAP-6-25-SB01-"depth1"-date IAAAP-6-25-SB01-"depth2"-date				2 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
6-94	IAAAP-6-94-SB01-“depth1”-date IAAAP-6-94-SB01-“depth2”-date IAAAP-6-94-SB02-“depth1”-date IAAAP-6-94-SB02-“depth2”-date IAAAP-6-94-SB03-“depth1”-date IAAAP-6-94-SB03-“depth2”-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	explosives, metals	6 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
6-34-2	IAAAP-6-34-2-SB01-“depth1”-date IAAAP-6-34-2-SB01-“depth2”-date IAAAP-6-34-2-SB02-“depth1”-date IAAAP-6-34-2-SB02-“depth2”-date IAAAP-6-34-2-SB03-“depth1”-date IAAAP-6-34-2-SB03-“depth2”-date IAAAP-6-34-2-SB04-“depth1”-date IAAAP-6-34-2-SB04-“depth2”-date IAAAP-6-34-2-SB05-“depth1”-date IAAAP-6-34-2-SB05-“depth2”-date IAAAP-6-34-2-SB06-“depth1”-date IAAAP-6-34-2-SB06-“depth2”-date IAAAP-6-34-2-SB07-“depth1”-date IAAAP-6-34-2-SB07-“depth2”-date IAAAP-6-34-2-SB08-“depth1”-date IAAAP-6-34-2-SB08-“depth2”-date IAAAP-6-34-2-SB09-“depth1”-date IAAAP-6-34-2-SB09-“depth2”-date IAAAP-6-34-2-SB10-“depth1 IAAAP-6-34-2-SB10-“depth2”-date				20 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
6-34-3	IAAAP-6-34-3-SB01-“depth1”-date IAAAP-6-34-3-SB01-“depth2”-date IAAAP-6-34-3-SB02-“depth1”-date IAAAP-6-34-3-SB02-“depth2”-date IAAAP-6-34-3-SB03-“depth1”-date IAAAP-6-34-3-SB03-“depth2”-date IAAAP-6-34-3-SB04-“depth1”-date IAAAP-6-34-3-SB04-“depth2”-date IAAAP-6-34-3-SB05-“depth1”-date IAAAP-6-34-3-SB05-“depth2”-date IAAAP-6-34-3-SB06-“depth1”-date IAAAP-6-34-3-SB06-“depth2”-date IAAAP-6-34-3-SB07-“depth1”-date IAAAP-6-34-3-SB07-“depth2”-date IAAAP-6-34-3-SB08-“depth1”-date IAAAP-6-34-3-SB08-“depth2”-date IAAAP-6-34-3-SB09-“ depths 1&2”-date IAAAP-6-34-3-SB10-“depths 1&2”-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	explosives, metals	20 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
6-35	IAAAP-6-35-SB01-“depth1”-date IAAAP-6-35-SB01-“depth2”-date IAAAP-6-35-SB02-“depth1”-date IAAAP-6-35-SB02-“depth2”-date IAAAP-6-35-SB03-“depth1”-date IAAAP-6-35-SB03-“depth2”-date IAAAP-6-35-SB04-“depth1”-date IAAAP-6-35-SB04-“depth2”-date IAAAP-6-35-SB05-“depth1”-date IAAAP-6-35-SB05-“depth2”-date IAAAP-6-35-SB06-“depth1 IAAAP-6-35-SB06-“depth2”-date				12 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
6-68	IAAAP-6-68-SB01-"depth1"-date IAAAP-6-68-SB01-"depth2"-date IAAAP-6-68-SB02-"depth1"-date IAAAP-6-68-SB02-"depth2"-date IAAAP-6-68-SB03-"depth1"-date IAAAP-6-68-SB03-"depth2"-date IAAAP-6-68-SB04-"depth1"-date IAAAP-6-68-SB04-"depth2"-date IAAAP-6-68-SB05-"depths1&2"-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	explosives, metals	10 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
6-87	IAAAP-6-87-SB01-"depth1"-date IAAAP-6-87-SB01-"depth2"-date IAAAP-6-87-SB02-"depth1"-date IAAAP-6-87-SB02-"depth2"-date IAAAP-6-87-SB03-"depth1"-date IAAAP-6-87-SB03-"depth2"-date IAAAP-6-87-SB04-"depth1"-date IAAAP-6-87-SB04-"depth2"-date IAAAP-6-87-SB05-"depth1&2"-date				10 - soil samples		
6-88	IAAAP-6-88-SB01-"depth1"-date IAAAP-6-88-SB01-"depth2"-date IAAAP-6-88-SB02-"depth1"-date IAAAP-6-88-SB02-"depth2"-date IAAAP-6-88-SB03-"depth1"-date IAAAP-6-88-SB03-"depth2"-date IAAAP-6-88-SB04-"depth1"-date IAAAP-6-88-SB04-"depth2"-date IAAAP-6-88-SB05-"depth1"-date IAAAP-6-88-SB05-"depth2"-date IAAAP-6-88-SB06-"depth1"-date IAAAP-6-88-SB06-"depth2"-date				12 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
6-90	IAAAP-6-90-SB01-“depth1”-date IAAAP-6-90-SB01-“depth2”-date IAAAP-6-90-SB02-“depth1”-date IAAAP-6-90-SB02-“depth2”-date IAAAP-6-90-SB03-“depth1”-date IAAAP-6-90-SB03-“depth2”-date IAAAP-6-90-SB04-“depth1”-date IAAAP-6-90-SB04-“depth2”-date IAAAP-6-90-SB05-“depth1”-date IAAAP-6-90-SB05-“depth2”-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	explosives, metals	10 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
6-96	IAAAP-6-96-SB01-“depth1”-date IAAAP-6-96-SB01-“depth2”-date				2 - soil samples		
6-97	IAAAP-6-97-SB01-“depth1”-date IAAAP-6-97-SB01-“depth2”-date IAAAP-6-97-SB02-“depth1”-date IAAAP-6-97-SB02-“depth2”-date IAAAP-6-97-SB03-“depth1”-date IAAAP-6-97-SB03-“depth2”-date IAAAP-6-97-SB04-“depth1”-date IAAAP-6-97-SB04-“depth2”-date IAAAP-6-97-SB05-“depth1”-date IAAAP-6-97-SB05-“depth2”-date IAAAP-6-97-SB06-“depth1”-date IAAAP-6-97-SB06-“depth2”-date				12 - soil samples		
6-98	IAAAP-6-98-SB01-“depth1”-date IAAAP-6-98-SB01-“depth2”-date				2 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
9-62	IAAAP-9-62-SB01-"depth1"-date IAAAP-9-62-SB01-"depth2"-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	metals	2- soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
9-64	IAAAP-9-64-SB01-"depth1"-date IAAAP-9-64-SB01-"depth2"-date				2 - soil samples		
800-03	IAAAP-800-03-SB01-"depth1"-date IAAAP-800-03-SB01-"depth2"-date			explosives, metals	2 - soil samples		
800-03-2	IAAAP-800-03-2-SB01-"depth1"-date IAAAP-800-03-2-SB01-"depth2"-date IAAAP-800-03-2-SB02-"depth1"-date IAAAP-800-03-2-SB02-"depth2"-date IAAAP-800-03-2-SB03-"depth1"-date IAAAP-800-03-2-SB03-"depth2"-date				6 - soil samples		
800-08	IAAAP-800-08-SB01-"depth1"-date IAAAP-800-08-SB01-"depth2"-date				2 - soil samples		
800-16	IAAAP-800-16-SB01-"depth1"-date IAAAP-800-16-SB01-"depth2"-date				2 - soil samples		
800-70-1	IAAAP-800-70-1-SB01-"depth1"-date IAAAP-800-70-1-SB01-"depth2"-date				6 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
800-70-2	IAAAP-800-70-2-SB01-"depth1"-date IAAAP-800-70-2-SB01-"depth2"-date IAAAP-800-70-2-SB02-"depth1"-date IAAAP-800-70-2-SB02-"depth2"-date IAAAP-800-70-2-SB03-"depth1"-date IAAAP-800-70-2-SB03-"depth2"-date IAAAP-800-70-2-SB04-"depth1"-date IAAAP-800-70-2-SB04-"depth2"-date IAAAP-800-70-2-SB05-"depth1"-date IAAAP-800-70-2-SB05-"depth2"-date IAAAP-800-70-2-SB06-"depth1"-date IAAAP-800-70-2-SB06-"depth2"-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	explosives, metals	12 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
800-192	IAAAP-800-192-SB01-"depth1"-date IAAAP-800-192-SB01-"depth2"-date IAAAP-800-192-SB02-"depth1"-date IAAAP-800-192-SB02-"depth2"-date IAAAP-800-192-SB03-"depth1"-date IAAAP-800-192-SB03-"depth2"-date IAAAP-800-192-SB04-"depth1"-date IAAAP-800-192-SB04-"depth2"-date IAAAP-800-192-SB05-"depth1"-date IAAAP-800-192-SB05-"depth2"-date IAAAP-800-192-SB06-"depth1"-date IAAAP-800-192-SB06-"depth2"-date IAAAP-800-192-SB07-"depth1"-date IAAAP-800-192-SB07-"depth2"-date				14 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
800-193	IAAAP-800-193-SB01-"depth1"-date IAAAP-800-193-SB01-"depth2"-date IAAAP-800-193-SB02-"depth1"-date IAAAP-800-193-SB02-"depth2"-date IAAAP-800-193-SB03-"depth1"-date IAAAP-800-193-SB03-"depth2"-date IAAAP-800-193-SB04-"depth1"-date IAAAP-800-193-SB04-"depth2"-date IAAAP-800-193-SB05-"depth1"-date IAAAP-800-193-SB05-"depth2"-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	explosives, metals	10 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
H-6	IAAAP-H-6-SB01-"depth1"-date IAAAP-H-6-SB01-"depth2"-date			PAHs, explosives, metals	2 - soil samples		
BG-12	IAAAP-BG-12-SB01-"depth1"-date IAAAP-BG-12-SB01-"depth2"-date IAAAP-BG-12-SB02-"depth1"-date IAAAP-BG-12-SB02-"depth2"-date IAAAP-BG-12-SB03-"depth1"-date IAAAP-BG-12-SB03-"depth2"-date IAAAP-BG-12-SB04-"depth1"-date IAAAP-BG-12-SB04-"depth2"-date IAAAP-BG-12-SB05-"depth1"-date IAAAP-BG-12-SB05-"depth2"-date				10 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
BG-199-1	IAAAP-BG-199-1-SB01-“depth1”-date IAAAP-BG-199-1-SB01-“depth2”-date IAAAP-BG-199-1-SB02-“depth1”-date IAAAP-BG-199-1-SB02-“depth2”-date IAAAP-BG-199-1-SB03-“depth1”-date IAAAP-BG-199-1-SB03-“depth2”-date IAAAP-BG-199-1-SB04-“depth1”-date IAAAP-BG-199-1-SB04-“depth2”-date IAAAP-BG-199-1-SB05-“depth1&2 IAAAP-BG-199-1-SB06-depth1&2”-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	PAHs, explosives, metals	12 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
H-7	IAAAP-H-7-SB01-“depth1”-date IAAAP-H-7-SB01-“depth2”-date				2 - soil samples		
BG-199-2	IAAAP-BG-199-2-SB01-“depth1”-date IAAAP-BG-199-2-SB01-“depth2”-date IAAAP-BG-199-2-SB02-“depth1”-date IAAAP-BG-199-2-SB02-“depth2”-date IAAAP-BG-199-2-SB03-“depth1”-date IAAAP-BG-199-2-SB03-“depth2”-date IAAAP-BG-199-2-SB04-“depth1”-date IAAAP-BG-199-2-SB04-“depth2”-date IAAAP-BG-199-2-SB05-“depth1”-date IAAAP-BG-199-2-SB05-“depth2”-date IAAAP-BG-199-2-SB06-depth1&2”-date				12 - soil samples		
H-8	IAAAP-H-8-SB01-“depth1”-date IAAAP-H-8-SB01-“depth2”-date				2 - soil samples		
H-9	IAAAP-H-9-SB01-“depth1”-date IAAAP-H-9-SB01-“depth2”-date				2 - soil samples		
5B-21	IAAAP-5B-21-SB01-“depth1”-date IAAAP-5B-21-SB01-“depth2”-date				2 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
L-03-1	IAAAP-L-03-1-SB01-"depth1"-date IAAAP-L-03-1-SB01-"depth2"-date IAAAP-L-03-1-SB02-"depth1"-date IAAAP-L-03-1-SB02-"depth2"-date IAAAP-L-03-1-SB03-"depth1"-date IAAAP-L-03-1-SB03-"depth2"-date IAAAP-L-03-1-SB04-"depth1"-date IAAAP-L-03-1-SB04-"depth2"-date IAAAP-L-03-1-SB05-"depth1"-date IAAAP-L-03-1-SB05-"depth2"-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	PAHs, explosives, metals	10 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
500-143-2	IAAAP-500-143-2-SB01-"depth1"-date IAAAP-500-143-2-SB01-"depth2"-date				2 - soil samples		
500-143-3	IAAAP-500-143-3-SB01-"depth1"-date IAAAP-500-143-3-SB01-"depth2"-date				2 - soil samples		
500-143-4	IAAAP-500-143-4-SB01-"depth1"-date IAAAP-500-143-4-SB01-"depth2"-date				2 - soil samples		
500-206-1	IAAAP-500-206-1-SB01-"depth1"-date IAAAP-500-206-1-SB01-"depth2"-date				2 - soil samples		
900-198-2	IAAAP-900-198-2-SB01-"depth1"-date IAAAP-900-198-2-SB01-"depth2"-date				2 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
600-84	IAAAP-600-84-SB01-“depth1”-date IAAAP-600-84-SB01-“depth2”-date IAAAP-600-84-SB02-“depth1”-date IAAAP-600-84-SB02-“depth2”-date IAAAP-600-84-SB03-“depth1”-date IAAAP-600-84-SB03-“depth2”-date IAAAP-600-84-SB04-“depth1”-date IAAAP-600-84-SB04-“depth2”-date IAAAP-600-84-SB05-“depth1”-date IAAAP-600-84-SB05-“depth2”-date IAAAP-600-84-SB06-“depth1”-date IAAAP-600-84-SB06-“depth2”-date IAAAP-600-84-SB07-“depth1”-date IAAAP-600-84-SB07-“depth2”-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	PAHs, explosives, metals	14 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
700-186-1	IAAAP-700-186-1-SB01-“depth1”-date IAAAP-700-186-1-SB01-“depth2”-date IAAAP-700-186-1-SB02-“depth1”-date IAAAP-700-186-1-SB02-“depth2”-date IAAAP-700-186-1-SB03-“depth1”-date IAAAP-700-186-1-SB03-“depth2”-date IAAAP-700-186-1-SB04-“depth1”-date IAAAP-700-186-1-SB04-“depth2”-date IAAAP-700-186-1-SB05-“depth1”-date IAAAP-700-186-1-SB05-“depth2”-date IAAAP-700-186-1-SB06-“depth1”-date IAAAP-700-186-1-SB06-“depth2”-date				12 - soil samples		

Table 18.1. Sampling Locations, Rationale, and Methods

Sampling Location	ID Number	Matrix	Depth (ft bgs)	Analytical Group	Number of Samples	Rationale	Field SOP Reference
800-68	IAAAP-800-68-SB01-“depth1”-date IAAAP-800-68-SB01-“depth2”-date IAAAP-800-68-SB02-“depth1”-date IAAAP-800-68-SB02-“depth2”-date IAAAP-800-68-SB03-“depth1”-date IAAAP-800-68-SB03-“depth2”-date IAAAP-800-68-SB04-“depth1”-date IAAAP-800-68-SB04-“depth2”-date IAAAP-800-68-SB05-“depth1”-date IAAAP-800-68-SB05-“depth2”-date	Soil	Depth of suspected highest contamination (Depth1); Depth 2 to 5 ft below suspected contamination (Depth2)	PAHs, explosives, metals	10 - soil samples	Evaluation of current conditions for contaminants within the building footprint subsurface.	FO-001, FO-005, FO-007, FO-008, FO-009, FO-010, FO-011, FO-012
900-194-8	IAAAP-900-194-8-SB01-“depth1”-date IAAAP-900-194-8-SB01-“depth2”-date IAAAP-900-194-8-SB02-“depth1”-date IAAAP-900-194-8-SB02-“depth2”-date IAAAP-900-194-8-SB03-“depth1”-date IAAAP-900-194-8-SB03-“depth2”-date IAAAP-900-194-8-SB04-“depth1”-date IAAAP-900-194-8-SB04-“depth2”-date IAAAP-900-194-8-SB05-“depth1”-date IAAAP-900-194-8-SB05-“depth2”-date				10 - soil samples		
900-199-2	IAAAP-900-199-2-SB01-“depth1”-date IAAAP-900-199-2-SB01-“depth2”-date IAAAP-900-199-2-SB02-“depth1”-date IAAAP-900-199-2-SB02-“depth2”-date IAAAP-900-199-2-SB03-“depth1”-date IAAAP-900-199-2-SB03-“depth2”-date IAAAP-900-199-2-SB04-“depth1”-date IAAAP-900-199-2-SB04-“depth2”-date IAAAP-900-199-2-SB05-“depth1”-date IAAAP-900-199-2-SB05-“depth2”-date				10 - soil samples		

Duplicate samples will be collected to represent 10 percent of the soil samples. Matrix spike/matrix spike duplicates will be collected to represent 5 percent of each sample group. Trip blanks will be included in coolers that include samples packaged for VOC analysis. Equipment blanks will be collected to be representative of nondisposable equipment.

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

Laboratory (Name, sample receipt address, Point of Contact, e-mail, and phone numbers):	Eurofins TestAmerica (TestAmerica Denver), 4955 Yarrow Street, Arvada, CO 80002 Patrick McEntee, 303-736-0107, Patrick.McEntee@Eurofinset.com
Required accreditation or certifications:	DoD ELAP Accreditation/Expiration Date: TestAmerica Denver DoD ELAP (QSM v5.3), A2LA Cert. No. 2907.01/Expires October 31, 2022 TestAmerica Savannah DoD ELAP (QSM v5.3), ANAB Cert. No. L2463/Expires September 22, 2022
Sample Delivery Method:	Fed Ex

Analyte Group/Methods	Matrix	Analytical / Preparation Method SOP Reference[1]	Container(s) (number, size & type per sample)	Sample Volume[2]	Preservation	Maximum Holding Time[3]
Metals SW6010D/SW3050B	Soil	DV-MT-0021 DV-IP-0015	1, 4 oz, glass jar	20 grams	Cool ≤ 6 °C	180 days to analysis
Mercury SW7471B	Soil	DV-MT-0016	1, 4 oz, glass jar	5 grams	Cool ≤ 6 °C	28 days to analysis
VOCs SW8260C/SW5035A	Soil	DV-MS-0010	3, 5 g, EnCore™ 3, 40 mL, VOA Vials – Terra Core 3, 40 mL, Core 'N One Sampler™ 1, 4 oz, glass jar with Teflon-lined lid	15 g (three 5 g) 15 g (three 5 g) 15 g (three 5 g) 15 g	Freeze DI water – freeze, Methanol or NaHSO4 - Cool ≤ 6 °C Freeze Cool ≤ 6 °C	48 hours from sampling to preservation/freezing, 14 days from sampling to analysis

Analyte Group/Methods	Matrix	Analytical / Preparation Method SOP Reference[1]	Container(s) (number, size & type per sample)	Sample Volume[2]	Preservation	Maximum Holding Time[3]
PAHs SW8270D SIM/SW3546	Soil	DV-MS-0002 /DV-OP-0015	1, 4 oz, glass jar	60 grams	Cool ≤ 6 °C	14 days to extraction, 40 days from extraction to analysis
Explosives SW8330B	Soil	DV-LC-0002 / DV-OP-0018	1, 4 oz, glass jar	4 grams	Cool ≤ 6 °C	14 days to extraction, 40 days from extraction to analysis

[1] Refer to the Analytical SOP References table (Worksheet #23).

[2] The minimum sample size is based on analysis allowing for sufficient sample for reanalysis. Additional volume is needed for the laboratory Matrix Spike/Matrix Spike Duplicate sample analysis.

[3] For a test with a recommended maximum holding time measured in hours, the holding time shall be tracked by the hour; for a test with a recommended maximum holding time measured in days, the holding time shall be tracked by the day; for a test with a recommended maximum holding time measured in months, the holding time shall be tracked by the month. One month is defined as 30 days.

DI = deionized
DoD = United States Department of Defense
ELAP = Environmental Laboratory Accreditation Program
NAHSO4 = sodium hydrogen sulfate
oz = ounce
PAH = polynuclear aromatic hydrocarbon
SVOC - semivolatile organic compound
VOA = volatile organic analysis
VOC = volatile organic compound

QAPP Worksheet #20
Field QC Sample Summary

This worksheet summarizes the field QC samples that may be collected for this project. It is expected that a minimum of 742 soil samples will be collected, all of which will be analyzed for metals analysis, 738 of which will be also be analyzed for explosives, and 480 of which will also be analyzed for PAHs.

The following field QC samples will be collected and/or submitted:

- Field duplicates will be collected at a frequency of 1 per 10 or fewer primary samples for each analyte (approximate total analysis of 48 samples analyzed for PAHs, and approximately 75 analyzed for explosives and metals), matrix, and method. Treatment systems will collect field duplicates once per year.
- MS and matrix spike duplicate (MSD) samples will be collected at a frequency of 1 MS/MSD for every 20 or fewer samples for each analyte (approximate total analysis of 24 MS/MSD samples analyzed for PAHs, and 40 MS/MSD samples analyzed for explosives and metals), matrix, and method.
- Trip blanks will be submitted with every cooler containing samples to be analyzed for VOCs.
- Equipment blanks will be submitted at a minimum frequency of 1 per set of 20 similar samples (minimum of 1) per sampling crew and for each equipment type and for each analyte (expected to be between 20 and 40 soil samples for PAHs, explosives and/or metals) for media to be investigated using that equipment. When disposable or dedicated sampling equipment is used, equipment rinsate blank samples do not need to be collected.

Field Duplicate Samples

A field duplicate sample is a second sample collected at the same location as the original sample. These samples are used to assess precision of the entire data collection activity, including sampling, analysis, and site heterogeneity. Duplicate samples will be collected simultaneously or in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. The samples may be either collocated samples or sub-samples of a single sample collection. Example of collocated samples includes side-by-side soil core samples, while sub-samples may be taken from one soil boring core. The sample containers for the duplicate samples will be assigned a unique ID number in the field.

Sample locations for collection of field duplicate samples can be identified when the sequence of sampling locations is determined, so that field duplicate collection will take place evenly over the course of the field effort. Specific locations will be designated for the collection of field duplicate samples by the field team before sample collection.

Matrix Spike and Matrix Spike Duplicate Samples

MS is used to assess the performance of the method as applied to a particular matrix. MS and MSD samples are aliquots of samples spiked with known amounts of target analytes. The spiking occurs in the laboratory before sample preparation and analysis. The spiking level should be greater than the lowest concentration standard used for calibration and less than or equal to the midpoint of the linear range calibration.

Sampling locations selected for the purpose of assigning an MS/MSD should be an area anticipated to be free from contamination or with low concentrations of targeted analytes.

Trip Blanks

Trip blanks are used to assess the potential introduction of contaminants to sample containers during the field collection event, including transportation and storage procedures. Trip blanks are samples of ASTM Type II, organic-free water prepared by the laboratory. Trip blanks consisting of unopened evacuated stainless-steel canisters may be used during gas phase sampling. Once prepared, trip blanks should not be opened until they reach the laboratory for analysis.

All trip blanks are transported to the sampling site, handled like an environmental sample, and returned to the laboratory for analysis. One trip blank accompanies each cooler containing samples scheduled to be analyzed for VOCs. Ideally, the analytical laboratory will analyze the source water for trip blanks routinely (once per week) as part of their internal QA/QC program.

Equipment Blanks

An equipment blank is a sample of ASTM Type II reagent-grade water poured into, poured over, or pumped through the sampling device, collected in a sample container, and transported to the laboratory for analysis. These may also be called equipment rinse blanks or rinsate blanks. Equipment blanks are used to assess the effectiveness of equipment decontamination procedures.

Field-cleaned equipment blanks are used to monitor the onsite sampling environment, sampling equipment decontamination, sample container cleaning, the suitability of sample preservatives and analyte-free water, and sample transport and storage conditions.

The following steps should be used:

1. Collect these blanks using sampling equipment that has been cleaned in the field (i.e., between sampling points). The cleaning procedures used for the blank collection must be identical to those used for the field sample collection.
2. Prepare field-cleaned equipment blanks immediately after the equipment is cleaned in the field and before leaving the sampling site.

3. Prepare equipment blanks by rinsing the sampling equipment set with the appropriate type of analyte-free water and collecting the rinse water in appropriate sample containers.

The equipment blank samples will be analyzed for the same parameters as the field samples that were collected using that piece of equipment. If analytes pertinent to the project are detected in the equipment blanks, then the procedure will be evaluated and the frequency of equipment blanks may be temporarily increased to assess the effectiveness of the decontamination procedures. Results of this evaluation may dictate modification to the decontamination procedure. Detections in the equipment blanks and their possible impacts to the investigation are evaluated on a site-specific basis.

Field Blanks

Per DoD Environmental Field Sampling Handbook, field blanks are prepared and analyzed to check the cleanliness of sample containers, environmental contamination (sampling environment), and purity of reagents or solvents used in the field. A sample container is filled with laboratory ASTM Type II water, preserved, shipped to the field with the clean sample containers, opened in the field for exposure to ambient field air for a time compatible with the field sampling process, and closed and submitted for analysis using the same parameters as the test sample. The reported results will indicate the potential presence of contamination. Field blanks are most often used when measuring for volatile analytes.

In an attempt to identify external variables affecting sample integrity, a program of QC blanks should be initiated. For volatile parameters, the QC blank sample program is a two-track approach using both a trip and a field blank. The trip blank acts as a check on potential contamination sources in the sample container, method blank water (including preservative), and sample transport and storage. The field blank acts as a check on the cleanliness of the sampling equipment, potential atmospheric contamination, and the effects of sampling procedures such as preservation on the analytes of interest. Complete documentation of the sources of these materials will assist with any problem solving.

Equipment field blanks may be collected at the start, during, and end of the sampling event to determine the cleanliness of the sampling devices and evaluate the cleaning techniques used in the field.

Trip blanks, field blanks, and rinsate blanks typically are prepared with metal-free and organic-free water purchased from a chemical supply company or provided by the laboratory that is performing chemical analyses on the groundwater samples.

Field blanks are samples of reagent water that are transferred from one vessel to another at the sampling site. Typically, the laboratory will fill sample bottles with ASTM Type I or II water, seal the bottles, and ship them to the sampling site along with the empty bottles. The field crew will transfer the reagent water to another set of clean sample bottles in the field and transport or ship the field blanks with the actual samples to the laboratory. This blank is used to show that the sampling procedures and atmosphere at the sampling site have not caused contamination. Additional reagent water should be available in field to ensure no air bubbles are in field blanks.

QAPP Worksheet #21
Project Sampling Field Procedure Reference Table

The field SOPs associated with the project field activities, including, but not limited to, sample collection and sample handling and custody, are listed in Table 21-1. The field SOPs are provided in Appendix A.

Table 21.1 Field Standard Operating Procedure Summary

Reference Number	Title	Originating Organization
FO-011	Site Reconnaissance, Preparation, and Restoration (modified November 2020)	ATI
FO-008	Decontamination (modified November 2020)	ATI
FO-001	Subsurface Soil Samples for VOC Analysis (November 2020)	ATI
FO-001	Soil Core Characterization (modified November 2020)	ATI
FO-007	Sample Identification	ATI
FO-007	Sample Handling and Custody (modified January 2022)	ATI
FO-010	Record Keeping (modified November 2020)	ATI
FO-005	Waste Management (modified November 2020)	ATI
FO-001	Operation of Field Equipment (modified November 2020)	ATI
FO-012	ASTM D 2488-00 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) (2000)	ATI
FO-009	Global Positioning System (modified November 2020)	ATI

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

Field equipment calibration, maintenance, testing, and inspection protocol for activities conducted at IAAAP are discussed in this worksheet.

Field Instrument Calibration

Sampling field personnel will be aware of and follow appropriate manufacturer's maintenance and calibration requirements for measuring and test equipment under their control. Compliance with maintenance, calibration/standardization, and record-keeping procedures ensures the quality of the data collected. Field instruments requiring calibration or calibration verification may include, but are not limited to, those listed in Table 22-1.

Calibration and preventive maintenance procedures apply to government-furnished equipment, leased, and rented equipment. Calibration standards will be traceable to reference standards commonly used by industry, such as the National Institute for Standards and Technology (NIST), where appropriate. These calibration and maintenance procedures do not apply to rulers, tape measures, levels, or other such devices when normal commercial standards provide acceptable accuracy.

Field Instrument Storage, Maintenance, Testing, and Inspection

Equipment will be stored in accordance with its operation manual. While in storage, each piece of measuring and test equipment will contain a unique number or marking that is readily legible and traceable to calibration and maintenance records.

Upon receipt and before the acceptance of government-furnished, leased, or rented equipment, a designated field crewmember will perform an initial instrument inspection consisting of a maintenance document review and a functional or operational check to ensure that the equipment is in proper working order. Field personnel will review maintenance records to verify that periodic maintenance activities are current and equipment-specific QC procedures are included with the instrument. In addition, field personnel will complete an inspection of measuring equipment to verify that it is working consistently and appears to be in satisfactory condition for its intended use, as specified in its operation manual or vendor supplied QC procedures.

All equipment deficiencies will be noted, addressed, and resolved during initial instrument inspection and before equipment acceptance. Equipment replacement or an equivalent substitution will be required in cases where equipment deficiencies are not resolved during the initial inspection.

An item discovered to be out of calibration or in need of maintenance will not be used until the required service is completed. If equipment does not conform to its operation criteria as specified in its operation manual, then the nonconformance will be documented in the project field logbook and the equipment returned to its source. Data generated from field instruments with calibrations outside the manufacturer's or project-specified calibration criteria will not be used.

Upon returning measuring and test equipment to the government property custodian or vendor, personnel will provide written documentation of any and all maintenance or calibration problems encountered in using the item.

All measuring and test equipment will be inspected and calibrated by the field team leader or designee before use in the field. The field team leader or designee will periodically review calibration logs to confirm that equipment calibration procedures and equipment performance is within operation standards, as specified in the equipment's operation manual.

Field Equipment Documentation

Record-keeping for government-furnished, leased, or rented equipment must comply with procedures for documenting periodic maintenance and associated calibration.

Personnel will maintain records of all field maintenance and calibration performed. Specific calibration standards (i.e., calibration gas) and calibration methods will be recorded. Such records will be entered directly into the field logbook in accordance with FO-010 included in Appendix A.

Table 22-1. Field Equipment Calibration, Maintenance, Testing, and Inspection
IAAAP, Middletown, Iowa

Field Equipment	Activity	SOP Reference	Title or Position of Responsible Person	Frequency	Acceptance Criteria	Corrective Action
PID	Calibrate for organic vapors using compressed isobutylene gas cylinders, per manufacturer's instructions.	SOP-FO-001	Field Team Leader	Daily before use	Check operations manual for acceptable range of calibrated probe for the specific lamp model.	If meter fails to calibrate, follow manufacturer's troubleshooting instructions. Use a moisture tube if necessary. Otherwise, do not use this meter.
	Charge batteries. Perform regular maintenance per manufacturer's instructions.					
	Screen for potential volatile compound vapors.					

Notes:
PID = photoionization detector

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QAPP Worksheet #23
Analytical SOP References Table

The laboratory SOP references were provided by Eurofins/TestAmerica. The laboratory SOPs are presented in Appendix B.

SOP #	Title	Definitive or Screening Data	Matrix/Analytical Group	Equipment Type	Modified for Project? Y/N
DV-IP-0015	Acid Digestion of Solids (EPA 3050B)	Not Applicable	Soil/metals digestion	Hot Block digestion	N
DV-MT-0021	ICP Analysis for Trace Elements by SW-846 Method 6010D/D	Definitive	Soil, TCLP extract/Metals	ICP	N
DV-MS-0010	Determination of Volatile Organics by GC/MS (SW846 8260C and EPA 624)	Definitive	Soil, Volatile Organics (VOCs)	GC/MS	N
DV-MT-0016	Mercury in Solids by Cold Vapor Atomic Absorption (SW-846 7471A)	Definitive	Soil/Mercury	CVAA Low-level, closed-system purge and trap	N
DV-MS-0002	Polynuclear Aromatic Hydrocarbons by GC/MS Selected Ion Monitoring (SIM) [SW 846 Method 8270C and 8270D]	Definitive	Soil/Polynuclear Aromatic Hydrocarbons (PAHs)	GC/MS	N
DV-OP-0016	Ultrasonic Extraction of Solid Samples [SW-846 3550B & 3550C]	Not Applicable	Soil/Organic extraction	Not applicable	N
DV-OP-0007	Concentration and Clean-up of Organic Extracts (SW-846 3510C, 3520C, 3540C, 3546, 3550B, 3550C, 3620C, 3660B, 3665A, and USEPA 600 series)	Not Applicable	Soil/Organic preparation	Not applicable	N
DV-OP-0015	Microwave Extraction of Solid Samples [SW-846 3546]	Not Applicable	Soil/Organic extraction	Not applicable	N
DV-LC-0002	Nitroaromatic and Nitramine Explosive Compounds by High Performance Liquid Chromatography (HPLC) (SW846 8330A & 8330B)	Definitive	Soil/Explosives	HPLC	N
DV-OP-0018	Extraction of Nitroaromatic and Nitroamine Explosive Compounds and Picric Acid from Soil Samples (SW-846 8330A & 8330B)	Not Applicable	Soil/Explosives extraction	Not applicable	N
DV-WC-0023	Percent Moisture in Soils and Wastes [ASTM D2216, CLP ILM05.3]	Screening	Soil/Moisture	Not applicable	N

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QAPP Worksheet #24
Analytical Instrument Calibration Tables

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for Corrective Action	SOP Reference
ICP-AES	Linear Dynamic Range (LDR) or high level check standard	At initial set up and checked every 6 months with a high standard at the upper limit of the range	Within ± 10% of true value	Dilute samples within the calibration range or re-establish/verify the LDR	Analyst / Section Supervisor	DV-MT-0021
ICP-AES	Initial Calibration (ICAL) - Minimum of one high standard and a calibration blank	Prior to sample analysis.	If more than one calibration standard is used, $r^2 \geq 0.99$	Correct problem, then repeat ICAL	Analyst / Section Supervisor	DV-MT-0021
ICP-AES	Initial calibration verification (ICV)	Second source standard Immediately following ICAL	All reported analytes ± 10% of expected value.	Correct any problems and rerun ICV. If that fails, correct problem and repeat ICAL. No samples shall be analyzed until the second-source calibration verification is successful.	Analyst / Section Supervisor	DV-MT-0021
ICP-AES	Low-Level Calibration Check Standard $\leq$ LOQ (Low-level ICV)	Daily after one-point ICAL	All reported analytes must be within ± 20% of expected value.	Correct any problems, then reanalyze or repeat ICAL. Results cannot be reported without a valid low-level calibration check standard.	Analyst / Section Supervisor	DV-MT-0021

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for Corrective Action	SOP Reference
ICP-AES	Interference Check Solutions (ICS)	After ICAL and prior to sample analysis	ICS-A: Absolute value of concentration for all non-spiked project analytes < ½ LOQ (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within + 20% of true value. (Not needed if instrument can read negative responses.)	Terminate analysis; locate and correct problem; reanalyze ICS, reanalyze all samples. If corrective action fails, apply Q-flag to all results for specific analytes in all samples associated with the failed ICS.	Analyst / Section Supervisor	DV-MT-0021
ICP-AES	Continuing Calibration Verification (CCV)	After every 10 field samples and at the end of the sequence.	All reported analytes ± 10% of expected value.	Evaluate failure and impact on samples. If samples non-detect for analytes which have a high bias, report non-detect results with case narrative comment with written approval from the client. or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s), and re-calibrate; then reanalyze all	Analyst / Section Supervisor	DV-MT-0021

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for Corrective Action	SOP Reference
				affected samples since the last acceptable CCV.		
ICP-AES	Initial and Continuing Calibration Blank (ICB, CCB)	Immediately after the ICV and immediately after every CCV.	The absolute values of all analytes must be < ½ LOQ or < 1/10 the amount measured in any sample. Non-detects associated with positive blank infractions may be reported.	ICB: Correct any problems and repeat ICV/ICB. If that fails, rerun ICAL. CCBs cannot be reanalyzed without reanalysis of the associated samples and CCVs. All samples following the last acceptable calibration blank must be reanalyzed. CCB failures due to carryover may not require an ICAL.	Analyst / Section Supervisor	DV-MT-0021
CVAA	Initial calibration (minimum 5 standards and a blank)	Daily initial calibration prior to sample analysis.	$r^2 \geq 0.99$	Correct problem then repeat initial calibration. If calibration fails again, re-digest the entire digestion batch.	Analyst/Lab Manager	DV-MT-0016, DV-MT-0017
CVAA	Initial calibration verification (ICV)	Run second-source standard once after each ICAL and prior to sample analysis.	Analytes within ±10% of expected value	Correct problem then rerun ICV. If that fails, repeat initial calibration. If calibration fails again, re-digest the entire digestion batch.	Analyst/Lab Manager	DV-MT-0016, DV-MT-0017

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for Corrective Action	SOP Reference
CVAA	Low-level Calibration Check Standard (LLCCV)	Daily If concentration of lowest calibration standard is less than or equal to the LOQ the lowest standard may be re-quantified against the calibration curve as a LLCCV.	Analytes within ±20% of expected value	Correct problem and repeat ICAL	Analyst/Lab Manager	DV-MT-0016, DV-MT-0017
CVAA	Continuing calibration verification (CCV)	After every 10 field samples, and at the end of the analysis sequence	All analytes within 10% of expected value	Evaluate failure and impact on samples. If samples non-detect for analytes which have a high bias, report non-detect results with case narrative comment with written approval from the client. or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s), and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.	Analyst/Lab Manager	DV-MT-0016, DV-MT-0017

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for Corrective Action	SOP Reference
CVAA	Initial and Continuing Calibration blank (ICB/CCB)	Immediately after the ICV and immediately after every CCV	Absolute values of analyte < ½ LOQ or < 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater. Non-detects associated with positive blank infractions may be reported. Sample results > 10x associated with negative blanks may be reported.	ICB: Correct problem and repeat ICV/ICB analysis. If that fails, rerun ICAL All samples following the last acceptable Calibration Blank must be reanalyzed. CCBs may not be re-analyzed without re-analysis of the associated samples and CCV(s) CCB failures due to carryover may not require an ICAL.	Analyst/Lab Manager	DV-MT-0016, DV-MT-0017
CVAA	Initial calibration (minimum 5 standards and a blank)	Daily initial calibration prior to sample analysis.	$r^2 \geq 0.99$	Correct problem then repeat initial calibration. If calibration fails again, re-digest the entire digestion batch.	Analyst/Lab Manager	DV-MT-0016, DV-MT-0017
GC/MS	Check of mass spectral ion intensities (tuning procedure) using BFB or DFTPP or PFTBA	Prior to ICAL and at the beginning of each 12-hour period.	Refer to method/SOP for specific ion criteria.	Retune instrument and verify.	Analyst / Section Supervisor	DV-MS-0002 DV-MS-0010 DV-MS-0012

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for Corrective Action	SOP Reference
GCMS	Performance Check (SVOCs including PAHs only)	At the beginning of each 12-hour period, prior to sample analysis	Degradation ≤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.	Analyst / Section Supervisor	DV-MS-0002 DV-MS-0012
GC/MS	Minimum five-point initial calibration (ICAL) for target analytes for linear or six-point for quadratic; lowest concentration standard at or below the reporting limit.	Initial calibration prior to sample analysis	Each analyte must meet one of the three options below: Option 1: RSD for each analyte ≤ 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: $r^2 \geq 0.99$.	Verify standard solutions still valid, perform instrument maintenance as needed, then repeat the ICAL.	Analyst / Section Supervisor	DV-MS-0002 DV-MS-0010 DV-MS-0012
GC/MS	Initial calibration verification (ICV)	Second source standard, once after each ICAL.	All reported analytes within ± 20% of true value.	Correct problem, and verify second source standard. Rerun verification. If still fails, repeat initial calibration.	Analyst / Section Supervisor	DV-MS-0002 DV-MS-0010 DV-MS-0012

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for Corrective Action	SOP Reference
GC/MS	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.	NA	Analyst / Section Supervisor	DV-MS-0002 DV-MS-0010 DV-MS-0012
GC/MS	Evaluation of Relative Retention Times (RRT)	With each sample	RRT of each reported analyte within ± 0.06 RRT units.	Correct problem, then rerun ICAL.	Analyst / Section Supervisor	DV-MS-0002 DV-MS-0010 DV-MS-0012
GC/MS	Daily calibration verification	Daily, prior to sample analysis and after every 12 hours of analysis time; and at the end of the analytical batch run.	All reported analytes and surrogates within ± 20% of true value. All reported analytes and surrogates within ± 50% for end of analytical batch CCV.	Evaluate failure and impact on samples. If samples non-detect for analytes which have a high bias, report non-detect results with case narrative comment. For closing CCVs, if compounds are not identified as critical compounds of concern report results with qualifiers. For closing CCVs, if the compound is identified as a critical compound of concern, then recalibrate, and reanalyze all affected samples since the last acceptable CCV; or Immediately analyze two	Analyst / Section Supervisor	DV-MS-0002 DV-MS-0010 DV-MS-0012

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for Corrective Action	SOP Reference
				additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s), and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.		
GC/MS	Internal Standards	During acquisition of calibration standard.	Retention time within ± 10 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	Analyst / Section Supervisor	DV-MS-0010
HPLC	Initial Calibration (ICAL) – Minimum five-point initial calibration for all target analytes	Initial calibration prior to sample analysis and after ICV or CCV failures. Perform instrument re-calibration once per year minimum.	Acceptance Criteria options: 1. RSD for each analyte ≤ 15%. 2. Linear least squares regression: $r^2 \geq 0.99$ 3. Non-linear regression: coefficient of determination (COD): $r^2 \geq 0.99$	Correct problem then repeat initial calibration	Analyst/Lab Manager	DV-LC-0002

Instrument	Calibration Procedure	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for Corrective Action	SOP Reference
HPLC	Initial calibration verification (ICV)	Second source standard immediately following initial calibration.	All analytes within 20% of expected value	Correct problem. Repeat ICV. If that fails, repeat initial calibration	Analyst/Lab Manager	DV-LC-0002
HPLC	Continuing calibration verification (CCV)	Before sample analysis, after every 10 field samples, and at the end of the analysis sequence	All analytes within ± 20% of true value	Evaluate failure and impact on samples. If samples non-detect for analytes which have a high bias, report non-detect results with case narrative comment with written approval from the client. or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s), and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.	Analyst/Lab Manager	DV-LC-0002

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

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for corrective action	Reference
ICP	Replace pump windings and gas tanks, check standard and sample flow	Monitor ISTD counts for variation	Instrument performance and sensitivity	As needed	Monitor ISTD counts for variation	Replace windings, recalibrate and reanalyze	Analyst	Quality Assurance Manual – Section 20
CVAA	Replace disposables, flush lines, check lamp current and gas flow	Sensitivity check	Instrument performance and sensitivity	Daily or as needed	CCV pass criteria	Recalibrate	Analyst	Quality Assurance Manual – Section 20
GC-MS	Clean sources, maintain vacuum pumps	Tuning	Instrument performance and sensitivity	Service vacuum pumps twice per year, other maintenance as needed	Tune and CCV pass criteria	Recalibrate instrument	Analyst	Quality Assurance Manual – Section 20
GC-MS	Change septum, clean injection port, change or clip column, install new liner, change trap	Response factors and chromatogram review	Instrument performance and sensitivity	As needed	Tune and CCV pass criteria	Re-inspect injector port, cut additional column, reanalyze CCV,	Analyst	Quality Assurance Manual – Section 20

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Title/position responsible for corrective action	Reference
						recalibrate instrument		
HPLC	Replace columns, DAD flow cell windows and ball-valve cartridges as needed, clean/change filters, check eluent reservoirs	Sensitivity check	Instrument performance and sensitivity	Daily or as needed	CCV pass criteria	Recalibrate	Analyst	Quality Assurance Manual – Section 20
Colorimetric	Replace disposable, flush lines, clean autosampler and pump rollers	Analytical standards	Instrument performance and sensitivity	Daily or as needed	CCV pass criteria	Recalibrate	Analyst	Quality Assurance Manual – Section 20
Probe & Meter	Replace Disposables, check for leaks, check probe is filled with KCL solution (if applicable)	Analytical standards	Instrument performance and sensitivity	Daily or as needed	CCV pass criteria	Recalibrate	Analyst	Quality Assurance Manual – Section 20

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

The primary objective of the documentation and custody procedures is to create an accurate written and/or electronic record that is suitable for tracking the possession and handling of all field samples. Sample shipment and handling procedures presented ensure that samples reach the appropriate laboratories intact and under appropriate custody. Sample handling and custody will be conducted in accordance with FO-007 in Appendix A.

Proper sample handling, shipment, and maintenance of a chain-of-custody are key components of building the documentation and support for data that can be used to make project decisions. The following sections summarize the field and laboratory sample custody procedures to be followed during the project.

Sample Custody and Security

Sample possession (custody) during all sampling efforts must be traceable from the time of collection until the results are verified and reported by the laboratory and the samples are disposed of. A sample is under custody if any of the following is true:

- It is in your possession.
- It is in your view, after being in your possession.
- It was in your possession and you locked it up.
- It is in a designated secure area.

Sample custody will be documented through the use of chain-of-custody records. These forms will be used to track sample custody from the point of sample collection through sample disposal. Security of samples will be ensured by the use of the procedures described below.

Chain-of-Custody Records

A chain-of-custody record will be completed before sample shipment or release. The form will include information for samples collected by the sampling team (an example chain-of-custody is provided in SOP FO-007, Sample Packing and Shipping, Appendix A). The chain-of-custody record, sample labels, and field documentation are cross-checked to verify sample ID, type of analysis, number of containers, sample volume, preservatives, collection time, and type of sample container.

The following information will be recorded on the chain-of-custody record:

- Sample ID
- Date and time of collection

- Sampler initials
- Analytical method(s) requested
- Sample volume
- Sample matrix (e.g., soil)
- Preservative
- Request for MS analysis or other QC analysis
- Signature blocks for release and acceptance of samples
- Time blocks for release and acceptance of samples
- Courier service airbill shipping ID number
- Any comments to identify special conditions or requests

Suppliers for individual projects may create project-specific chain-of-custody forms, but they must contain (at a minimum) the information described above.

Sample Custody During Shipment

Completion of sample custody forms and sample packaging for shipment is performed in the supplier's staging area. Designated field and/or sample control staff will complete and verify chain-of-custody forms and pack samples for shipment at the end of each sampling day. When shipping or transferring samples, the shipping container(s) will have at least two custody seals affixed. One custody seal will be placed on the front of the container and one on the back in a manner that would indicate if the container had been opened during transit (an example cooler packed for shipping with custody seals affixed is provided in SOP FO-007, Sample Packing and Shipping, Appendix A).

If samples are collected for onsite laboratory analysis, the sample control designee or field team member will log in the samples and release them to the onsite laboratory. Sample transfer between supplier staff or between supplier staff and courier or laboratory will be documented by signing and dating "relinquished by" and "received by" blocks whenever sample possession changes. Samples will be released for shipment by overnight couriers by noting the air bill number on the chain-of-custody record.

Sample Shipment and Handling

All sample shipments are accompanied by a completed chain-of-custody record. Each sample cooler must have its own separate chain-of-custody record. The original chain-of-custody record will accompany the shipment and a copy of the form will be retained in the project file.

When samples are split for duplicate analysis, a separate chain-of-custody record will be prepared. The person relinquishing the samples to the facility or agency will request the signature of a representative to acknowledge sample receipt. If a representative is unavailable, a note will be made in the "received by" space. When appropriate, as in the case of overnight shipment, the custody record will contain a statement that the samples were delivered to the designated location and the date and time of delivery noted. Sample collection and shipment will be coordinated to ensure that the receiving laboratory has staff available to process the samples according to method specifications.

Sample Handling Procedures

Following appropriate sample handling procedures will allow samples to arrive at the laboratory intact, at the proper temperature, and free of external contamination. Samples may be shipped to designated laboratories via overnight carriers according to Department of Transportation standards, or the samples may be delivered to local laboratories by project personnel or courier. Chain-of-custody procedures will be followed during any form of transport.

When samples are required to be stored at 4°C or lower, generous amounts of bagged ice will be packed with the samples. The ice will be present at the top and bottom of the container. Samples will be cooled with ice or in a refrigerator (if available) before being packed for shipment.

The following procedures will be used to prevent bottle breakage and cross-contamination:

- Sample bottles will be sealed in individual plastic bags.
- All samples will be transported inside appropriate laboratory-provided containers.
- Glass bottles will be placed in plastic mesh sleeves to prevent glass-to-glass contact.
- Bagged ice and/or foam blocks will be used to separate glass bottles.
- Original chain-of-custody form will be packed inside the shipping container in a resealable plastic bag.
- Containers will be taped shut and sealed with signed chain-of-custody seals.
- Samples that are known or suspected to be highly contaminated (based on field screening data or observation) will be packaged and shipped separately from other samples and identified on the COC.

Laboratories will be notified of any known or suspected highly contaminated samples. These samples will be stored separately from less contaminated samples to minimize the potential for cross-contamination.

Laboratory Sample Custody Procedures

Laboratory handling of samples will be completed in accordance with the Handling of Samples section of the Laboratory Quality Assurance Manual provided in Appendix B. Laboratory sample control personnel or a laboratory courier will accept the shipped samples and verify that the received samples match those on the chain-of-custody record. The laboratory representative will document the condition, temperature, and appropriate preservation of the samples should be checked and documented on the chain-of-custody form, and initiate an internal chain-of-custody for laboratory use by analysis and a sample disposal record. A unique laboratory project identification number will be assigned to the samples, and each sample container will be assigned a unique sample identification number that is cross-referenced to the original chain-of-custody such that traceability of test samples is unambiguous and documented.

Any non-conformance, irregularity, or compromised sample receipt must be documented on a Sample Receiving Checklist and brought to the immediate attention of the TAC-JV chemist and documented in the laboratory records. The laboratory will review this information for accuracy. The laboratory must supply sample receipt confirmation that includes the following:

- A fully executed copy of the chain-of-custody received with the samples
- Proper labeling of samples
- Proper sample containers with adequate volume for the analysis and necessary QC
- Cooler and sample receipt form noting any problems, breakages, holding time issues, temperature exceedances, inconsistencies between the chain-of-custody, purchase order, and project instructions, etc.

Sample holding-time tracking begins with the collection of samples and continues until the analysis is complete. Holding times for analytical methods required for this project are specified in Worksheets #19 and #30 (Sample Containers, Preservation, and Holding Times). Subcontracted analyses will be documented with the chain-of-custody form. Procedures ensuring internal laboratory chain-of-custody also will be implemented and documented by the laboratory. Specific instructions concerning the analysis specified for each sample will be communicated to the analysts. Analytical batches will be created, and laboratory QC samples will be introduced into each batch.

In order to avoid deterioration, contamination or damage to a sample during storage and handling, from the time of receipt until all analyses are complete, samples are stored in refrigerators, freezers or protected locations suitable for the sample matrix, except metals sample containers for only ICP or ICPMS analysis which may be stored unrefrigerated. In addition, samples to be analyzed for volatile organic parameters are stored in separate refrigerators designated for volatile organic parameters only. Samples are never to be stored with reagents, standards or materials that may create contamination.

Analysts and technicians retrieve the sample container allocated to their analysis from the designated refrigerator and place them on carts, analyze the sample, and return the remaining sample or empty container to the refrigerator from which it originally came. All unused portions of samples, including empty sample containers, are returned to the secure sample control area. Samples will be stored for 30 days after analysis and reporting, at which time the samples will be disposed of. The samples will be disposed of in accordance with the laboratory's waste disposal procedures and applicable local, state, and federal regulations. Disposal records will be maintained by the laboratory. SOPs describing sample control and custody will be maintained by the laboratory.

QAPP Worksheet #28 Table 28.1
Method QC Table - Metals in Soil by 6010D

Matrix: Soil
Analytical Group: Metals
Analytical Method/SOP: SW6010D/DV-MT-0021

QC Sample	Number/Frequency	Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator (DQI)
Method Blank	1 per Preparatory Batch (20 samples)	No Target Compounds> ½ LOQ or greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Common lab contaminants: no analytes detected > LOQ.	If sufficient sample is available, reanalyze samples. Qualify data as needed.	Analyst / Section Supervisor	Bias-Contamination
Laboratory Control Sample	1 per 20 field samples per matrix	QC acceptance criteria specified in DoD QSM v5.3, Table C-3,4	If acceptable, report. If LCS has high bias, and samples non-detect, report with case narrative comment. If the LCS has a high bias, and samples are detects, report and flag for the occurrence. If LCS has low bias, 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 / Section Supervisor	Accuracy
Matrix Spike	1 per 20 field samples per matrix	LCS acceptance criteria specified in DoD QSM v5.3, Table C-3,4	For specific analyte(s) in parent sample, apply J-flag if acceptance criteria are not met. If MS falls outside limits, evaluate data to determine the source of the difference and to determine if there is a matrix effect or analytical error. For Sample/Matrix Duplicate criteria only apply to analytes whose concentration in the sample is greater than or equal to the LOQ.	Analyst / Section Supervisor	Bias/Accuracy

Matrix: Soil
Analytical Group: Metals
Analytical Method/SOP: SW6010D/DV-MT-0021

QC Sample	Number/Frequency	Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator (DQI)
Matrix Spike Duplicate	1 per 20 field samples per matrix	RPD between MS and MSD < 20%	For specific analyte(s) in parent sample, apply J-flag if acceptance criteria are not met. If MSD falls outside limits, evaluate data to determine the source of the difference and to determine if there is a matrix effect or analytical error.	Analyst / Section Supervisor	Bias/Precision
Field Duplicate (FD)	1 per 10 field samples per matrix.	RPD < 50%	For specific analyte(s) in parent sample, apply to analytes whose concentration in the sample is greater than or equal to the LOQ.	Analyst / Section Supervisor	Precision
Dilution test	One per preparatory batch if MS or MSD fails. Only applicable for samples with concentrations >50 x LOQ. Use along with MS/MSD and PDS data to confirm matrix effects	Five-fold dilution must agree within ± 10% of the original determination	If dilution test fails analyze post digestion spike.	Analyst / Section Supervisor	Accuracy/Bias/ Precision
Post digestion spike addition	When MS/MSD fails and analyte concentration < 50 x LOQ	Recovery within 80-120% of expected results	For specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Analyst / Section Supervisor	Accuracy/Bias
Method of Standard Additions	When dilution test or PDS fails	NA	Document use of MSA in Case Narrative	Analyst / Section Supervisor	Accuracy/Bias

QAPP Worksheet #28 Table 28.2
Method QC Table - Mercury in Soil by 7470A/7471A

Matrix: Soil
Analytical Group: Mercury
Analytical Method/SOP: SW7470A/7471A/DV-MT-0016/DV-MT-0017

QC Sample	Number/Frequency	Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator (DQI)
Method Blank	1 per Preparatory Batch (20 samples)	No Target Compounds> ½ LOQ or greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Common lab contaminants: no analytes detected > LOQ.	If sufficient sample is available, reanalyze samples. Qualify data as needed.	Analyst / Section Supervisor	Bias-Contamination
Laboratory Control Sample	1 per 20 field samples per matrix	QC acceptance criteria specified in DoD QSM v5.3, Table C-11,12	If acceptable, report. If LCS has high bias, and samples non-detect, report with case narrative comment. If the LCS has a high bias, and samples are detects, report and flag for the occurrence. If LCS has low bias, 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 / Section Supervisor	Accuracy
Matrix Spike	1 per 20 field samples per matrix	LCS acceptance criteria specified in DoD QSM v5.3, Table C-11,12	For specific analyte(s) in parent sample, apply J-flag if acceptance criteria are not met. If MS falls outside limits, evaluate data to determine the source of the difference and to determine if there is a matrix effect or analytical error. For Sample/Matrix Duplicate criteria only apply to analytes whose concentration in the sample is greater than or equal to the LOQ.	Analyst / Section Supervisor	Bias/Accuracy

Matrix: Soil
Analytical Group: Mercury
Analytical Method/SOP: SW7470A/7471A/DV-MT-0016/DV-MT-0017

QC Sample	Number/Frequency	Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator (DQI)
Matrix Spike Duplicate	1 per 20 field samples per matrix	RPD between MS and MSD < 20%	For specific analyte(s) in parent sample, apply J-flag if acceptance criteria are not met. If MSD falls outside limits, evaluate data to determine the source of the difference and to determine if there is a matrix effect or analytical error.	Analyst / Section Supervisor	Bias/Precision
Field Duplicate (FD)	1 per 10 field samples per matrix.	RPD < 50%	For specific analyte(s) in parent sample, apply to analytes whose concentration in the sample is greater than or equal to the LOQ.	Analyst / Section Supervisor	Precision

QAPP Worksheet #28 Table 28.3
Method QC Table - VOCs in Soil by 8260C

Matrix: Soil
Analytical Group: Volatile Organics
Analytical Method/SOP: SW8260C/DV-MS-0010

QC Sample	Number/Frequency	Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator (DQI)
Internal Standards	Each calibration standard, sample and QC sample	Retention time within ± 10 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 in accordance with DoD QSM v5.3 requirements. If field samples still outside criteria, qualify data and explain in case narrative.	Analyst / Section Supervisor	NA
Method Blank	1 per Preparatory Batch (20 samples)	No Target Compounds> ½ LOQ or greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Common lab contaminants: no analytes detected > LOQ.	If sufficient sample is available, reanalyze samples. Qualify data as needed.	Analyst / Section Supervisor	Bias-Contamination
Laboratory Control Sample	1 per 20 field samples per matrix	QC acceptance criteria specified in DoD QSM v5.3, Table C-23,24	Reanalyze LCS once. If acceptable, report. Otherwise, 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 / Section Supervisor	Accuracy/Bias
Matrix Spike	1 per 20 field samples per matrix	LCS acceptance criteria specified in DoD QSM v5.3, Table C-23,24	Determine root cause; flag MS/MSD data; discuss in narrative.	Analyst / Section Supervisor	Bias/Accuracy/ Precision
Matrix Spike Duplicate	1 per 20 field samples per matrix	RPD between MS and MSD < 20%	For specific analyte(s) in parent sample, apply J-flag if acceptance criteria are not met.	Analyst / Section Supervisor	Bias/Precision

Matrix: Soil
Analytical Group: Volatile Organics
Analytical Method/SOP: SW8260C/DV-MS-0010

QC Sample	Number/Frequency	Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator (DQI)
			If MSD falls outside limits, evaluate data to determine the source of the difference and to determine if there is a matrix effect or analytical error.		
Surrogates	Every field and QC sample	Analyte acceptance criteria specified in DoD QSM v5.3, Table C-23,24	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, reextract and reanalyze.	Analyst / Section Supervisor	Accuracy/Bias

QAPP Worksheet #28 Table 28.4
Method QC Table - PAHs in Soil by 8270D-SIM

Matrix: Soil
Analytical Group: Polynuclear Aromatic Hydrocarbons
Analytical Method/SOP: SW8270D SIM/DV-MS-0002

QC Sample	Number/Frequency	Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator (DQI)
Internal Standards	Each calibration standard, sample and QC sample	Retention time within ± 10 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 in accordance with DoD QSM v5.3 requirements. If field samples still outside criteria, qualify data and explain in case narrative.	Analyst / Section Supervisor	NA
Method Blank	1 per Preparatory Batch (20 samples)	No Target Compounds> ½ LOQ or greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Common lab contaminants: no analytes detected > LOQ.	If sufficient sample is available, reanalyze samples. Qualify data as needed.	Analyst / Section Supervisor	Bias-Contamination
Laboratory Control Sample	1 per 20 field samples per matrix	QC acceptance criteria specified in DoD QSM v5.3, Table C-27	If acceptable, report. If LCS has high bias, and samples non-detect, report with case narrative comment. If the LCS has a high bias, and samples are detects, report and flag for the occurrence. If LCS has low bias, evaluate and reprep and	Analyst / Section Supervisor	Accuracy

Matrix: Soil
Analytical Group: Polynuclear Aromatic Hydrocarbons
Analytical Method/SOP: SW8270D SIM/DV-MS-0002

QC Sample	Number/Frequency	Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator (DQI)
			reanalyze the LCS and all samples in the associated prep batch for failed analytes, if sufficient sample material is available.		
Matrix Spike	1 per 20 field samples per matrix	LCS acceptance criteria specified in DoD QSM v5.3, Table C-27	For specific analyte(s) in parent sample, apply J-flag if acceptance criteria are not met. If MS falls outside limits, evaluate data to determine the source of the difference and to determine if there is a matrix effect or analytical error. For Sample/Matrix Duplicate criteria only apply to analytes whose concentration in the sample is greater than or equal to the LOQ.	Analyst / Section Supervisor	Bias/Accuracy
Matrix Spike Duplicate	1 per 20 field samples per matrix	RPD between MS and MSD < 20%	For specific analyte(s) in parent sample, apply J-flag if acceptance criteria are not met. If MSD falls outside limits, evaluate data to determine the source of the difference and to determine if there is a matrix effect or analytical error.	Analyst / Section Supervisor	Bias/Precision

Matrix: Soil
Analytical Group: Polynuclear Aromatic Hydrocarbons
Analytical Method/SOP: SW8270D SIM/DV-MS-0002

QC Sample	Number/Frequency	Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator (DQI)
Field Duplicate (FD)	1 per 10 field samples per matrix.	RPD < 40%	For specific analyte(s) in parent sample, apply to analytes whose concentration in the sample is greater than or equal to the LOQ.	Analyst / Section Supervisor	Precision
Surrogates	Every field and QC sample	Analyte acceptance criteria specified in DoD QSM v5.3, Table C-27 if available or use historical lab control limits	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, reextract and reanalyze.	Analyst / Section Supervisor	Accuracy/Bias

QAPP Worksheet #28 Table 28.5
Method QC Table - Explosives in Soil by 8330B

Matrix: Soil
Analytical Group: Explosives (Nitroaromatics, Nitramines, and Nitrate Esters)
Analytical Method/SOP: SW8330B/DV-LC-0002

QC Sample	Number/Frequency	Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator (DQI)
Method Blank	1 per Preparatory Batch (20 samples)	No Target Compounds> ½ LOQ or greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Common lab contaminants: no analytes detected > LOQ.	If sufficient sample is available, reanalyze samples. Qualify data as needed.	Analyst / Section Supervisor	Bias-Contamination
Laboratory Control Sample	1 per 20 field samples per matrix	QC acceptance criteria specified in DoD QSM v5.3, Table C-35	If acceptable, report. If LCS has high bias, and samples non-detect, report with case narrative comment. If the LCS has a high bias, and samples are detects, report and flag for the occurrence. If LCS has low bias, 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 / Section Supervisor	Accuracy
Matrix Spike	1 per 20 field samples per matrix	LCS acceptance criteria specified in DoD QSM v5.3, Table C-35	For specific analyte(s) in parent sample, apply J-flag if acceptance criteria are not met. If MS falls outside limits, evaluate data to determine the source of the difference and to determine if there is a matrix effect or analytical error. For Sample/Matrix Duplicate criteria only apply to analytes whose concentration in the sample is greater than or equal to the LOQ.	Analyst / Section Supervisor	Bias/Accuracy

Matrix: Soil
Analytical Group: Explosives (Nitroaromatics, Nitramines, and Nitrate Esters)
Analytical Method/SOP: SW8330B/DV-LC-0002

QC Sample	Number/Frequency	Acceptance Criteria	Corrective Action	Title/position of person responsible for corrective action	Data Quality Indicator (DQI)
Matrix Spike Duplicate	1 per 20 field samples per matrix	RPD between MS and MSD < 20%	For specific analyte(s) in parent sample, apply J-flag if acceptance criteria are not met. If MSD falls outside limits, evaluate data to determine the source of the difference and to determine if there is a matrix effect or analytical error.	Analyst / Section Supervisor	Bias/Precision
Field Duplicate (FD)	1 per 10 field samples per matrix.	RPD < 50%	For specific analyte(s) in parent sample, apply to analytes whose concentration in the sample is greater than or equal to the LOQ.	Analyst / Section Supervisor	Precision
Surrogates	Every field and QC sample	Analyte acceptance criteria specified in DoD QSM v5.3, Table C-35 or lab limits	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, reextract and reanalyze	Analyst / Section Supervisor	Accuracy
Confirmation of positive results	All results > DL must be confirmed	Calibration and QC criteria are the same for the confirmation analysis as for initial or primary column analysis. Results between primary and second column RPD $\leq$ 40%. Confirmation column must be capable of resolving all of the analytes of interest and must have a different retention time order relative to the primary column. Report from primary column unless project directs otherwise.	For specific analyte(s) in parent sample, apply J-flag if acceptance criteria are not met.	Analyst / Section Supervisor	Confirmation

QAPP Worksheet #29
Project Documents and Records

The required data package deliverables during every aspect of the project are identified in this worksheet. These include, but are not limited to, the following: (1) sample collection and field measurement records, (2) analytical records, and (3) data assessment records.

Sample collection and field record generation and storage are summarized in Table 29-1.Table 29.1. Sample Collection and Field Records

Project Document/Record	Generation	Verification	Storage Location/Archival
Field Logbook or Data	Field Sampler(s)	Field Site Manager	Hard copies: Project folder Electronic copies: SharePoint project folder
Chain-of-custody Forms	Field Sampler(s)	Field Site Manager	Hard copies: Project folder Electronic copies: SharePoint project folder
Air Bills	Field Sampler(s)	Field Site Manager	Hard copies: Project folder Electronic copies: SharePoint project folder
Contractor Daily QC Reports	Field Team Leader	Field Site Manager	Hard copies: Project folder Electronic copies: SharePoint project folder
Deviations	Field Sampler(s)	Field Site Manager	SharePoint project folder
Corrective Action Reports	Site Manager	Project Manager	SharePoint project folder
Correspondence	Field Site Manager	Project Manager	SharePoint project folder

Analytical record generation and storage are summarized in Table 29-2.

Table 29.2. Laboratory Records

Project Document/Record	Generation	Verification	Storage Location/Archival
Hard-copy Analytical Data Deliverables (in PDF format)	Eurofins/TestAmerica	Gary Torf	Project folder
Electronic Analytical Data Deliverables	Eurofins/TestAmerica	Gary Torf	Project folder
Electronic Data Reports	Torf Environmental Services	Gary Torf	SharePoint project folder

Project audit, evaluation, and final report generation and storage are summarized in Table 29-3.

Table 29.3. Project Assessments

Project Document/Record	Generation	Verification	Storage Location/Archival
Field Audit Checklists	Health and Safety Manager	Project Manager	SharePoint project folder
Final Reports	Site Managers	Project Manager	SharePoint project folder
Data Quality Evaluation Report	Project Chemist	Project Chemist	SharePoint project folder

QAPP Worksheets #31, #32, and #33
Assessments and Corrective Action

During the project activities at IAAAP the project manager, project chemist, field managers, and sampling team members must verify that measurement and field procedures are followed as specified in this UFP-QAPP and that measurement data meet the prescribed acceptance criteria. The TAC JV Field Team Leader will communicate proposed changes in the field to the TAC JV Task Manager, who, together with the TAC JV Project Manager will communicate the related issue to the USACE PM, as needed. CA may be required as a result of deviations from field and/or analytical procedures. Deficiencies identified in audits and data quality assessments may also call for CA. If a problem arises, prompt action to correct the problem is imperative.

Periodic assessments will be performed during the course of the project to verify that the planned project activities are implemented in accordance with this UFP-QAPP. The type, frequency, and responsible parties of possible assessment activities for the project are summarized in Table 31-1.

Based on the findings of the project assessments, CA may be required. For assessment findings that require CA, deficiencies will be documented and communicated to the appropriate project personnel. CA will then be implemented and a follow-up assessment performed to verify the results of the CA. Procedures for handling deviations during each type of assessment are summarized in the Tables 31-1 and 31-2.

Table 31.1. Assessments and Corrective Actions

Assessment Type	Responsible Party and Organization	Number/Frequency	Estimated Dates	Assessment Deliverable	Deliverable Due Date
Planning documents	Project Staff and QA Manager	To be prepared before initiation of activities at the site(s)	Planning documents will be finalized before project mobilization.	QC checklist for each document	7 to 10 business days after response to comments
Technical project reports	Project Staff and QA Manager	To be prepared upon completion of activities at the site(s)	Reports will be completed following the completion of field activities and the receipt and validation of laboratory data deliverables.	QC checklist for each document	7 to 10 business days after response to comments
Internal and external project reporting reviews	Project Staff	After receiving comments	7 to 10 business days	Internal and external corrective action reports, updated case narratives, and corrected data submissions	7 to 10 business days
Laboratory technical evaluation	Project Manager and Project Chemist	Once, before laboratory subcontract award	During UFP-QAPP development	Laboratory subcontract award based on evaluation of the technical proposal	Before project mobilization
Subcontractor technical evaluation	Project Manager	Once, before subcontract award	During UFP-QAPP development	Subcontract award based on evaluation of the technical proposal	Before project mobilization
Readiness review	Project Manager	Once before project mobilization	Before field work	Meeting minutes, email, or other correspondence to document action items that remain to be addressed	Before project mobilization
Daily QC audit	Project Manager or Site Manager	Daily during field activities	During field work	Document variances in logbook notes, daily QC report, or correspondence	Within 24 hours of audit
Review of written or electronic field documentation (logbook notes, sampling data sheets, etc.)	Project Manager or Site Manager	Weekly, during field activities	During field work	Document variances in logbook notes, daily QC report, or correspondence	Within 5 days of audit

Table 31.1. Assessments and Corrective Actions

Assessment Type	Responsible Party and Organization	Number/Frequency	Estimated Dates	Assessment Deliverable	Deliverable Due Date
Laboratory performance evaluation	QA Manager, Project Chemist, or Project Manager	As required by USACE	USACE Program Manager will be notified at least 1 month before sampling at site where program will be implemented	Proficiency testing sample results report and/or split sample results evaluation	USACE Program Manager will provide PT sample results or split sample results to the project chemist. These data will be evaluated during the data validation and usability assessment and included in the project report.
Health and safety audit	Health and Safety Manager	Once during field activities	3 to 5 business days	Written report	24 hours after notification

Table 31.2. Assessment Response and Corrective Action

Assessment Type	Responsibility for Responding to Assessment Findings	Assessment Response Documentation	Timeframe for Response	Responsibility for Implementing Corrective Action	Responsible for Monitoring Corrective Action Implementation
Review of planning documents	Lead Author or Project Team	Responses to comments	7 to 10 business days	Lead Author(s), or as directed by Project Manager	QA Manager or Project Manager
Technical project reports (e.g., after-action reports, remedial action reports, annual reports)	Lead Author or Project Team	Responses to comments	7 to 10 business days	Lead Author(s), or as directed by Project Manager	QA Manager or Project Manager
Daily QC audit	Project Manager or Site Manager	Daily QC report, internal memo, or correspondence	As appropriate based on findings	Site Manager or designee	Project Manager
Review of written or electronic field documentation (logbook notes, sampling data sheets, etc.)	Site Manager	Daily QC report, internal memo, or correspondence	As appropriate based on findings	Field Team	Project Manager
Review of field instrument calibration logs	Field Team or Site Manager	Daily QC report, internal memo, or correspondence	Within 24 hours of review	Field Team	Project Manager
Review of chain-of-custody forms	Project Chemist	Daily QC report, internal memo, or correspondence	Within 24 hours of review	Project Chemist	Project Manager
Review of laboratory cooler receipt information	Project Chemist	Internal correspondence or correspondence with subcontract laboratory	Within 24 hours of review	Project Chemist	Project Manager
Field performance audit	Field Team	Verbal debriefing after audit and/or written corrective action plan	As appropriate based on findings	Field Team or Site Manager	Field Team or Site Manager
Laboratory system audit	Project Chemist	Verbal debriefing after audit and/or written documentation	Before the start of field activities	Project Chemist	QA Manager
Laboratory performance assessment	Project Chemist	Verbal debriefing after audit and/or written report	As appropriate based on findings	Project Chemist	Project Manager

Table 31.2. Assessment Response and Corrective Action

Assessment Type	Responsibility for Responding to Assessment Findings	Assessment Response Documentation	Timeframe for Response	Responsibility for Implementing Corrective Action	Responsible for Monitoring Corrective Action Implementation
Data quality and usability assessment	Project Chemist	Data validation report IDNR Laboratory Data Review Checklist(s) Corrective action (if required)	For inclusion in Draft and Final reports, or as determined by corrective action	Project Chemist	Project Manager
Laboratory performance evaluation	QA Manager or Project Chemist	Written report	As determined by report results	Project Chemist	QA Manager
Health and safety audit	Health and Safety Manager	Written report	As determined by report results	Health and Safety Manager or designee	Health and Safety Manager

QAPP Worksheet #34
Data Verification and Validation Inputs

Item	Description	Verification (completeness)	Validation (conformance to specifications)
Planning Documents/Records			
1	Approved UFP-QAPP	**X**	**X**
2	Contract	**X**	
3	Field SOPs	**X**	**X**
4	Laboratory certifications	**X**	**X**
5	Laboratory SOPs	**X**	**X**
Field Records			
6	Field logbooks	**X**	**X**
7	Equipment calibration records	**X**	**X**
8	Chain-of-Custody Forms	**X**	**X**
9	Sampling diagrams/surveys	**X**	**X**
10	Drilling logs	**X**	**X**
11	Relevant Correspondence	**X**	**X**
12	Change orders/deviations	**X**	**X**
13	Field audit reports	**X**	**X**
14	Field corrective action reports	**X**	**X**
Analytical Data Package			
15	Cover sheet (laboratory identifying information)	**X**	**X**
16	Case narrative	**X**	**X**
17	Internal laboratory chain-of-custody		
18	Sample receipt records	**X**	**X**
19	Sample chronology (i.e. dates and times of receipt, preparation, & analysis)	**X**	**X**
20	Communication records	**X**	**X**
21	Project-specific PT sample results		
22	LOD/LOQ establishment and verification	**X**	**X**
23	Standards Traceability		
24	Instrument calibration records	**X**	**X**
25	Definition of laboratory qualifiers	**X**	**X**
26	Results reporting forms	**X**	**X**
27	QC sample results	**X**	**X**
28	Corrective action reports	**X**	**X**
29	Raw data	**X**	**X**
30	Electronic data deliverable	**X**	**X**

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QAPP Worksheet #35
Data Verification Procedures

Records Reviewed	Requirement Documents	Process Description	Responsible Person, Organization
Field logbook	QAPP, Field Standard Operating Procedures (SOPs)	▪ Verify that records are present and complete for each day of field activities. ▪ Verify that planned samples including field QC samples were collected and that sample collection locations are documented. ▪ Verify that meteorological data were provided for each day of field activities. ▪ Verify that changes/exceptions are documented and were reported in accordance with requirements. ▪ Verify that required field monitoring was performed, and results are documented.	Weekly - Project Manager At conclusion of field activities - Project Manager
Chain-of-custody forms	QAPP, Field SOPs	▪ Verify completeness of Chain-of-Custody records. ▪ Examine entries for consistency with the field logbook. ▪ Check that appropriate methods and sample preservation have been recorded. ▪ Verify that the required volume of sample has been collected and that sufficient sample volume is available for QC samples (e.g., MS/MSD). ▪ Verify that required signatures and dates are present. ▪ Check for transcription errors.	Daily - Field Lead At conclusion of field activities - Project Chemist

Records Reviewed	Requirement Documents	Process Description	Responsible Person, Organization
Laboratory Deliverable	QAPP, Lab SOPs	▪ Verify that the laboratory deliverable contains all records specified in the UFP-QAPP. ▪ Check sample receipt records to ensure sample condition upon receipt was noted, and any missing/broken sample containers were noted and reported according to plan. ▪ Compare the data package with the Chains-of-Custody to verify that results were provided for all collected samples. ▪ Review the narrative to ensure all QC exceptions are described. ▪ Check for evidence that any required notifications were provided to project personnel as specified in the QAPP. ▪ Verify that necessary signatures and dates are present. ▪ The data will be verified to the Quality Control requirements contained in the DoD QSM v5.3 and the requirements of this UFP-QAPP Laboratory Electronic Data Deliverable (EDD) will be verified to the Laboratory hardcopy report	Before release – Laboratory Project Manager Upon receipt – Data Validator At conclusion of Data Validation - Project Chemist
Audit Reports, Corrective Action Reports	QAPP	▪ Review the audit reports to ensure that all planned audits were conducted. ▪ Examine audit reports. For any deficiencies noted, verify that corrective action was implemented according to plan.	Project Quality Assurance Manager

QAPP Worksheet #36
Data Validation Procedures

Analytical Group/Method:	Definitive Analyses
Data deliverable requirements:	Laboratory Report (PDF) consistent with USEPA Stage 4 Validation Requirements
Analytical specifications:	UFP-QAPP and DoD QSM v5.3
Measurement performance criteria:	UFP-QAPP WS 12, WS 28
Percent of data packages to be validated:	100% Validated to Stage 2A (Screening data) and Stage 2B (Definitive data)
Percent of raw data reviewed:	100% percent (calibrations and laboratory QA/QC will be reviewed with raw data for all samples)
Percent of results to be recalculated:	As needed if systematic quantitation errors are found during validation
Validation procedure:	UFP-QAPP; DoD General Data Validation Guidelines, September 2019, Revision 1 and applicable Modules
Validation code (*see attached table):	S2AVEM (Screening methods), S2BVEM (Definitive methods)
Electronic validation program/version:	Documented if used

Validation Code*	Validation Label	Description/Reference
S2BVEM	Stage 2B Validation Electronic and Manual	EPA 540-R-08-005

The following data qualifiers will be applied during data validation. Potential impacts on project-specific data quality objectives will be discussed in the data validation report:

Data Validation Codes	Definitions
U	Analyte was not detected and is reported as less than the LOD. The LOD has been adjusted for any dilution or concentration of the sample. When applied to a result considered to be an artifact from blank contamination, the associated numerical value is the detected concentration prior to qualification.
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
UJ	The analyte was not detected above the reported sample LOQ. However, the reported LOQ is approximate and may or may not represent the actual LOQ necessary to accurately and precisely measure the analyte in the sample.
X	The sample results (including non-detects) were affected by serious deficiencies in the ability to analyze the sample and to meet published method and project QC criteria. The presence or absence of the analyte cannot be substantiated by the data provided.

	Acceptance or rejection of the data should be decided by the project team (which should include a project chemist), but exclusion of the data is recommended.
JN	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification." The associated numerical result is an estimate. Data qualified "JN" are for screening purpose only and will need confirmatory analysis to further increase usability.

Analysis Method Name	**Analysis**	**QC Element**	**Action (Detect Flag/Non-Detect Flags)**				**QC Rule**
				Lower Control	**Upper Control**		
Metals by Inductively Coupled Plasma/Atomic Emission Spectrometry	SW6010D	Blank - Negative		None	J/UJ		All in Batch
		Calibration Blank		None	U/None		No Rule
		Continuing Calibration Verification		X/X	X/X		No Rule
		Equipment Blank		None	U/None		No Rule
		Field Duplicate RPD		None	J/None		Parent and FD Only
		Initial Calibration Verification		X/X	X/X		No Rule
		Interference Check Sample A		None	J/None		No Rule
		Interference Check Sample A - Negative		None	J/UJ		No Rule
		Interference Check Sample AB		J/UJ	J/None		No Rule
		Lab Blank		None	U/None		All in Batch
		Lab Replicate RPD		None	J/UJ		Parent Only
		LCS Recovery		if ≥60%, J-/UJ if <60%, J-/X	J+/None		All in Batch
		LCS RPD		None	J/UJ		All in Batch

Analysis Method Name	Analysis	QC Element	Action (Detect Flag/Non-Detect Flags)				QC Rule
				Lower Control	Upper Control		
		Low Level Calibration Verification		J/UJ	J/None		No Rule
		MS Recovery		if ≥30%, J/UJ if ≤30%, J-/X	J+/None		Parent Only
		MS RPD		None	J/UJ		Parent Only
		Post Spike		None	J/None		Parent Only
		Test Hold Time		None	J/UJ		No Rule
Mercury in Soil (Manual Cold-Vapor Technique)	SW7471A	Calibration Blank		None	U/None		No Rule
		Continuing Calibration Verification		J-/UJ	J+/None		No Rule
		Equipment Blank		None	U/None		No Rule
		Field Duplicate RPD		None	J/None		Parent and FD Only
		Initial Calibration Verification		J-/UJ	J+/None		No Rule
		Lab Blank		None	U/None		All in Batch
		Lab Replicate RPD		None	J/UJ		Parent Only
		LCS Recovery		J-/X	J+/None		All in Batch
		LCS RPD		None	J/UJ		All in Batch
		Low Level Calibration Verification		J-/UJ	J+/None		No Rule
		MS Recovery		J-/UJ	J+/None		Parent Only
		MS RPD		None	J/UJ		Parent Only

Analysis Method Name	Analysis	QC Element	Action (Detect Flag/Non-Detect Flags)				QC Rule
				Lower Control	Upper Control		
		Test Hold Time		None	J/UJ		No Rule
Volatile Organic Compounds by GC/MS	SW8260C	Continuing Calibration Verification		J-/UJ	J+/UJ		No Rule
		Ending Continuing Calibration Verification		J-/UJ	J+/UJ		No Rule
		Equipment Blank		None	U/None		No Rule
		Field Duplicate RPD		None	J/None		Parent and FD Only
		Initial Calibration Verification		J-/UJ	J+/UJ		No Rule
		Lab Blank		None	U/None		All in Batch
		Lab Replicate RPD		None	J/None		Parent Only
		LCS Recovery		J-/X	J+/None		All in Batch
		LCS RPD		None	J/None		All in Batch
		MS Recovery		J-/UJ	J+/None		Parent Only
		MS RPD		None	J/None		Parent Only
		Surrogate		J-/UJ	J+/None		1 Out
		Test Hold Time		None	J/UJ		No Rule
		Trip Blank		None	U/None		No Rule
Semivolatile Organic Compounds by Capillary GC/MS	SW8270D	Continuing Calibration Verification		J-/UJ	J+/UJ		No Rule
		Ending Continuing Calibration Verification		J-/UJ	J+/UJ		No Rule
		Equipment Blank		None	U/None		No Rule

Analysis Method Name	Analysis	QC Element	Action (Detect Flag/Non-Detect Flags)				QC Rule
				Lower Control	Upper Control		
		Field Duplicate RPD		None	J/None		Parent and FD Only
		Initial Calibration Verification		J-/UJ	J+/UJ		No Rule
		Lab Blank		None	U/None		All in Batch
		Lab Replicate RPD		None	J/None		Parent Only
		LCS Recovery		J-/UJ	J+/None		All in Batch
		LCS RPD		None	J/None		All in Batch
		MS Recovery		J-/UJ	J+/None		Parent Only
		MS RPD		None	J/None		Parent Only
		Surrogate		J-/UJ	J+/None		1 Out
		Test Hold Time		None	J/UJ		No Rule
Polynuclear Aromatic Hydrocarbons by GC/MS SIM	SW8270D SIM	Continuing Calibration Verification		J-/UJ	J+/UJ		No Rule
		Ending Continuing Calibration Verification		J-/UJ	J+/UJ		No Rule
		Equipment Blank		None	U/None		No Rule
		Field Duplicate RPD		None	J/None		Parent and FD Only
		Lab Blank		None	U/None		All in Batch
		Lab Replicate RPD		None	J/None		Parent Only
		LCS Recovery		J-/UJ	J+/None		All in Batch
		LCS RPD		None	J/None		All in Batch
		MS Recovery		J-/UJ	J+/None		Parent Only
		MS RPD		None	J/None		Parent Only

Analysis Method Name	Analysis	QC Element	Action (Detect Flag/Non-Detect Flags)				QC Rule
				Lower Control	Upper Control		
		Surrogate		J-/UJ	J+/None		1 Out
		Test Hold Time		None	J/UJ		No Rule
Explosives by HPLC	SW8330B	Continuing Calibration Verification		J-/UJ	J+/UJ		No Rule
		Ending Continuing Calibration Verification		J-/UJ	J+/UJ		No Rule
		Equipment Blank		None	U/None		No Rule
		Field Duplicate RPD		None	J/None		Parent and FD Only
		Initial Calibration Verification		J-/UJ	J/UJ		No Rule
		Lab Blank		None	U/None		All in Batch
		Lab Replicate RPD		None	J/None		Parent Only
		LCS Recovery		J-/UJ	J+/None		All in Batch
		LCS RPD		None	J/None		All in Batch
		MS Recovery		J-/UJ	J+/None		Parent Only
		MS RPD		None	J/None		Parent Only
		Surrogate		J/UJ	J/None		1 Out
		Test Hold Time		None	J/UJ		No Rule

QAPP Worksheet #37
Data Usability Assessment

Tony Finch, the TAC JV Project Manager, and David Nelson, the TAC JV Task Manager, will be responsible for information included in the usability assessment and for assigning task work for data included in the data usability assessment. The project team will perform the operations summarized in Worksheet #35 and Worksheet #36 to evaluate sampling team and laboratory compliance with the requirements with this QAPP. Evaluation activities will be documented in the QA reports listed in Worksheet #29 and will be used to assess the usability of project data in levels of detail ranging from an analyte- and sample-specific basis to the overall dataset for the sampling event. The DQIs and formulas used to evaluate data quality are presented in Worksheet #12.

The assessment will include an evaluation of the QC elements relating to precision, accuracy, representativeness, comparability, completeness (both sample collection and analytical), and sensitivity. The impact of any data gaps resulting from sampling incompleteness or rejected data will be evaluated in a data quality evaluation included as an appendix to the RACR.

Personnel responsible for performing the usability assessment include the TAC JV Project Manager, TAC JV Task Manager, Project Chemist.

Evaluation activities performed throughout the data collection process will be documented in the assessment reports listed in Worksheet #29. An overall assessment of the impact of data usability issues will be presented in the RACR. The usability assessment will evaluate the overall dataset from all of the building and line locations.

Summarize of the data usability assessment process used to analyze the data:

Step 1	Review the project’s objectives and sampling design ▪ Review the data quality objectives ▪ Review the sampling design as implemented for consistency with stated objectives ▪ Summarize any deviations from the planned sample design and describe their impacts on the data quality objectives
Step 2	Review data outputs and evaluate conformance to measurement performance criteria ▪ Review the data verification/validation reports ▪ Evaluate conformance to MPCs (WS #12), including precision, accuracy, representativeness, comparability, completeness, and sensitivity
Step 3	Document data usability and draw conclusions ▪ Assess performance of sampling design ▪ Identify limitations on data use ▪ Update CSM, apply decision rules, document conclusions
Step 4	Document lessons learned and make recommendations ▪ Summarize conclusions ▪ Document Lessons Learned ▪ Prepare the data usability summary report

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FIGURES

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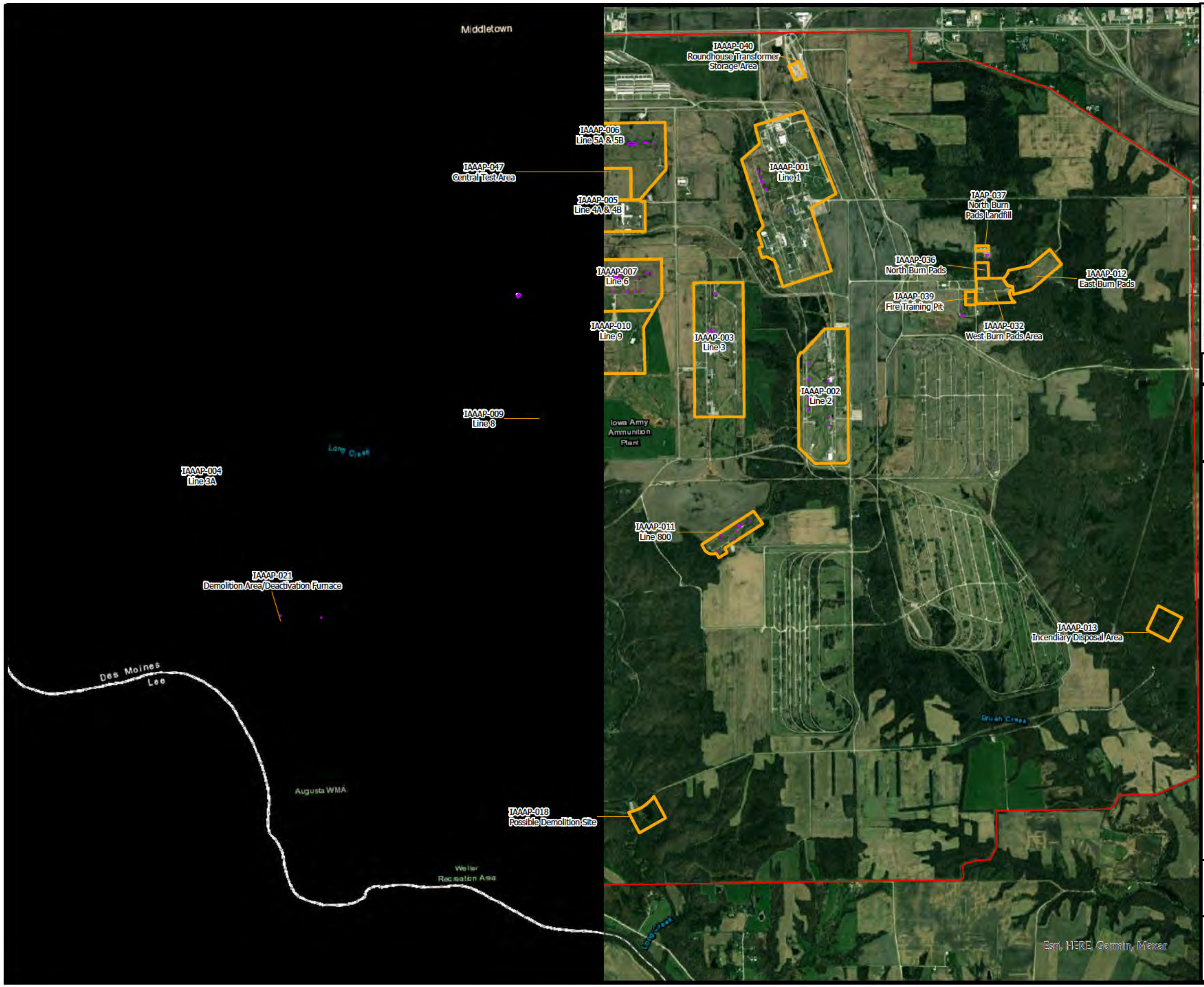

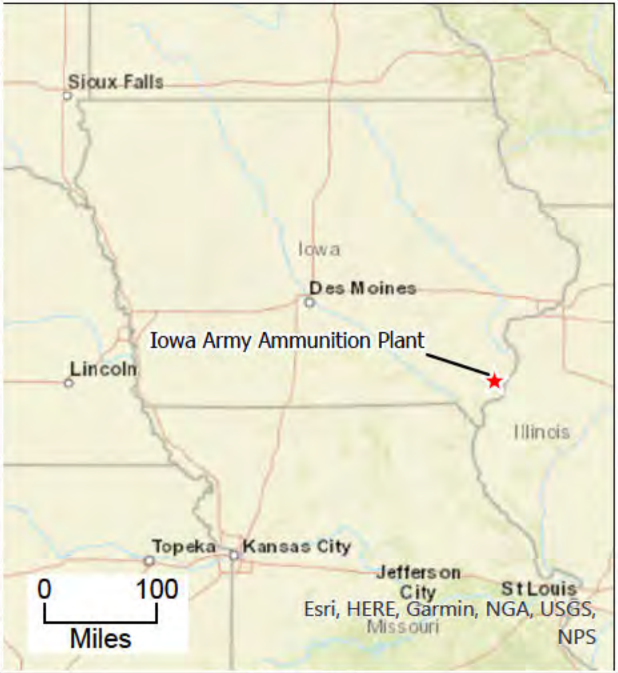

Site Location

FIGURE 1
Site Location Map
Iowa Army Ammunition Plant

LEGEND

🟧 Line Boundary
🟥 IAAAP Boundary
🟪 Structures

Notes:

IAAAP - Iowa Army Ammunition Plant

N

0 0.5 1
Miles

Uniform Federal Policy Quality Assurance Project Plan
Contaminated Soil Remedial Design
Iowa Army Ammunition Plant, Middletown, Iowa

Date Created: 12/16/2020
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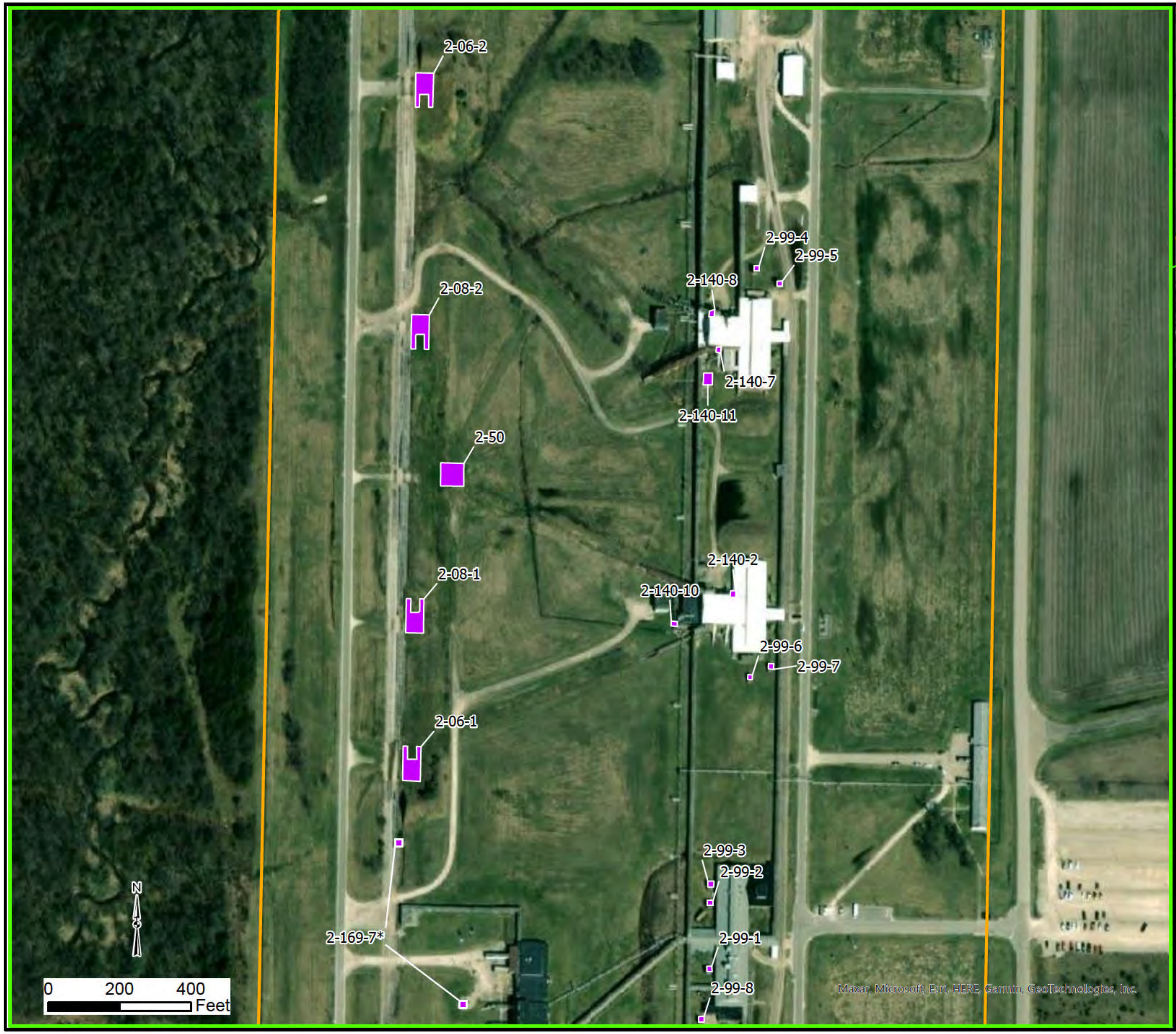

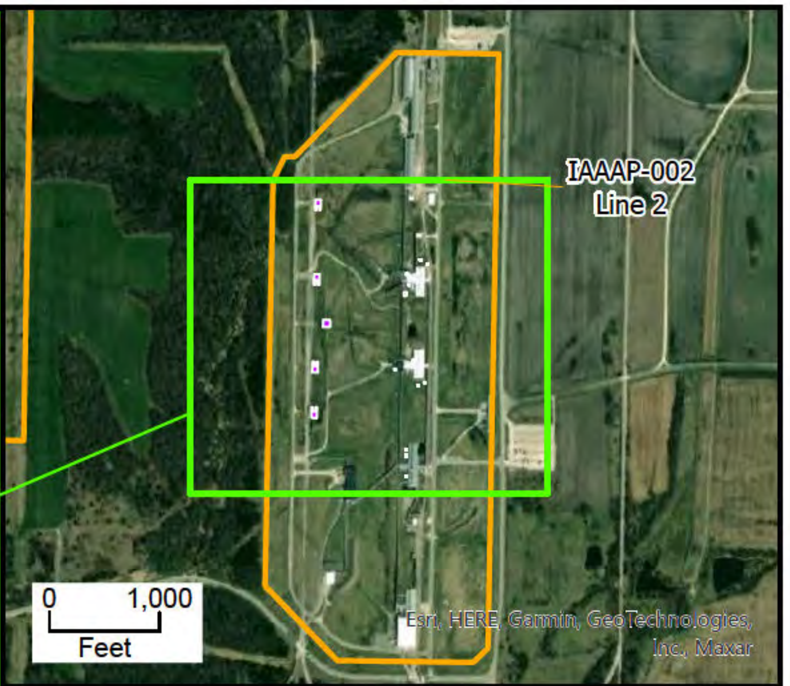

Line Location

FIGURE 2
Proposed Sample Locations, Line 2
Iowa Army Ammunition Plant

LEGEND

🟧 Line Boundary

🟪 Building

Bldg #	# of Samples
2-06-1	12
2-06-2	12
2-08-1	12
2-08-2	12
2-50	12
2-99-1	6
2-99-2	6
2-99-3	6
2-99-4	6
2-99-5	6

Bldg #	# of Samples
2-99-6	6
2-99-7	6
2-99-8	6
2-140-2	6
2-140-7	6
2-140-8	6
2-140-10	6
2-140-11	6
2-169-7	6

Notes:

* - Two potential locations for structure 2-169-7
IAAAP - Iowa Army Ammunition Plant
Bldg - Building

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Iowa Army Ammunition Plant, Middletown, Iowa

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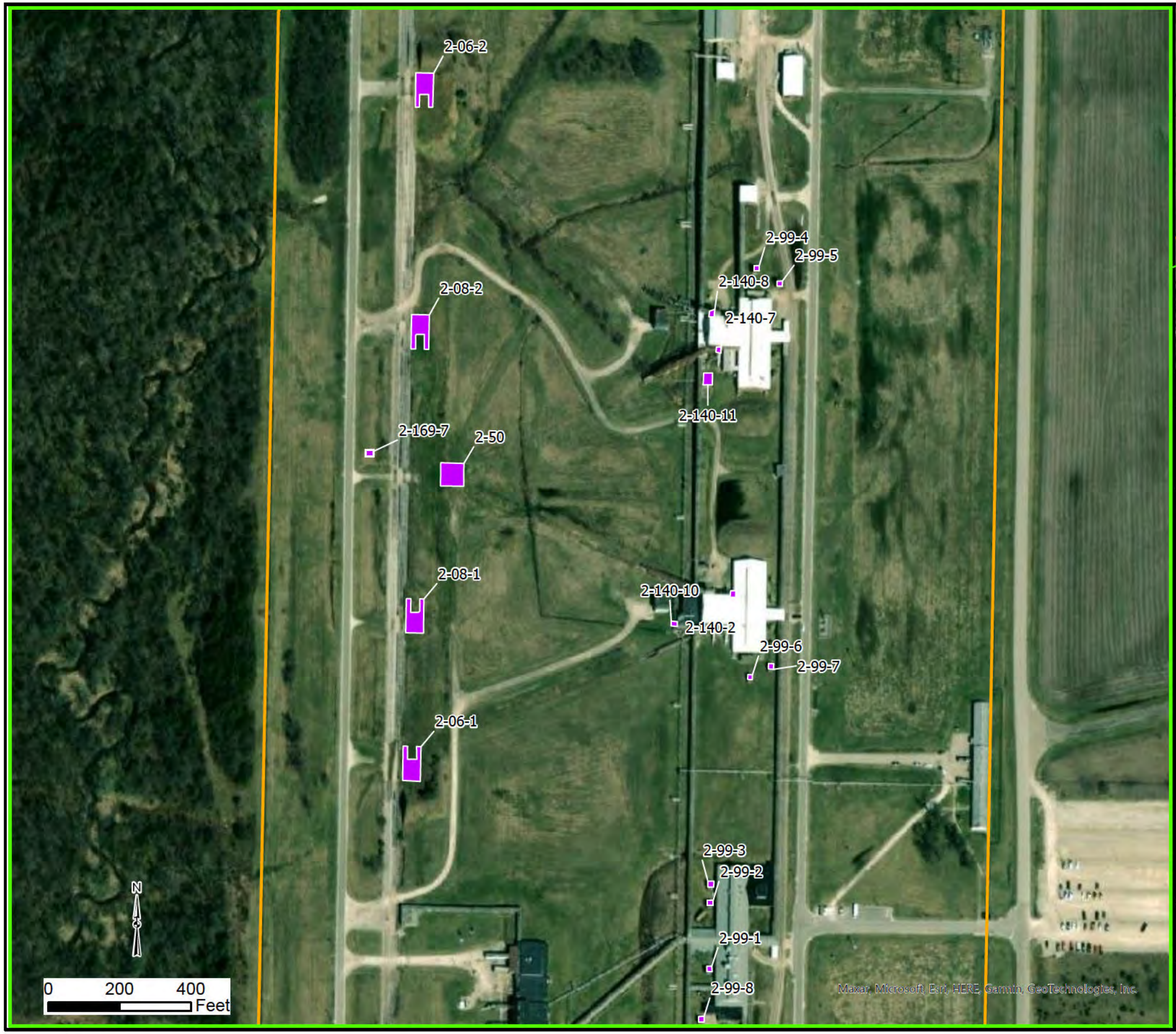

Line Location

FIGURE 3
Proposed Sample Locations, Line 2
Iowa Army Ammunition Plant

LEGEND

🟧 Line Boundary

🟪 Building

Bldg #	# of Samples
2-06-1	12
2-06-2	12
2-08-1	12
2-08-2	12
2-50	12
2-99-1	6
2-99-2	6
2-99-3	6
2-99-4	6
2-99-5	6

Bldg #	# of Samples
2-99-6	6
2-99-7	6
2-99-8	6
2-140-2	6
2-140-7	6
2-140-8	6
2-140-10	6
2-140-11	6
2-169-7	6

Notes:

IAAAP - Iowa Army Ammunition Plant
Bldg - Building

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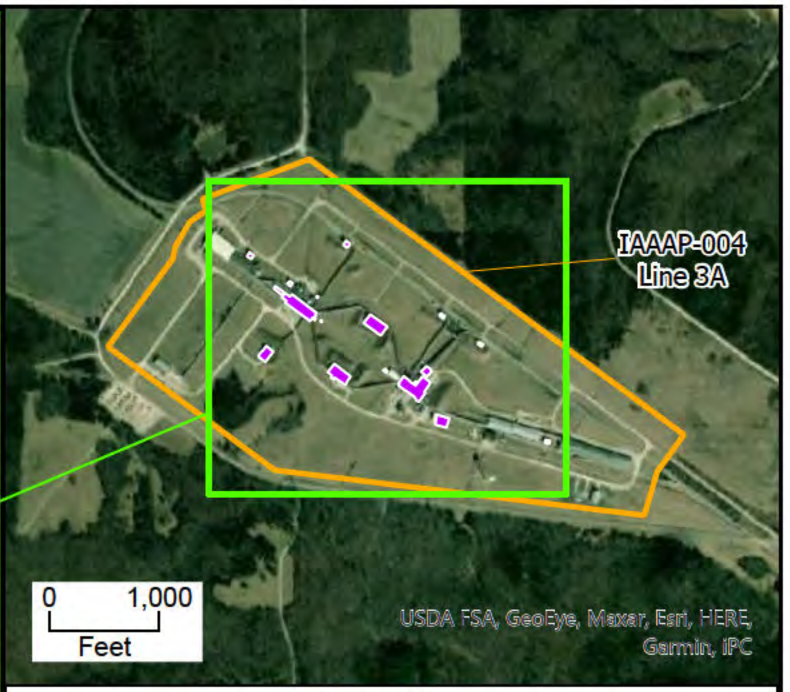

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Line Location

FIGURE 4
Proposed Sample Locations, Line 3A
Iowa Army Ammunition Plant

LEGEND

▢	Line Boundary
■	Building

Bldg #	# of Samples
3A-03-1	10
3A-03-2	10
3A-05-1	26
3A-05-2	26
3A-06	10
3A-08-1	10
3A-08-2	10
3A-10-5	12
3A-20-1	20
3A-20-2	20

Bldg #	# of Samples
3A-50-1	12
3A-99-1	2
3A-99-2	2
3A-99-7	2
3A-99-8	10
3A-100	12
3A-140-2	2
3A-140-3	2
3A-140-4	2

Notes:
IAAAP - Iowa Army Ammunition Plant
Bldg - Building

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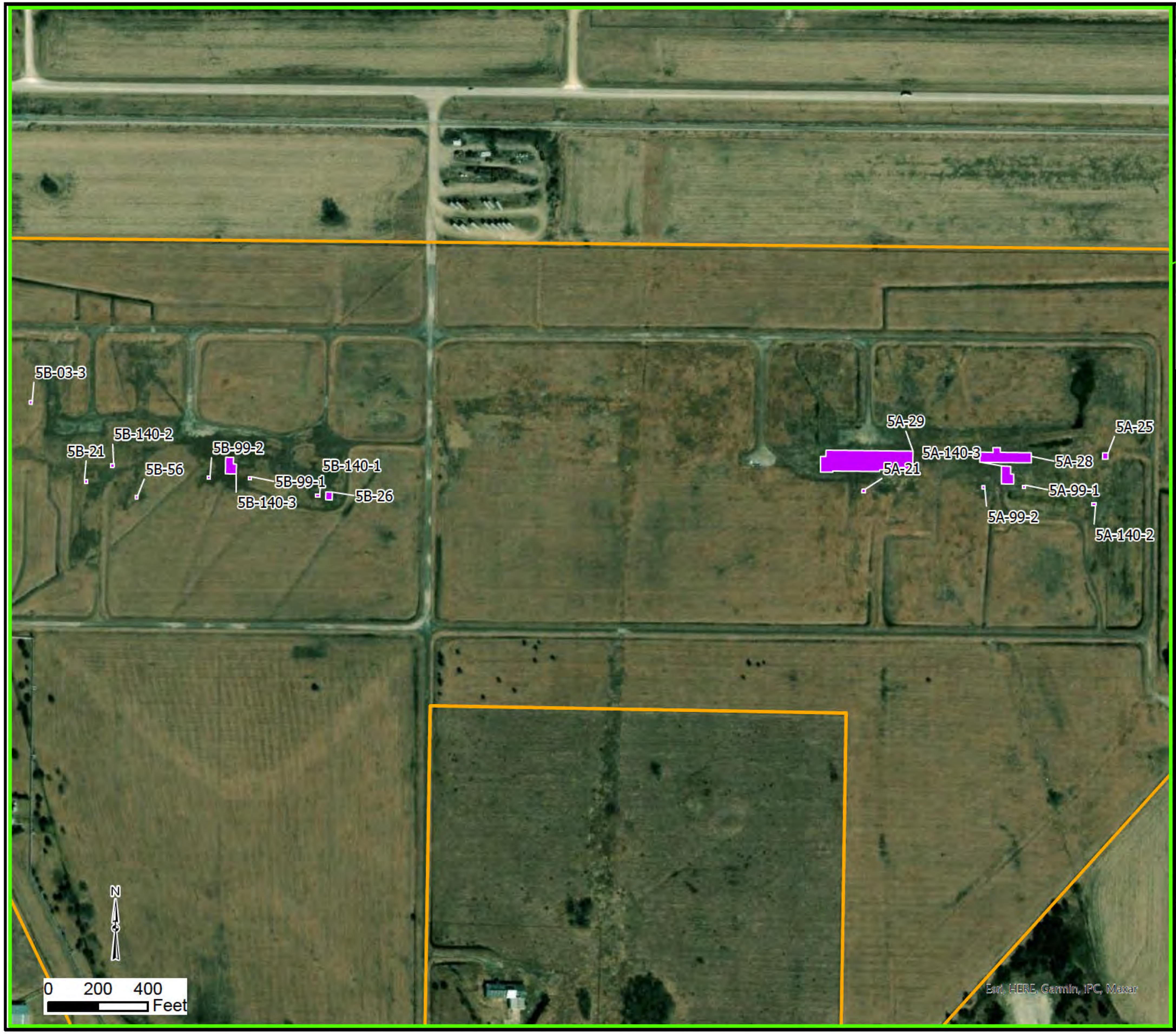

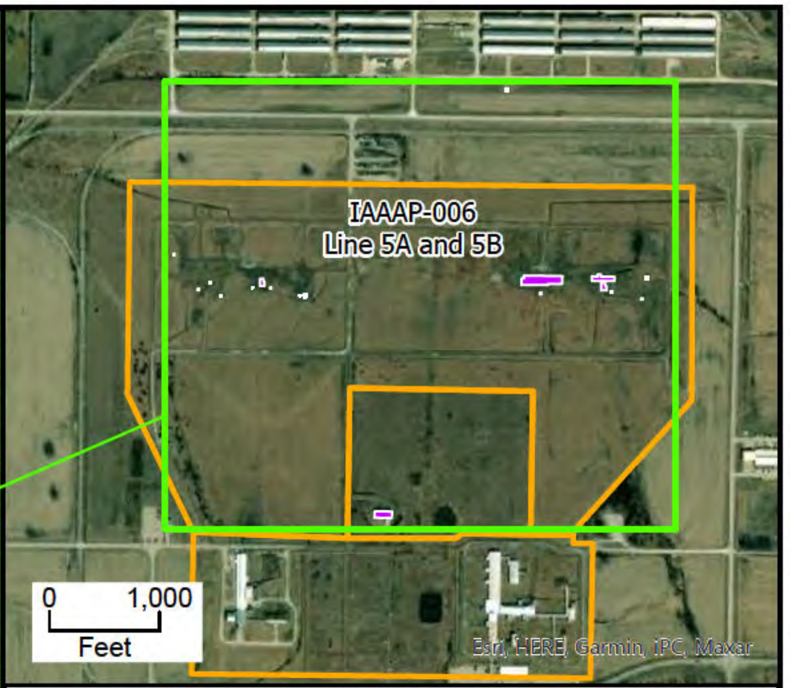

Line Location

FIGURE 5
Proposed Sample Locations, Line 5A and Line 5B Iowa Army Ammunition Plant

LEGEND

☐ Line Boundary

■ Building

Bldg #	# of Samples
5A-21	6
5A-25	6
5A-28	12
5A-29	20
5A-99-1	6
5A-99-2	6
5A-140-2	6
5A-140-3	10
5B-03-3	6

Bldg #	# of Samples
5B-21	6
5B-26	10
5B-56	6
5B-99-1	6
5B-99-2	6
5B-140-1	6
5B-140-2	6
5B-140-3	10
600-84	14

Notes:

IAAAP - Iowa Army Ammunition Plant
Bldg - Building

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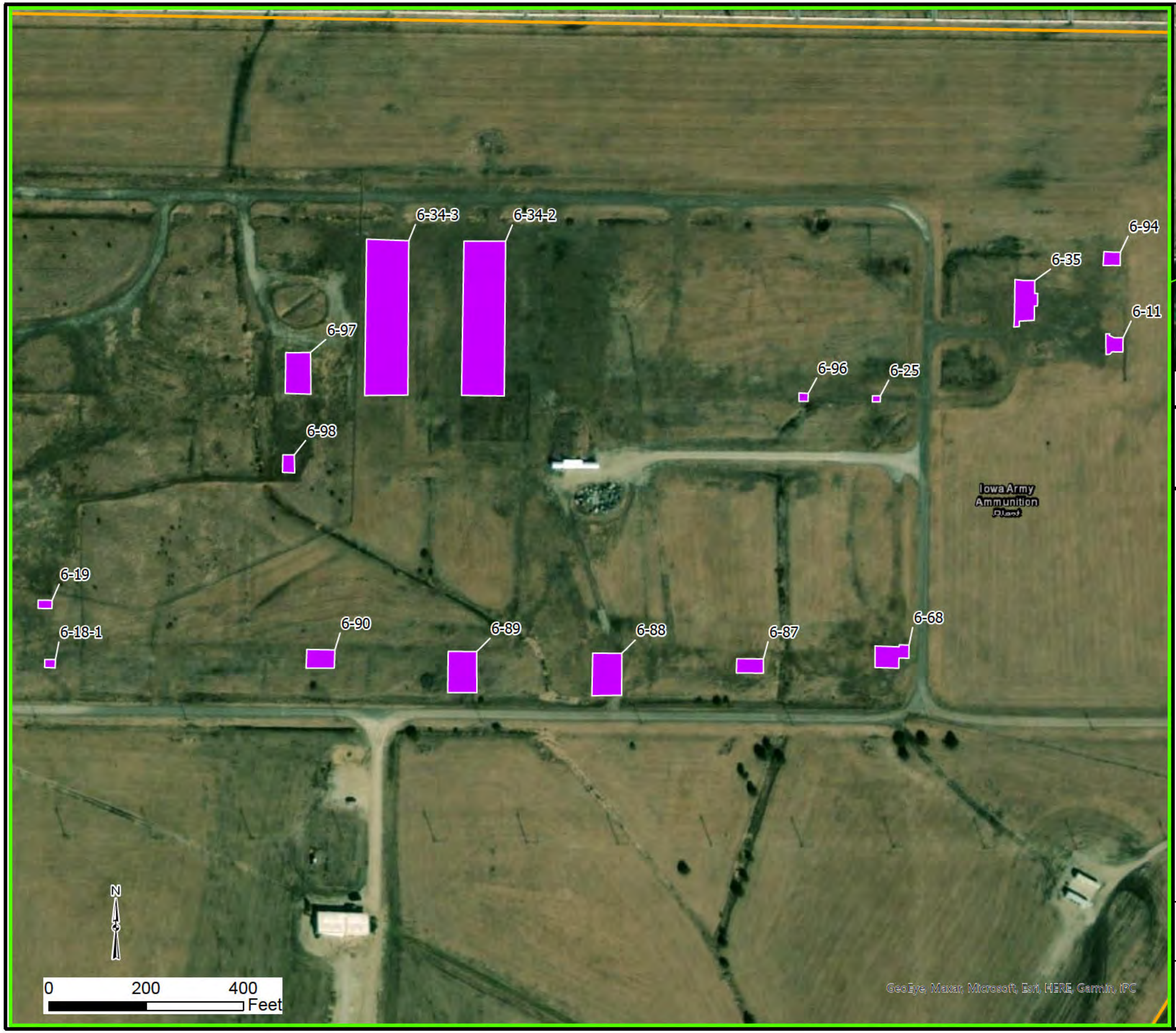

GeoEye, Maxar, Microsoft, Esri, HERE, Garmin, IPC

USDA FSA, GeoEye, Maxar, Esri, HERE, Garmin, IPC

Line Location

FIGURE 6
Proposed Sample Locations, Line 6
Iowa Army Ammunition Plant

LEGEND

- 🟧 Line Boundary
- 🟪 Building

Bldg #	# of Samples
6-11	10
6-18-1	2
6-19	6
6-25	2
6-34-2	20
6-34-3	20
6-35	12
6-68	10

Bldg #	# of Samples
6-87	10
6-88	12
6-90	10
6-94	6
6-96	2
6-97	12
6-98	2

Notes:

IAAAP - Iowa Army Ammunition Plant
Bldg - Building

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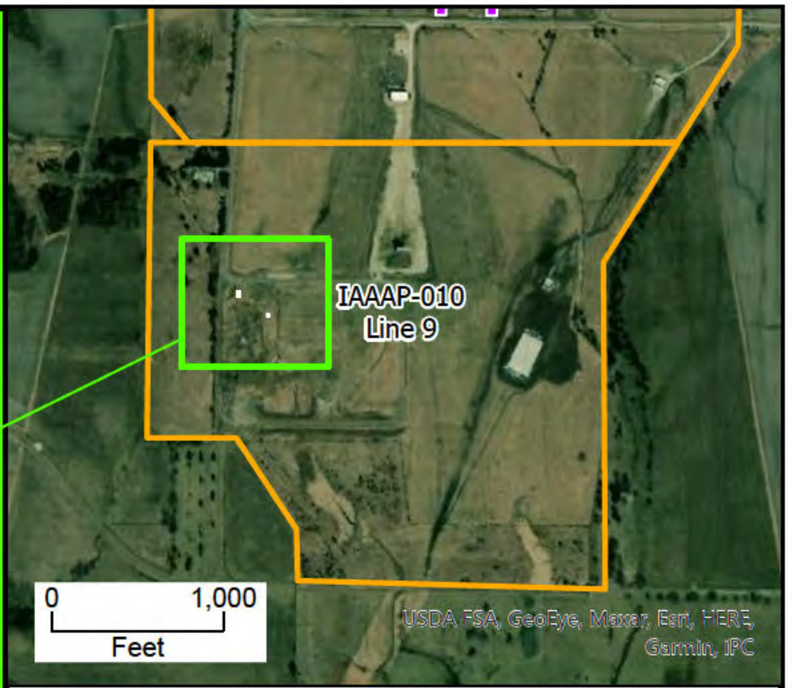

Line Location

FIGURE 7
Proposed Sample Locations, Line 9
Iowa Army Ammunition Plant

LEGEND

☐ Line Boundary
🟪 Building

Bldg #	# of Samples
9-62	2
9-64	2

Notes:
IAAAP - Iowa Army Ammunition Plant
Bldg - Building

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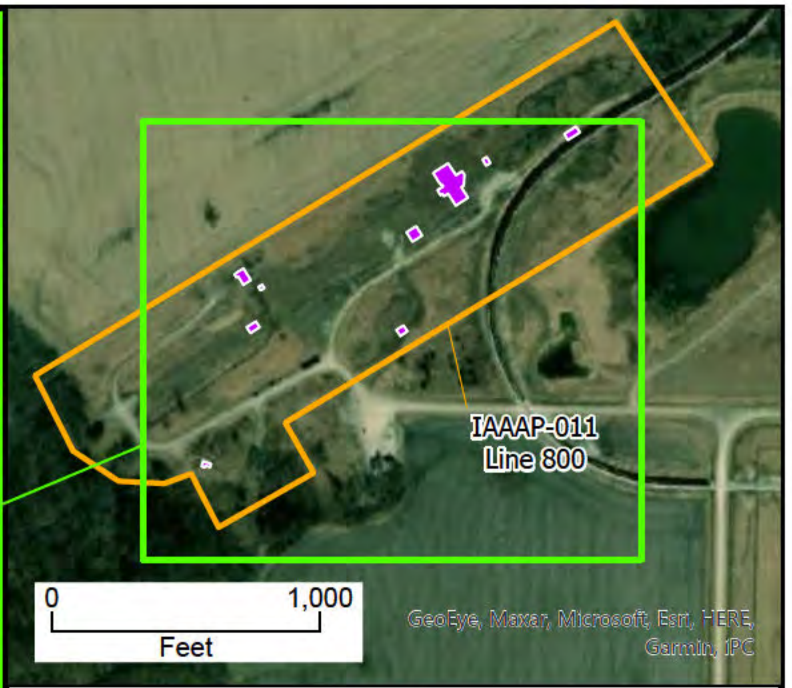

Line Location

FIGURE 8
Proposed Sample Locations, Line 800
Iowa Army Ammunition Plant

LEGEND

- ▭ Line Boundary
- ▬ Building

Bldg #	# of Samples
800-03	2
800-03-2	6
800-08	2
800-16	2
800-68	10
800-70-1	2
800-70-2	12
800-192	14
800-193	10

Notes:

IAAAP - Iowa Army Ammunition Plant
Bldg - Building

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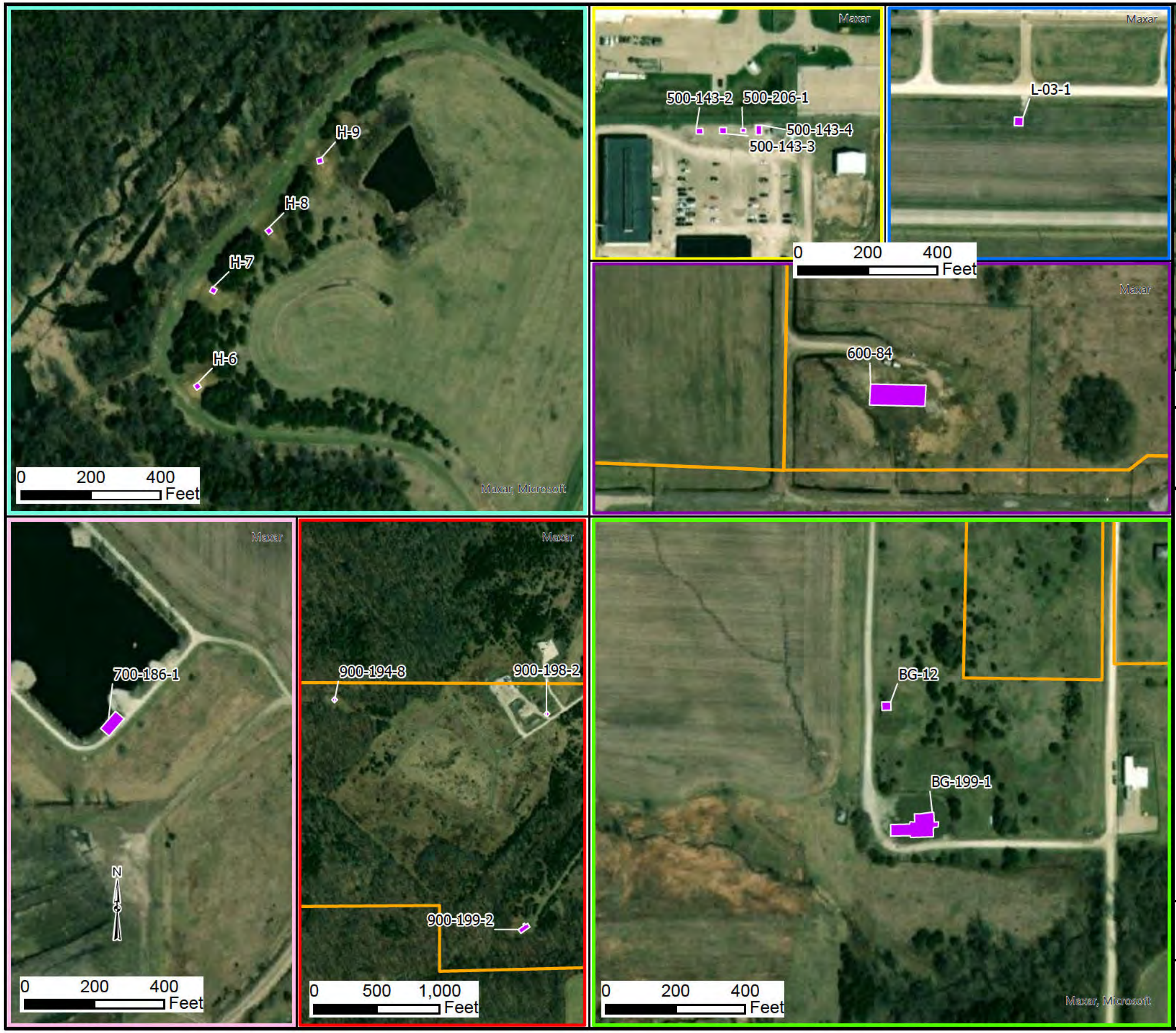

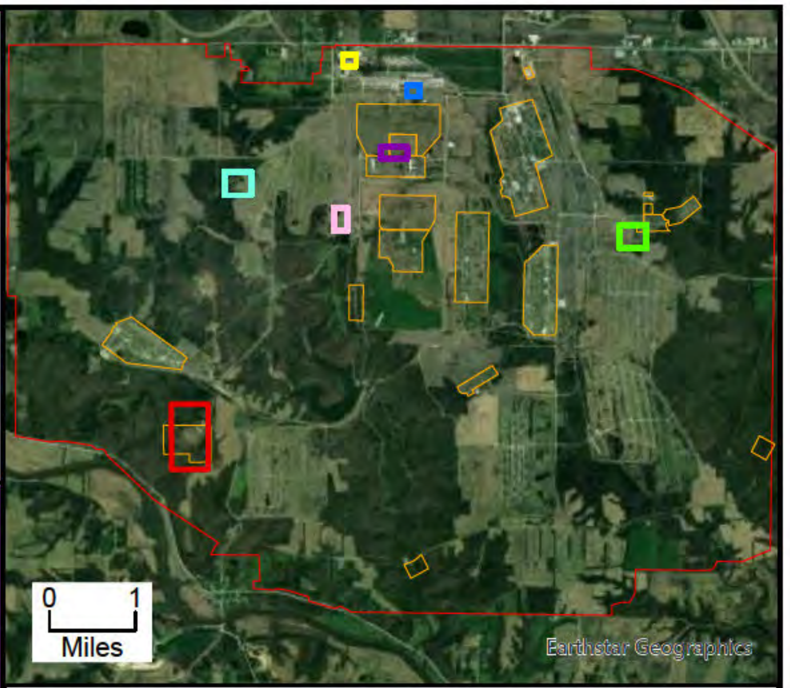

Viewport-Extent Location

FIGURE 9
Proposed Sample Locations, Other Locations
Iowa Army Ammunition Plant

LEGEND

🟧	Line Boundary
🟥	IAAAP Boundary
🟪	Building

Bldg #	# of Samples
BG-12	10
BG-199-1	12
BG-199-2	12
H-6	6
H-7	6
H-8	6
H-9	6
L-03-1	10

Bldg #	# of Samples
500-143-3	6
500-143-4	6
500-206-1	6
600-84	14
700-186-1	12
900-194-8	10
900-198-2	6
900-199-2	10

Notes:

IAAAP - Iowa Army Ammunition Plant
Bldg - Building

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APPENDIX A FIELD

STANDARD OPERATING PROCEDURES

SOIL SAMPLING: SOP FO-001

1.0 OBJECTIVE / BACKGROUND

The objective of soil sampling is to collect a sample that is representative of conditions of interest as they exist at a site. This is done by selecting the appropriate sampling device and/or method, taking measures to avoid introduction of contaminants or inaccurate results due to poor sampling techniques, and by reducing the potential of cross contamination between samples.

The intent of this field operations (FO) standard operating procedure (SOP) is to provide standardized guidance for soil sample collection for chemical analysis. As such, this procedure is not intended to eliminate the need for professional judgment during unforeseen circumstances. However, deviations from this procedure while executing planned activities must be approved in writing by both the Project Manager and Corporate Quality Officer.

2.0 RESPONSIBLE PARTIES

- Project Manager
- Site Manager
- Engineering/Environmental Technician
- Field personnel assigned to sampling tasks

3.0 ACRONYMS AND DEFINITIONS

- FO – Field Operations
- ft – Foot/Feet
- ID – Identification
- MIP – membrane interface probe
- PID – photoionization detector
- SOP – Standard Operating Procedure
- VOC – volatile organic compound
- VOA - volatile organic analyte

4.0 SOIL SAMPLING

Soil sampling must be completed using proper equipment and advanced planning. In some cases, field screening of the soil may be required to facilitate selection of the appropriate sampling interval.

4.1 EQUIPMENT

All sampling equipment utilized for soil boring advancement and sample collection that may potentially come into contact with soil samples must be thoroughly decontaminated before and between sampling events.

4.2 PRE-SAMPLING ACTIVITIES

Sampling personnel will record in the field logbook the preparation activities that may be pertinent to the sampling event at each sampling location. For soil sampling, documentation may include information on the presence of surface staining, water logging or ponding, proximity to roads or waste piles, apparent up-gradient physiographic or hydrogeologic features of significance, the depth from which the samples were collected, and the equipment and materials that were used to construct the boring.

Field personnel should wear appropriate personal protective equipment (e.g., nitrile gloves) at all times while sampling. All disposable equipment and supplies used to collect samples should be containerized for appropriate disposal. All non-dedicated equipment/supplies should be decontaminated with a nonphoshate solution prior to sampling at each location.

4.3 SPLIT-SPOON OR GEOPROBE SOIL SAMPLING

Field personnel will wear latex or surgical inner gloves and nitrile or neoprene outer gloves to protect from potential dermal contact with the soil.

A direct-push rig equipped with an open-tube MacroCore sampler consisting of a 48-inch-long, 2-inch-outer diameter (OD) core barrel capable of recovering a 45-inch-long, 1.5-inch diameter soil sample core will be used to obtain soil samples. The core barrel will be lined with pre-cleaned, thin-walled stainless steel sleeve measuring 6 inches long by 1.5 inches in diameter. The sampler will be fitted with sleeves, attached to the end of a 4-foot long steel probe and advanced a predetermined distance with the direct push rig.

After the core barrel is removed from the borehole and opened by the driller, it will be turned over to the field personnel. For Geoprobe sampling, the stainless-steel sleeves will be removed from the drive tube and placed on the core table or on visqueen on the ground surface.

The sample description, depth, time, and date will be recorded on the borehole log form and in the field logbook.

4.4 SOIL CHARACTERIZATION

Soil cores will be collected by a qualified drilling subcontractor in accordance with their standard procedures and specifications, and will be logged by the field geologist. Logging information will include time and date of core collection, Station location or identification, and total depth drilled.

Visually characterize for soil type, color, moisture content, texture, grain size and shape, consistency, visible evidence of staining, and any other observations.

Describe the soil using the Unified Soil Classification System based visual-manual identification and Munsell color chart, and record on the soil boring log field form. Photograph core segments as necessary to support observations, and include scale, station identification, depth of interval, date of core collection, and direction of the core sample (top and bottom).

Describe odor as none, strong, moderate, or faint and as sulfur-like, petroleum hydrocarbon-like, or tar-like. Visible contamination may be noted as non-aqueous phase liquid for free-phase product, with notation of color, distribution, and viscosity. Soil with visible contamination may be described as having a sheen; being stained or coated, containing blebs, or saturated.

4.5 OPERATION OF FIELD EQUIPMENT

4.5.1 Photoionization Detector Meter - MiniRAE

A photoionization detector (PID) will be used to screen soil for selection of soil samples and to describe variation in VOC content within the soil column. The PID meter will be calibrated daily, and more frequently dependent on field conditions. Calibration of the instrument should be noted in the logbook and/or the instrument calibration form. The operation manual supplied by the manufacturer of each instrument should be consulted for operating instructions and calibration as needed.

Calibration instructions for the MiniRAE are summarized below:

1. Press the [MODE] key to turn the instrument on and initiate self-diagnostics.
2. After the MiniRAE has completed self-diagnostics, simultaneously press [N/-] and [MODE] keys for 3 seconds.
3. Respond to the “Calibrate/Select Gas” prompt by pressing [Y/+] key.
4. Respond to the “Fresh air cal?” prompt by pressing [Y/+] key, and proceed to calibration in the outdoors.
5. Wait approximately 15 seconds until the “zero in progress” and “wait” prompts are replaced by the message, “update data…zeroed…reading= x.x ppm…”. Record this reading in the field logbook.
6. Respond to the “Span cal?” prompt by pressing [Y/+] key.
7. Respond to the isobutylene gas prompt by pressing [Y/+] key.
8. Connect the isobutylene tank to the pressure valve and open the valve in response to the prompt, “Apply gas now!”
9. The display will show “wait…30” and countdown to 0 and then provide a calibrated value. Record the reading the in the field logbook or on the equipment calibration form. Repeat the calibration process if the calibration gas does not stabilize to 1 to 2 parts per million with the calibration gas range (100 parts per million, using isobutylene).
10. Press the [MODE] key to exit the calibration mode, turn off the gas, and disconnect the calibration gas cylinder from the MiniRAE.

Following successful calibration, the MiniRAE can be turned off and on by pressing the [MODE] key. The instrument will provide instantaneous readings of VOC concentrations after it has completed self-diagnostics (approximately 30 seconds).

4.6 SOIL SAMPLING COLLECTION METHODS

Grab samples, or a discrete aliquot representative of a specific location at a given point in time, will be collected from intervals identified during the investigation and based on PID readings and soil depths being below the former building footers. Each grab sample will be collected all at once at one particular point in the sample medium. The sampling strategy will be judgmental, and representative of the depth of suspected greatest contamination below the previous building footers or slab. Soil samples will be collected to assess the materials below the former building footers, as follows:

A total of two samples per boring will be collected for laboratory analysis: One soil sample will be collected from a depth correlating with the highest photoionization detector (PID) readings and/or visual or olfactory evidence of impact, and one soil sample will be collected at a depth 2 to 5 ft below this depth, or when there is no longer visual or olfactory evidence of impact. If the soil column appears homogeneous, the initial soil sample will be collected approximately 2 to 5 ft below the building footer, and the second soil sample will be collected approximately 2 to 5 ft below the first sample depth.

4.7 SOIL SAMPLES FOR VOC ANALYSIS

Observe sample as it is brought to surface and scan using a PID to evaluate presence of elevated VOCs. Observe and document soil type. Select the section of the sample interval (approximately 2 ft interval) from which the sample for VOC laboratory analysis will be collected. The sample interval will be dependent on depth, soil type, PID reading, and visual observation. Immediately after the depth interval to be samples is identified, collect the sample aliquot using TerraCore Samplers or equivalent. Duplicate samples should be collected from the same interval and as close as possible to the parent sample. Once the VOC sample is collected, the remaining soil from the sample interval may be composited for the remaining analyses.

- Collect 3 TerraCore samples (or laboratory required volume) and one 40-millileter (mL)unpreserved volatile organic analyte (VOA) vial (to determine moisture content for each VOC sample point). *or* Collect 1 Encore sample and one 4-ounce jar (to determine moisture content for each VOC sample point).
- Remove the TerraCore sample plunger or Encore sample and cap from package and seat in plunger or T-handle.
- Quickly push the sampler into the selected interval of soil until the sampler is full.
- Visually confirm that the sampler body is full by looking at the sample chamber (TerraCore) or observing the o-ring in the hole on the side of the T-handle (Encore).
- Scrape or wipe away any excess soil from the mouth of the sampler with a paper towel or dedicated plastic/decontaminated stainless steel spoon or trowel.
- Rotate the plunger of the TerraCore plunger that was seated in the handle top 90 degrees until it is aligned with the slots in the body, and place the mouth of the sampler into the pre-tared 40-mL VOA containing the magnetic stir bar and extrude the sample by pushing the plunger down. Quickly place the lid back on the 40-mL VOA vial, complete the sample label on the pre-tared VOA using indelible ink and repeat the procedure for the other two TerraCore samplers. *or* Push cap on Encore sampler with a twisting motion to attach the cap, ensuring it hooks to the sampler base.
- Place the samplers in the provided zipper locked package and seal the zipper lock.
- Collect the percent moisture sample in the separate unpreserved sample container.
- Place all samples in a cooler with bagged ice to maintain 4 degrees Celsius while storing on site and during shipment to the laboratory.
- Samples must be shipped to the laboratory nightly to meet strict 24-hour sampling holding time.

4.8 SOIL SAMPLES FOR NON-VOC ANALYSIS

Once the sample for VOC analysis is collected, place the remaining soil from the interval to be sampled in a decontaminated stainless steel bowl or disposable aluminum tray and mix as follows:

- Roll the contents of the compositing container to the middle of the container and mix.
- Quarter the sample and move to the sides of the container
- Mix each quarter individually, then combine and mix opposite quarters, then roll to the middle of the container.
- Mix the sample once more, then quarter the sample again.
- Mix each quarter individually, then combine and mix adjacent corners, then roll to the middle of the container. The goal is to achieve a consistent physical appearance before sample containers are filled.
- Flatten the pilled material into an oblong shape.
- Using a flat-bottomed scoop, collect a strip of soil across the entire width of the short axis and place it into a sample container. Repeat until the sample containers are filled.
- Place the sample bottles in a cooler with ice. Maintain the samples at 0 to 6 degrees Celsius.

5.0 ASSOCIATED DOCUMENTS

- Uniform Federal Policy-Quality Assurance Project Plan
- Site Safety and Health Plan
- Soil sample form
- Drilling field form
- Equipment calibration field form
- SOP FO-005 - Management of Investigation Derived Waste
- SOP FO-007 - Sample Packing and Shipping
- SOP-FO-008 - Equipment Decontamination
- SOP-FO-009 - Global Positioning System
- SOP-FO-010 - Field Logbook Documentation
- SOP-FO-011 - Utility Clearance

MANAGEMENT OF INVESTIGATION DERIVED WASTE:
SOP FO-005

1.0 OBJECTIVE / BACKGROUND

This document describes general and specific procedures and considerations to be used and observed when managing investigation derived waste (IDW) generated during the course of hazardous waste site investigations.

The procedure described here is not intended to eliminate the need for professional judgment during unforeseen circumstances. However, deviations from this Standard Operating Procedure (SOP) while executing planned activities must be approved in writing by the Project Manager.

2.0 RESPONSIBLE PARTIES

- Any ATI employee or subcontractor tasked with disposing of IDW.
- ATI Project Manager and/or Site Manager.

3.0 ACRONYMS AND DEFINITIONS

- DOT – Department of Transportation
- EPA – Environmental Protection Agency
- IATA – International Air Transportation Association
- IDW – investigation derived waste
- PPE – personal protective equipment
- RCRA – Resource Conservation and Recovery Act
- SOP – Standard Operating Procedure
- SVOC - semivolatile organic compound
- TCLP - Toxicity Characteristic Leaching Procedure
- TPH - total petroleum hydrocarbon
- VOC - volatile organic compound

4.0 TYPES OF IDW

Materials which may become IDW include, but are not limited to:

- Personal protective equipment (PPE) - This includes disposable coveralls, gloves, booties, respirator canisters, splash suits, etc.
- Disposable equipment and items - This includes plastic ground and equipment covers, aluminum foil, conduit pipe, composite liquid waste samplers (COLIWASAs), Teflon® tubing, broken or unused sample containers, sample container boxes, tape, etc.
- Soil cuttings from drilling or hand augering
- Groundwater obtained through well development or well purging.
- Cleaning fluids such as spent solvents and wash water.
- Packing and shipping materials.

For the purpose of determining the ultimate disposal of IDW, it is typically distinguished as being either hazardous or non-hazardous. This determination and subsequent management is the responsibility of the program site manager. Based on the site history and proposed field effort, wastes are not expected to be hazardous. Table 1 lists the types of IDW expected to be generated during the field investigation and the current disposal practices for these materials.

Table 1: Disposal of IDW

TYPE	Management
PPE-Disposable	Place waste in trash bag. Place in dumpster with permission of site operator, otherwise return to ATI for disposal in dumpster.
PPE-Reusable	Decontaminate as per SOP FO-008, Equipment Decontamination, and return to ATI.
Soil Cuttings	Containerize in a 55-gallon steel drum with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal. May be placed on the ground if doing so does not endanger human health or the environment or violate federal or state regulations.
Groundwater	Containerize in an appropriate container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal. May be placed on the ground if doing so does not endanger human health or the environment or violate federal or state regulations.
Decontamination Water	Containerize in an appropriate container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal. May also be disposed in a sanitary sewer system, with permission from the wastewater treatment plant representative, and if doing so does not endanger human health or the environment, or violate federal or state regulations.
Disposable Equipment	Containerize in an appropriate container with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with program site manager for testing and disposal. If unfeasible, return to ATI for disposal in dumpster.
Trash	Place waste in trash bag. Place in dumpster with permission of site operator, otherwise return to ATI for disposal in dumpster.

5.0 MANAGEMENT OF IDW

Waste that is expected to be generated during the field effort includes PPE, soil cuttings, purge water, and decontamination fluids. Waste will be minimized to the extent possible, and containerized and labeled with its contents and date of collection and staged at an approved location. IDW liquids and solids will be placed in 55-gallon steel drums, labeled, and staged in a designated location for subsequent characterization and off-site disposal.

6.0 WASTE SAMPLING

One composite IDW water sample will be collected for waste characterization to determine waste disposal options. The liquid waste characterization sample will be analyzed for the following:

- Volatile organic compounds (VOCs) using Method SW8260
- Semivolatile organic compounds (SVOCs) using Method SW8270
- Metals using Method SW6020/7470
- Total Petroleum Hydrocarbon (TPH) using Method TX1005
- Reactivity using Method SW-846 Chapter 7, Reactive Cyanide and Sulfide
- Corrosivity using Method SW9040
- Ignitability Using Method SW1020

One composite soil sample will be collected for waste characterization to determine waste disposal options. The solid waste characterization sample will be analyzed for the following:

- Toxicity Characteristic Leaching Procedure (TCLP) VOCs using Method SW1311/SW8260
- TCLP SVOCs Method SW1311/8270
- TCLP metals using Method SW1311/6020/7470
- Total Petroleum Hydrocarbon using Method TX1005
- Reactivity using Method SW-846 Chapter 7, Reactive Cyanide and Sulfide
- Corrosivity using Method SW9040
- Ignitability Using Method SW1020

7.0 ADDITIONAL NOTES

- ATI **must not take ownership** of any IDW that was generated by another party or resulted from contaminated material that was on or from the property of a client or other entity. This includes contaminated soil, groundwater, man-made materials (e.g., concrete, pavement, building materials, etc.), or chemicals that were not brought onsite by ATI. Do not, under any circumstances, sign a waste manifest as the generator of any of the above waste, as that may result in ATI being held liable for the waste.

- With written permission from the owner of the waste, an ATI employee can sign a waste manifest as “for” the owner of the waste. This should be a very rare occurrence.

8.0 ASSOCIATED DOCUMENTS

- ATI SOP FO-001-Soil Sampling.
- ATI SOP FO-002-Groundwater Sampling.
- ATI SOP FO-010-Equipment Decontamination.
- Uniform Federal Policy Quality Assurance Project Plan
- Site Safety and Health Plan

9.0 INFORMATION CONTACTS

- ATI Project Manager

SAMPLE PACKING AND SHIPPING: SOP FO-007

1.0 OBJECTIVE / BACKGROUND

Sample packing and shipping is critical to ensure the integrity of the samples. By following this standard operating procedure (SOP), the sample will arrive to the lab in a timely manner unbroken and at the correct temperature.

Regulations for packing, marking, labeling, and shipping of dangerous goods by air transport are promulgated by Department of Transportation (DOT) under 49 Code of Federal Regulations (CFR), Subchapter C, Hazardous Materials Regulations, and the International Air Transport Authority (IATA), which is equivalent to United Nations International Civil Aviation Organization (UN/ICAO). This SOP describes general and specific procedures, methods and considerations to be used and observed by ATI field investigators when packing, marking, labeling and shipping environmental and waste samples to ensure that all shipments are in compliance with the above regulations and guidance.

The procedures contained in this document are to be used by field personnel when packing, marking, labeling, and shipping environmental samples and dangerous goods by air transport. Samples collected during field investigations must be classified prior to shipment, as either environmental or hazardous materials (dangerous goods) samples.

In general, environmental samples include drinking water, most groundwater and ambient surface water, soil, sediment, treated municipal and industrial wastewater effluent, biological specimens, or any samples not expected to be contaminated with high levels of hazardous materials. Samples collected from process wastewater streams, drums, bulk storage tanks, soil, sediment, or water samples from areas suspected of being highly contaminated may require shipment as dangerous goods.

2.0 RESPONSIBLE PARTIES

- All ATI field employees and subcontractors

3.0 ACRONYMS AND DEFINITIONS

- CFR – Code of Federal Regulations
- CoC – Chain of Custody (example form attached)
- DOT– Department of Transportation
- IATA – International Air Transport Authority
- POTW – Publicly Owned Treatment Works
- SOP – Standard operating procedure
- UN/ICAO – United Nations International Civil Aviation Organization
- USEPA – U.S. Environmental Protection Agency

4.0 SAMPLE PACKING AND SHIPPING

4.1 SHIPMENT OF DANGEROUS GOODS

The Project Manager is responsible for determining if samples collected during a specific field investigation meet the definitions for dangerous goods. If a sample is collected of a material that is listed in the Dangerous Goods List, Section 4.2, IATA, then that sample must be identified, packaged, marked, labeled, and shipped according to the instructions given for that material. If the composition of the collected sample(s) is unknown, and the Project Manager knows or suspects that it is a regulated material (dangerous goods), the sample may not be offered for air transport. If the composition and properties of the waste sample or highly contaminated soil, sediment, or water sample are unknown, or only partially known, the sample may not be offered for air transport.

In addition, the shipment of pre-preserved sample containers or bottles of preservatives (e.g., sodium hydroxide pellets, hydrochloric acid, etc.) which are designated as dangerous goods by IATA is regulated. Shipment of nitric acid is strictly regulated. Consult the IATA Dangerous Goods Regulations for guidance.

4.2 SHIPMENT OF ENVIRONMENTAL SAMPLES

Based on information from the U.S. Environmental Protection Agency (USEPA) Region 4 SOP SESDPROC-209-R3 (Packing, Marking, Labeling and Shipping of Environmental and Waste Samples), the shipment of the following unpreserved samples is not regulated:

- Drinking water
- Treated effluent
- Biological specimens
- Sediment
- Water treatment plant sludge
- Publicly Owned Treatment Works (POTW) sludge

In addition, the shipment of the following preserved samples is not regulated, provided the amount of preservative used does not exceed the amounts found in 40 CFR 136.3:

- Drinking water
- Ambient water
- Treated effluent
- Biological specimens
- Sediment
- Wastewater treatment plant sludge
- Water treatment plant sludge

Untreated wastewater and sludge from POTWs are considered to be "diagnostic specimens" (not environmental laboratory samples). However, because they are not considered to be infectious agents they are not restricted and may be shipped using the procedures outlined below.

4.3 SAMPLE PACKING

1. Use the appropriate size cooler that conforms to DOT drop test specifications. When selecting the proper cooler, account for the number of samples that will be shipped, the sample jar sizes, packing material, coolant, and overall cooler weight (i.e., generally less than 50 pounds).
2. Place two large thick trash bags within the cooler, one bag inside the other. These bags act as the final barrier preventing liquids from leaking from the cooler when wet ice is used as the coolant. Line the bottom, sides and top of the cooler (inside the trash bags) with packing material.
3. Seal each container in a bubble-wrap or Ziploc bag to prevent labels from peeling off containers or to contain them if they happen to peel off and place within the cooler being sure to evenly distribute the sample weight within the cooler.
4. Place packing material between each glass container. Foam packing and bubble-wrap work very well for packaging material. They provide shock protection and the trapped air provides thermal insulation, which keeps your samples cold. Avoid using packing material that absorbs water. Materials such as paper, cardboard and peanuts become soggy and decompose in water thereby losing any cushioning effects.
5. Add a coolant to the cooler, inside the inner trash bag. Generally, natural ice poured over sealed sample bags is the best choice for keeping containers cold. A 48-quart cooler should be able to hold a minimum one, but no more than two, 8 or 10-lb bags of ice in addition to any sample jars. In some cases, gel ice packs may be required in lieu of wet ice (e.g., samples shipped from Alaska). Since these gel packs do not often maintain low enough temperatures in large coolers, one may need to use more coolant than the equivalent amount of wet ice, which will reduce the volume of samples capable of being shipped per cooler.
6. Once the sample jars are placed inside the cooler and trash bags and secured with cushioning packing material, seal the inside trash bag. Preferably, one should twist the excess trash bag material while removing air from the inner bag. If enough material is available, the excessive bag material can be tied into a knot. If not, one should wrap duct-tape around the twisted excess bag. Repeat this step for the outer trash bag.
7. Seal the chain-of-custody (CoC) documents in a Ziploc bag and tape to the inside of the cooler lid.
8. Apply completed custody seals to two sides of the cooler, across the opening. Tape the cooler well using clear packaging tape. Go completely around the cooler in at least two different areas. Then, tape the seam where the lid closes. All labels and seals attached to the cooler should also be taped so that they do not come off during shipment. An example cooler packed for shipping with example custody seal on the front (custody seal will be placed similarly to the back) is shown below:

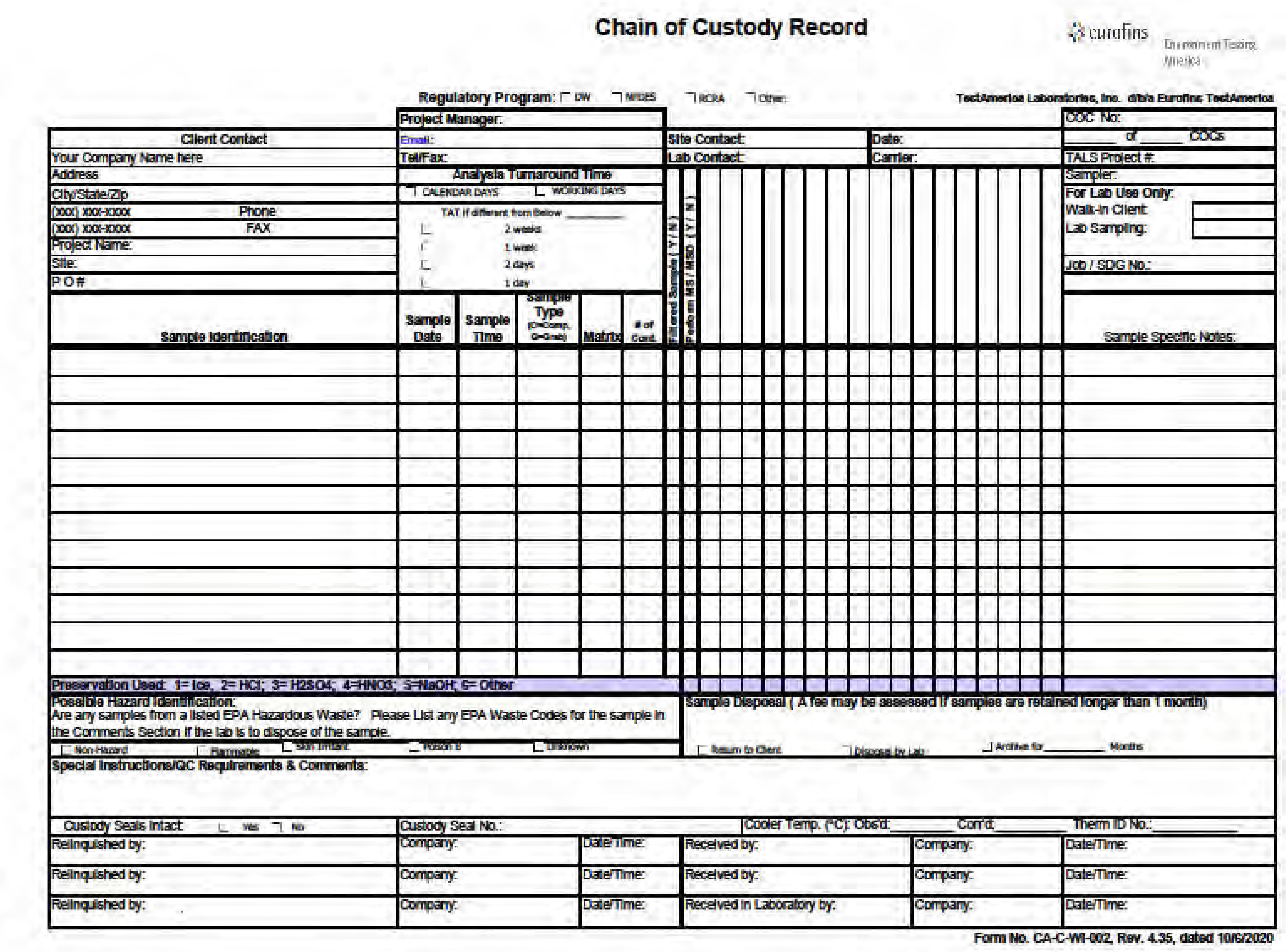
9. Call the lab to let them know the cooler's arrival date. Give them the tracking number of the package from the shipping courier's paperwork.

4.4 SAMPLE SHIPPING

- Completely fill out all empty fields in the shipping label. ATI's preferred shipping vender is FedEx.
    a. Completely fill out all required spaces in Section 1: Sender's Information of FedEx air bill, using the ATI's Maryland office as the sender's address.
    b. Completely fill out all required spaces for recipient's information (i.e. laboratory) in Section 3 on FedEx air bill.
    c. In the Section labeled 4a Express, put an "X" in the box for FedEx Priority Overnight delivery. This is very important because samples are time sensitive.
    d. In Section 5: Packing, put an "X" in the box next to "Other".
    e. In section labeled Special Handling and Delivery Signature Options, put an "X" next to the box "NO" under the area labeled "Does this shipment contain dangerous good?"
    f. If you are shipping on a Friday call the lab to make sure they are accepting deliveries on that Saturday. If they are accepting Saturday deliveries, mark an "X" in the box next to "Saturday Delivery." If you do not mark this box, the package will not be delivered until Monday and the sample may exceed the temperature requirement. If the lab is not accepting Saturday deliveries do not ship samples until the following Monday. Plan ahead to ensure sample holding times are met.
    g. In Section 7: Payment Bill, ask the Project Manager if the Recipient or a third party is to be billed. If so enter the FedEx account number in the appropriate place.
    h. Have a second person review your shipping label for the correct address, contact telephone number, and delivery priority. If unsure about sample holding times, double-check the delivery priority with the ATI Project Manager and or the lab's Project Manager. Most shipments will be priority overnight, morning (10:00 am) delivery.

5.0 ASSOCIATED DOCUMENTS

- U.S. Environmental Protection Agency (EPA), 2015. Standard Operating Procedure, Packing, Marking, Labeling and Shipping of Environmental and Waste Samples Region 4, Science and Ecosystems Support Division SOP SESDPROC-209-R3. May.



Chain of Custody Record

eurofins Environment Testing America

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☐ Other:

TestAmerica Laboratories, Inc. d/b/a Eurofins TestAmerica

Client Contact	Project Manager:		COC No:
Your Company Name here	Email:	Site Contact: Date:	_______ of _______ COCs
Address	Tel/Fax:	Lab Contact: Carrier:	TALS Project #:
City/State/Zip	**Analysis Turnaround Time** ☐ CALENDAR DAYS ☐ WORKING DAYS		Sampler:
(xxx) xxx-xxxx Phone	TAT if different from Below __________		For Lab Use Only:
(xxx) xxx-xxxx FAX	☐ 2 weeks		Walk-in Client:
Project Name:	☐ 1 week		Lab Sampling:
Site:	☐ 2 days		Job / SDG No.:
P O #	☐ 1 day		

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y / N)	Perform MS / MSD (Y / N)	Sample Specific Notes:

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return to Client ☐ Disposal by Lab ☐ Archive for__________ Months

Special Instructions/QC Requirements & Comments:

Custody Seals Intact: ☐ Yes ☐ No
Custody Seal No.:
Cooler Temp. (°C): Obs'd:__________ Corr'd:__________ Therm ID No.:__________

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:

Form No. CA-C-WI-002, Rev. 4.35, dated 10/6/2020

EQUIPMENT DECONTAMINATION: SOP FO-008

1.0 OBJECTIVE / BACKGROUND

Proper decontamination is essential to eliminate cross contamination of equipment. Decontamination should occur before each and every use of sampling equipment.

2.0 RESPONSIBLE PARTIES

- Any ATI employee or subcontractor working with sampling equipment.

3.0 ACRONYMS AND DEFINITIONS

- SOP – Standard Operating Procedure

4.0 ATI'S EQUIPMENT DECONTAMINATION STANDARDS

4.1 SPECIFICATION FOR STANDARD CLEANING MATERIALS

1. Soap shall be a standard brand of phosphate-free laboratory detergent such as Liquinox® or Alconox. Use of other detergent must be justified in the approved sampling analysis plan and documented in the field logbooks.
2. Solvent shall be pesticide-grade isopropanol. Use of a solvent other than pesticide-grade isopropanol for equipment cleaning purposes must be justified in the Sampling Analysis Plan.
3. Tap water may be used from any municipal water treatment system. Use of an untreated potable water supply is not an acceptable substitute for tap water.
4. Analyte free water (deionized water) is tap water that has been treated by passing through a standard deionizing resin column. At a minimum, the finished water should contain no detectable heavy metals or other inorganic compounds (i.e., at or above analytical detection limits) as defined by a standard inductively coupled Argon Plasma Spectrophotometer (or equivalent) scan. Analyte free water obtained by other methods is acceptable, as long as it meets the above analytical criteria. A portable system to produce organic/analyte free water under field conditions is available.
5. Other solvents may be substituted for a particular purpose if required. For example, removal of concentrated waste materials may require the use of either pesticide-grade hexane or petroleum ether. After the waste material is removed, the equipment must be subjected to the standard cleaning procedure. Because these solvents are not miscible with water, the equipment must be completely dry prior to use.

4.2 DECONTAMINATION OF DOWN WELL PUMPS

1. Have three decontamination containers (tubs) ready.
    a. First decontamination tub should be distilled or tap water mixed completely with phosphate-free laboratory detergent such as Liquinox®.
    b. Second decontamination tub should only have clean deionized water for rinsing.
    c. Third decontamination tub should only have deionized water for final rinsing.

2. After removing tubing from pump insert pump into the first decontamination tub and run pump for several minutes to allow enough soapy water to run though the pump. The outside of the pump housing should also be cleaned using a brush.
3. The next step of decontamination is to insert pump in to the second Decontamination tub cleaning techniques using the deionized water should be repeated as described above.
4. Spray / rinse equipment with pesticide grade isopropyl alcohol.
5. The final process is to insert the pump into the third decontamination tub for the final rinse of deionized water to ensure the pump is completely cleaned. Cleaning techniques using the deionized water should be repeated as described above.

4.3 DECONTAMINATION OF SOIL SAMPLING EQUIPMENT (HAND AUGERS, BOWLS, ETC.)

1. Have three decontamination tubs ready.
2. Put all sampling equipment into the first decontamination tub (i.e., distilled water mixed Liquinox®). Scrub thoroughly with brush to insure that all soil residue is completely removed from equipment.
3. Place sampling equipment into the second decontamination tub (deionized water) and wash as described above to ensure all soap is completely rinsed off equipment.
4. Spray / rinse equipment with pesticide grade isopropyl alcohol.
5. Place sampling equipment into the third decontamination tub (deionized water) and rinse equipment thoroughly to ensure equipment is clean.
6. Allow time for equipment to air dry.
7. Wrap all sampling equipment in clean aluminum foil to keep out any cross-contaminates.

4.4 DECONTAMINATION OF DRILLING EQUIPMENT (DOWNHOLE RODS, SAMPLING DEVICES, ETC.).

1. Decontamination of augers, downhole rods and sampling devices (i.e. split spoons)
    a. Upon the subcontracted drillers arrival on site, the sub should be instructed to construct a decontamination pit lined with plastic sidewalls should be high enough to prevent any overspray.
    b. Drillers will clean all equipment inside the decontamination pit prior to drilling and between each borehole.
    c. Drillers must also decontaminate all equipment prior to leaving the site.
    d. When the decontamination pit is full or all decontamination has been completed the drillers will pump the water into 55 gallon drums for disposal.
    e. After all decontamination is complete the plastic used will be wrapped up and placed into a separate 55 gallon drum for disposal.
2. Decontamination of direct-push equipment (i.e., Geoprobe®)
    a. All equipment (rods, macro-cores, and shoes) should be decontaminated before arrival on-site and between each new boring. Drillers should have two buckets, one mixed with Liquinox® water and a second with rinse water.
    b. Larger downhole tools may require decontaminating using a decontamination pit, as described above.

c. Each piece of equipment that touches site media (i.e., soil or water) will be washed and rinsed before being used at the next sample location.
d. At the end of each day, water used for decontamination should be placed into separate 55-gallon drums for proper disposal.

4.5 DECONTAMINATION OF HEAVY EQUIPMENT AND TOOLS

All heavy equipment, including backhoes, dump trucks, graders, drilling rigs, rods and augers, and other downhole equipment will be decontaminated upon arrival at the site, between locations, and prior to departure to ensure contaminants are not transported off site.

Decontamination will be completed as follows:

1. Set up a decontamination pad in designated area
2. Steam clean heavy equipment until no visible signs of dirt are observed. This may require wire or stiff brushes to dislodge dirt from some areas.

5.0 ASSOCIATED DOCUMENTS

- ATI Standard Operating Procedure (SOP) FO-001– Soil Sampling
- ATI SOP FO-002 – Groundwater Sampling

6.0 INFORMATION CONTACTS

- ATI Project Manager

GLOBAL POSITIONING SYSTEM: SOP FO-009

1.0 OBJECTIVE / BACKGROUND

This standard operating procedure (SOP) describes the Global Positioning System (GPS) and procedures, methods and considerations to be used and observed when using GPS to record location data in the field. Guidance is provided on accuracy requirements for various uses of location data and potential means to obtain the requisite accuracy.

The procedures contained in this document are to be used by ATI field investigators when using the Global Positioning System to obtain the geographical coordinates of sampling locations and/or measurements during field investigations. In ATI investigations, GPS is the preferred means of collecting horizontal location information. In most cases the accuracy of GPS is unsuitable for collection of elevation data.

The intent of this SOP is to provide standardized guidance describing general and specific procedures, methods, and considerations to be used when conducting field investigations.

If ATI field personnel determine that any of the procedures described in this section cannot be used to obtain the required coordinate information and alternate procedures are employed, the alternate procedure will be documented in the field logbook, along with a description of the circumstances requiring its use. GPS users must be currently qualified as proficient in the operation of the specific GPS equipment to be used. The manufacturer's operation manuals should be used for detailed information on the use of specific GPS equipment.

The procedure described here is not intended to eliminate the need for professional judgment during unforeseen circumstances. However, deviations from this SOP while executing planned activities must be approved in writing by the Project Manager.

2.0 RESPONSIBLE PARTIES

- Any ATI employee or subcontractor conducting activities that require spatial data.
- ATI Project Manager and/or Site Manager.

3.0 ACRONYMS AND DEFINITIONS

The following acronyms are used in this SOP:

- cm – centimeter
- db – decibels
- DGPS – Differential Global Positioning System
- DMS – degrees, minutes, seconds
- DoD – Department of Defense
- DOP – Dilution of Precision
- EPA – Environmental Protection Agency
- GIS – Geographic Information System
- GNSS – Global Navigation Satellite System
- GPS – Global Positioning System
- HASP – Health and Safety Plan

- HDOP – Horizontal Dilution of Precision
- in. – inch
- m – meter
- NAVSTAR – Navigation Satellite Time and Ranging
- NIST – National Institute of Standards and Technology
- PDOP – Position Dilution of Precision
- QAPP – Quality Assurance Project Plan
- SA – Selective Availability
- SBAS – Space Based Augmentation System
- SNR – signal to noise ratio
- SOP – Standard Operating Procedure
- WAAS – Wide Area Augmentation System

4.0 METHODOLOGY

4.1 GENERAL

4.1.1 GPS Description

The Navigation Satellite Time and Ranging (NAVSTAR) GPS is a worldwide radio-navigation system created by the U. S. Department of Defense (DoD) to provide navigation, location, and timing information for military operations. System testing using a limited number of satellites began in 1978 with the system being declared fully operational in 1995. The system was declared available for civilian uses in the 1980s and has seen burgeoning civilian application for navigation and mapping. GPS is the U.S. implementation of a Global Navigation Satellite System (GNSS). Increasingly, GPS receivers have the capability to utilize signals from other GNSS such as the Russian GLONASS or European Galileo systems. ATI has no limitations on the use of signals from other GNSS.

The GPS system consists of three basic elements: the space segment, control segment, and user segment. The space segment consists of the constellation of up to 24 active NAVSTAR satellites in six orbital tracks. The satellites are not in geo-synchronous orbit and are in constant motion relative to a ground user. The control segment consists of several ground stations that serve as uplinks to the satellites and that make adjustments to satellite orbits and clocks when necessary. The user segment consists of the GPS receiver which will typically consist of an antenna, multi-channel receiver, and processing unit.

For the purposes of this document, the user segment GPS receivers may be loosely grouped into Recreational and Navigational receivers (henceforth referred to as General-Use receivers), Mapping Grade receivers, and Survey Grade receivers.

- Most General-Use grade receivers are available on the retail market to consumers for a variety of applications including boating, hiking, and automotive navigation. They display an instantaneous reading of position and are generally not optimized for data collection. Waypoints containing instantaneous position fixes can often be stored and downloaded. The accuracy of these receivers is adequate for many environmental applications.
- Mapping Grade receivers are used for applications such as resource management and Geographical Information System (GIS) feature collection. The receivers are capable of

averaging multiple position fixes for greater accuracy and then data- logging the results with sufficient information to post-correct the positions as described below. The accuracy that can be achieved may be better than one meter.

- Survey Grade receivers can provide accuracy at the centimeter level by using long occupation times and special techniques for receiver use and data processing. Survey Grade receivers are not currently used by ATI in field investigations.

GPS receivers derive positions by simultaneously measuring the distance (range) to several satellites in precisely known orbits, and using trilateration of the ranges to calculate a unique position for the receiver. The range to each satellite is determined by precisely measuring the transit time of radio signals broadcast from the satellites.

4.1.2 GPS Accuracy Factors

The accuracy of the basic GPS system is approximately 15 meters. GPS accuracy can be affected by a number of factors including the Selective Availability feature, atmospheric delays, satellite clock and orbit errors, multipath signals, signal strength, and satellite geometry relative to the user.

In the early GPS implementation, the DOD used a feature known as Selective Availability (SA) to degrade the quality and subsequent accuracy of the GPS signals to non-DOD users. With Selective Availability enabled, accuracy of position fixes could be as poor as 100m without the use of differential correction techniques described below. Currently there is no SA limitation in accuracy in place with a stated Executive Branch intention to not return to the use of the SA signal degradation.

As satellites move in their orbits and some signals are blocked by obstructions, the geometry of the available satellite signals relative to the user will constantly change. When the satellites with available signals are clustered closely together in the sky, small errors in range will result in large errors in reported position. Conversely, when the satellites are distributed more broadly across the sky, the resultant position errors will be at their minimum. The general measure of this phenomenon is Dilution of Precision (DOP), which may be represented as Position Dilution of Precision (PDOP), or more specifically for geographical coordinate collection, Horizontal Dilution of Precision (HDOP). Mapping and Survey Grade receivers generally can calculate and display DOP and allow the user to limit logging to times when the higher potential accuracy conditions of low DOP prevail. General-Use receivers may display DOP and use DOP with other factors to estimate a general accuracy figure. DOP may range from approximately 2 to 50, with high quality work usually requiring a HDOP of less than 4-6.

Signal strength and multipath signals relate to the strength and quality of the signal reaching the receiver antenna. Signal attenuation by the atmosphere, buildings, and tree cover limit the accuracy of the ranges obtained. The measure of signal strength is Signal to Noise Ratio (SNR), generally measured in decibels (db). Most receivers of any grade will display the SNR of the satellite signals in a bar graph or table. Mapping Grade Receivers generally allow the user to specify a minimum signal strength for the use of a satellite signal (commonly 2-15 db). Poor signal strength can be resolved by waiting for satellite locations to change or moving the receiver location. Multipath signals result from portions of the satellite signal bouncing off terrain, structures, or atmospheric disturbances, resulting in a degraded total signal. Higher quality Mapping Grade receivers may be capable of rejecting the stray multipath signals, such as Trimble® receivers using Everest™ technology.

4.1.3 Differential GPS

Selective Availability, clock errors, and orbital errors affect all GPS users, and atmospheric delays affect all users over a relatively wide region. A second GPS receiver in the same general area as the user will experience the same errors from these sources as the user's receiver. Consequently, correction factors from a remote station at a known location can be applied to the user's receiver in a process known as Differential GPS (DGPS). DGPS can be applied in real-time using additional radio signals, or after the collection event by a method called post-correction.

Real-time DGPS uses established networks of base stations at precisely surveyed locations. The US Coast Guard operates a system of 80 base stations which became fully operational in 1999. The range corrections are broadcast on marine radio-beacon frequencies, with redundant coverage of most of the US coastline and the Mississippi River. There is near complete single beacon coverage of most of the internal US, but there are known gaps in coverage in the US. The system is sometimes referred to using the more general term DGPS or in nomenclature referring to the beacon-based nature of the system. Beacon-based DGPS is implemented primarily in Navigational and Mapping Grade receivers.

Real-time DGPS can also be implemented with a Space Based Augmentation System (SBAS). The most common SBAS used in the United States is the Wide Area Augmentation System (WAAS), developed by the Federal Aviation Administration to meet the additional demands on GPS for aircraft navigation. The WAAS network of base stations collects information on satellite clock errors, orbital errors, and atmospheric conditions. The error information is transferred to satellites in geo-synchronous orbits and subsequently broadcast to suitably equipped GPS receivers on frequencies compatible with the GPS range signals. While the beacon-based DGPS passes specific satellite range corrections to the receivers, WAAS communicates a model for the errors which is usable over large areas. Current Mapping Grade receivers will likely use WAAS with or without the option of beacon-based DGPS. Modern General-Use receivers are generally equipped with WAAS differential correction capability.

Post-Corrected DGPS is accomplished by downloading the receiver survey files to a desktop or laptop computer and then retrieving correction files for the same time period (generally via the internet) from an established base station in the area of the survey. Post- processed accuracy improves with proximity of the base station to the surveyed locations and base station data should be used from a station within 300km of the site surveyed. The survey positions are processed by application software and a new set of positions is generated using the correction data. The capability for post-processed differential correction is limited to Mapping Grade and Survey Grade receivers.

Various factors limit GPS accuracy in the vertical plane to approximately half of that obtainable in the horizontal plane, i.e., if a location fix is accurate to 3 m in the horizontal plane, it may only be accurate to 6 m in the vertical plane. Since relatively high accuracy is usually required for the uses of elevation data, GPS is rarely used to obtain and report elevations.

4.2 REQUIREMENTS FOR LOCATIONAL INFORMATION

4.2.1 Data Uses

Locational information can serve many purposes in an environmental investigation, a few of which are listed below:

- Providing an unambiguous means to identify facilities or sampling plats.
- Providing locational information to key analytical data in a GIS based data archiving system to the original sampling locations.
- Differentiating watersheds.
- Providing information to calculate extents and volumes of contamination.
- Providing a means to relocate the media represented by samples for removal or treatment.
- Providing information to prepare presentation graphics of sampling locations.

Depending on the specific uses for the data and the type of work being performed, there will be different needs for the accuracy of the locational data. Studies where a sample represents a large area of relatively homogeneous material would not require the same accuracy as the location of a permanent monitoring well. Table 1 presents broad guidelines for the accuracy that might be required for different applications.

Desired Accuracy	**Application**
100 meters (m)	Open ocean work where sample is presumed to be representative of a large area
20 m	Open water work (lakes or estuaries) where sample is presumed to be representative of a large area
10 m	Stream and river work where samples are presumed to be broadly representative of a reach
5 - 3 m	Stream work where samples are representative of a specific narrowly defined section
10 m	Air Monitoring Stations
10 - 3 m	Microscale air monitoring
3 - 1 m	Permanent monitoring wells
1 m	Locations of 'Hot Spots' destined for removal of limited areal extent
3 - 1 m	Locations of temporary groundwater wells in plumes requiring narrow delineation
3 m	Locations of temporary groundwater wells in broad plumes
3 m	Locations of environmental samples with sample spacing >20 m
5 m	Locations of environmental samples with sample spacing >60 m
200 - 20 m	Coordinates describing a facility where mobile waste units are sampled
30 - 3 m	Locations of industrial process areas or NPDES permitted facilities where the sampling locations are described in field notes relative to the process or site features

Specific demands of a study may drive increased or decreased requirements for accuracy. The preferred means of locational data collection for most studies will be GPS, although alternate means are permissible if they meet accuracy requirements. The following table indicates the accuracy that may be expected from various means of establishing coordinates.

Accuracy	**Description**
200 - 50 m	Map Derived, coarse work
40 - 20 m	Map Derived, fine work or using GIS with digital imagery
15 m	General-Use Grade GPS, w/o WAAS
5 m	General-Use Grade GPS, w/ WAAS or beacon corrections
10 m	Mapping Grade GPS, no corrections, averaged readings,
3 m	Mapping Grade GPS w/ differential correction, averaged readings
1 m	Mapping Grade GPS w/ differential correction, controlled DOP and SNR, averaged readings
<10 centimeters (cm)	Surveying Grade GPS or optical surveying (dependent on baseline length)

Accuracy is a term used to describe the degree of conformity of a measurement. In GPS, accuracy is usually specified as an estimate of the radius from the measured coordinates that is likely to include the actual coordinates. The estimate will be based on a percentage likelihood or a certain number of standard deviations that the accuracy estimate is met. As such, it is recognized that some measurements will fall outside of the specified accuracy. For the purposes of ATI GPS work, the nominal accuracy figures derived from manufacturer's literature for specific operating conditions, displayed by the receiver at the time of feature collection, or output from processing software will be taken at face value.

4.2.2 Datums and Data Formats

In general, a datum is a reference from which other measurements are taken. In the development of surveying systems by civil entities, different datums were used as base references that will result in differing coordinates for the same location. A GPS receiver will generally display coordinates in a number of different user-selected datums. Unless there are specific requirements on a project, all ATI work should be conducted using the WGS84 datum. Alternatively, the nearly equivalent NAD83 datum may be used if WGS84 is unavailable as a receiver option. If an alternate coordinate system is used where coordinates are obtained and recorded in field logbooks, the use of the alternate coordinate system should also be noted in the logbook.

There is no ATI policy on significant digits for GPS information, and accuracy should not be implied from the presence of significant digits in reported coordinates. However, good scientific practice should be followed in the presentation of locational information in order that useful information not be truncated or a higher degree of accuracy implied. The following table shows the incremental distance in latitude represented by the least significant digit for various coordinate formats:

dd.dddddd°	Approximately 4 inches (in.) or 10 cm
dd.ddddd°	Approximately 44 in. or 1.1 m
dd.dddd°	Approximately 36 feet or 11 m

dd°mm’ss”	Approximately 100 feet or 30 m
dd°mm’ss.x”	Approximately 10 feet or 3 m
dd°mm’ss.xx”	Approximately 1 foot or 30 cm
dd°mm.xxxx’	Approximately 7 in. or 18 cm
dd°mm.xxx’	Approximately 6 feet or 1.8 m
dd°mm.xx’	Approximately 60 feet or 18 m

4.3 QUALITY CONTROL PROCEDURES

By nature of its origin in the DoD and recent application to aircraft navigation, the GPS is designed for high reliability. GPS failures resulting in an incorrect reading beyond the bounds of known errors are so rare that the possibility can be ignored for most studies. If a study requires the verification of receiver function, this can be accomplished by verifying that a receiver displays the correct position while occupying a known benchmark.

4.4 SPECIAL CONSIDERATIONS

The data quality objectives for the application, availability of receivers, and other factors will dictate the type of receiver used. There are several specific considerations for the use of various GPS receivers.

4.4.1 Special considerations for the use of Trimble® Geo7X Mapping Grade Receivers

Several important settings can be adjusted or checked under the “Setup” toolbar. Suggested settings for Trimble® Geo7X receivers are:

1. Settings>Coordinate System:

   System = Latitude/Longitude
   Datum = WGS 1984
   Altitude Reference = MSL
   Altitude Units – Feet

These settings would rarely need to be changed, but should be checked prior to collecting data.

2. Settings>Real-time Settings Set to:

   Choice 1 = Integrated SBAS
   Choice 2 = Wait for Real-time

When ‘Choice 2’ is set to ‘Wait for Real-time’, the receiver will not log positions if a WAAS signal cannot be received. When this occurs, ‘Choice 2’ may need to be changed temporarily to ‘Use uncorrected GNSS’. The location would then be logged with the reduced accuracy of uncorrected GPS, which should be noted in field logbooks. The accuracy of the position can be improved later by post-processing.

3. Settings>Logging Settings

At the top of the logging settings dialog is the ‘Accuracy Settings’ label. Tap the ‘wrench’ box to the right of the first field to open the Accuracy Settings dialog box.

Set the first box under ‘Accuracy Value for Display/Logging’ to ‘Horizontal’

The box below the Horizontal/Vertical selection chooses whether positions will be corrected in real time or by post-processing. Choose ‘In the field’ if Real-time WAAS corrections will be used, or ‘Postprocessed’ if positions will be post-corrected. This selection will affect the accuracy estimates displayed. If Real-time correction is used when this setting is set to ‘Postprocessed’, the estimated error reported will be erroneously low.

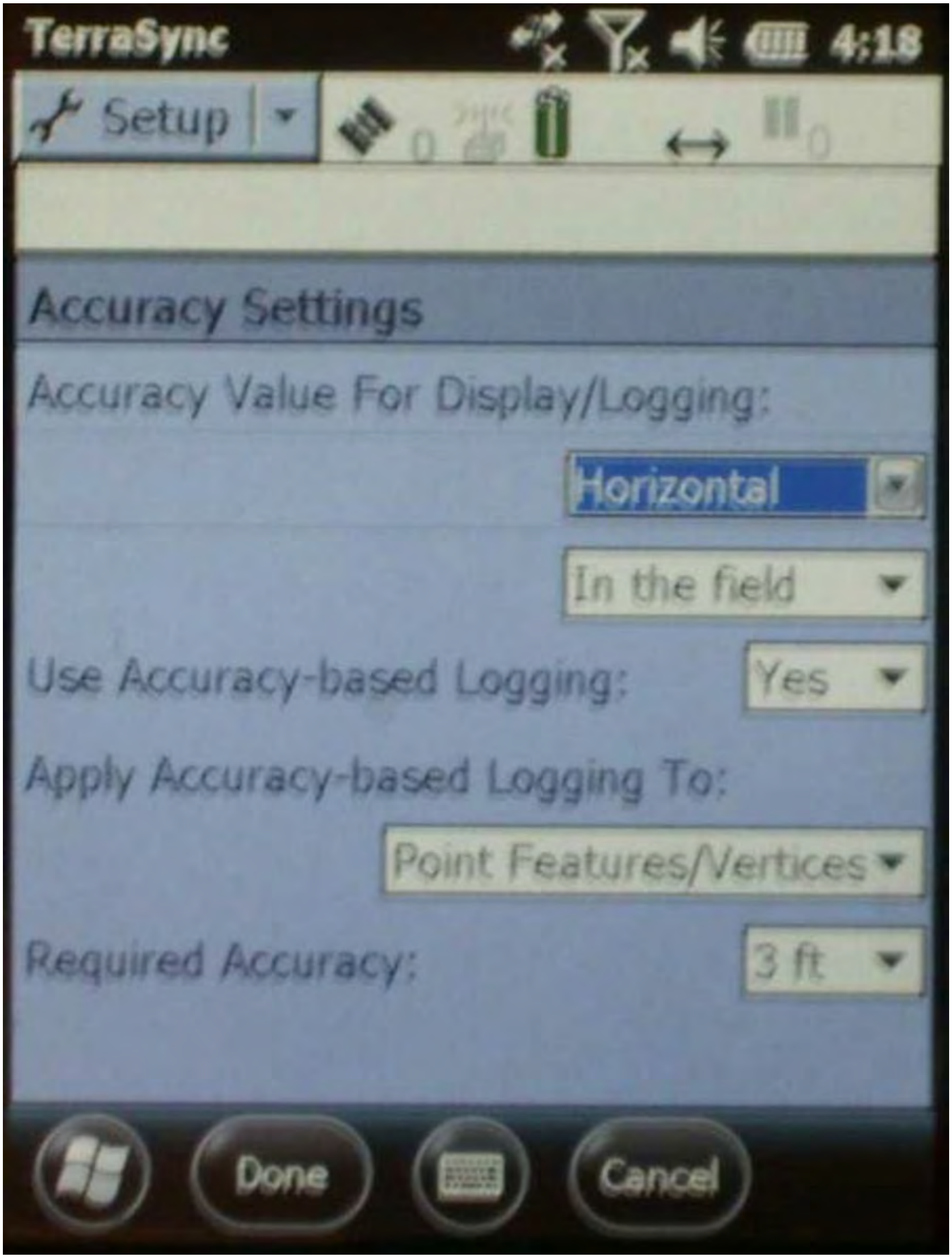
Select ‘Yes’ or ‘No’ for accuracy based logging. Selecting ‘Yes’ will prevent the receiver from logging until the desired accuracy can be achieved. This setting is recommended when a specific accuracy for locational data is required. Selecting ‘Yes’ enables the following choices:

The next box, ‘Apply Accuracy-based Logging to:’ can be set to point features or ‘All Features’. Set appropriately.

The ‘Required Accuracy’ field selects the accuracy threshold that will allow logging. If a position cannot be logged because the threshold cannot be met, several options are available:

1. Set the accuracy threshold to a higher but still acceptable value.
2. Plan to post-correct the coordinates and change the settings in this dialogs accordingly. Post-correction will generally allow more accurate correction than WAAS.
3. Return to the point at a later time when propagation or satellite geometry is more suitable.
4. Use the ‘Offset’ feature (see below) to log the positions from a more suitable location (e.g. less tree cover).

The screen shot below shows the Accuracy Settings Dialog Box:



Accuracy Settings

Accuracy Value For Display/Logging: Horizontal

In the field

Use Accuracy-based Logging: Yes

Apply Accuracy-based Logging To: Point Features/Vertices

Required Accuracy: 3 ft

If the point to be logged cannot be occupied, or signals cannot be received at the location, the ‘Offset’ feature of the receiver can be used. The Trimble® Geo7X receivers can employ a laser rangefinder and internal compass to calculate the offsets. To use the ‘Offset’ feature:

1. Begin logging from the offset location.
2. Pull down the ‘Options’ menu and select ‘Offset’, then ‘Distance – Bearing’
3. The Offset dialog will open where distances and bearings could be manually entered.
4. To use the laser rangefinder and compass to populate the dialog fields, press the physical ‘⌖ □’ button located on the receiver below the screen.
5. The laser rangefinder application will start and a red sighting laser will turn on. Point the laser at the desired point to survey and sight the object in the crosshairs on the screen. When sighted on the survey object, tap on the ‘⌖’ icon on the screen to lock in the distance and bearing at the bottom of the screen. Press the ‘⌖’ icon again to update the readings, or press the ‘✓ □ ’ icon to transfer the bearing and distance to the Offset dialog box.
6. If the numbers transferred to the Offset dialog box are appropriate, tap ‘Done’ to return to the feature logging screen.

There is no quality system calibration performed on the electronic compass and rangefinder. It is the responsibility of the user to assure that the bearings and ranges returned by the laser rangefinder system will result in accuracy consistent with the overall GPS work. A quick check for reasonableness can be performed by comparing the logged position on the Map screen with the current position shown.

Photos can also be taken with the unit and associated with the logged features. The user is referred to vendor documentation for instruction in the use of this feature.

The logging interval of the Trimble® Geo 7X receivers can be set to a 1 or 5 second interval as an option during feature collection. The setting may be set to 1 second to expedite feature collection. A point feature should have a minimum of 36 positions logged to obtain the additional accuracy afforded by the averaging of positions. After a minimum of 36 positions are logged and the feature is closed, the averaged coordinates for the location can be obtained by selecting the feature on the ‘Map’ screen. The averaged position should always be the one entered into field notebooks.

4.4.2 Coordinate Conversion

Geographic coordinates can be presented using the degrees, minutes, seconds (DMS) system or as decimal degrees. Specific applications may require one system or the other; coordinates displayed on the receiver or obtained from outside ATI may be in a format other than what is required. If the coordinates are in the correct datum but the wrong format, they can be arithmetically converted as follows.

> Converting from DMS (dd°mm′ss.sss″) to decimal degrees (dd.dddddd°) is done with the following formula:

$$\text{dd.dddddd}^\circ = \text{dd} + (\text{mm}/60) + (\text{ss.sss}/3600)$$

Example: Convert 33°28′45.241″ to decimal degrees (equation 1):

$$33 + (28/60) + (45.241/3600) = 33.479234° \qquad (1)$$

The reverse conversion (decimal degrees to DMS) is more complex, and is accomplished as follows, using the same example as above:

Example: Convert 33.479234° to DMS

Subtract the whole degree (33°) from the decimal degree value (33.479234°), which results in a fractional degree as follows (equation 2):

$$33.479234° - 33° = 0.479234° \qquad (2)$$

Multiply the remaining fraction of degrees (0.479236) by 60 minutes as follows (equation 3):

$$0.479236 \times 60' = 28.75404' \qquad (3)$$

Subtract the whole minutes (28′) from this result, and multiply the remaining fraction of minutes (0.75416) by 60 seconds as follows:

$$0.75404 \times 60'' = 45.241'' \qquad (4)$$

The result in DMS is the whole degrees (33°) from the original coordinate; the whole minute value (28′) from equation 3; and the remaining seconds (45.241″) from equation 4, or 33°28′45.241″.

GPS users need to familiarize themselves with the differences between the decimal degree and DMS formats, as they can appear similar. Spreadsheets can automate the conversion process.

4.5 RECORDS

The GPS coordinates and the ATI equipment identification number of the GPS receiver should be recorded in field logbooks at the time of GPS coordinate collection. The data logging capability of receivers may be used in lieu of the requirement to record the coordinates in logbooks when the following conditions can be met:

1. The location can easily be found later if it needs to be resurveyed prior to demobilization. A permanent monitoring well can easily be resurveyed, while most open-water work would not afford this opportunity.
2. The data are downloaded and ascertained to meet the accuracy requirements for the project prior to demobilization from the site.
3. The data are stored in at least two separate locations for transport, such as a laptop hard drive and a flash drive or compact disc.

Where locational data are collected and processed electronically, but not reported explicitly in the final report, a copy of the coordinates in text format should be output and entered into the project file in paper or electronic form. The output should include latitude and longitude (generally decimal degrees); date of collection; a note on the differential correction process used where it supports the accuracy requirements; and the datum used for the export.

5.0 ASSOCIATED DOCUMENTS

- ATI SOP FO-010, Field Logbook
- Uniform Federal Policy Quality Assurance Project Plan
- U.S. Environmental Protection Agency (EPA), 2015. Standard Operating Procedure, Global Positioning System. Region 4, Science and Ecosystems Support Division SOP SESDPROC-110-R4. December.

6.0 INFORMATION CONTACTS

- ATI Project Manager

FIELD LOGBOOK DOCUMENTATION: SOP FO-010

1.0 OBJECTIVE / BACKGROUND

This standard operating procedure (SOP) is to be used by field investigators when documenting pertinent and factual information in logbooks related to environmental and military response field investigations involving sampling and measurement procedures and/or other data collection events. Accurate and legible field notes are often included as project deliverables, used for Quality Control (QC), used as supporting documentation for work modifications, and may be required to verify hours worked for payment.

Field records are the basis for later written reports and are discoverable in legal actions. Therefore, entries should be objective, factual, and free of personal feelings or terminology that might be deemed inappropriate. Completed field logbooks are “record” documents for QC purposes and must be maintained as part of the official project files.

Field notes are the only record that is left after the field team departs the site. If field notes are not clear and complete, the field activities are of little value. It is therefore critical that field notes contain a complete record of all the observations and measurements made during the fieldwork.

The field logbook should include, where necessary, sketches and narrations to clarify the notes. If stand-alone forms are used for specific items discussed in this procedure (calibration, monitoring, safety, etc.), they should be referenced in the field logbook by date, time and subject. Electronic data should be referenced in the field logbook.

2.0 RESPONSIBLE PARTIES

- Site Manager
- Engineering/Environmental Technician
- Any field person designated to maintain a field book

3.0 ACRONYMS AND DEFINITIONS

- QAPP – Quality Assurance Project Plan
- QC – Quality Control
- SOP – Standard operating procedure
- SOW – Scope of Work

4.0 FIELD BOOK DOCUMENTATION

4.1 PHYSICAL CHARACTERISTICS

The field logbook itself should be small and easy to carry and preferably a bright color for ease of identification. It should be bound so the pages will not fall out and the pages should be numbered. It should have a hard cover for durability and for ease of note taking. The field logbook should be weatherproof so that notes can be taken in inclement weather and so that notations will remain legible when wet.

4.2 FIELD LOGBOOK REQUIREMENTS

Each project should have a dedicated field logbook. Additional dedicated field logbooks may be needed if separate field teams are working on the same project and/or the same site, and/or as field logbooks are filled. Field logbooks may be designated for specific elements of a project (e.g., task, drilling logs, environmental data, safety, QC, etc.). The name of the Project Manager, the name of the Site Manager, the project name and location, and the project number should be entered on the inside of the front cover of the logbook.

The entries should be legible and contain accurate and inclusive documentation of the note taker's project activities. Each page of the field logbook should be dated and initialed. At the end of all entries for each day or at the end of a particular event, the note taker should draw a diagonal line and initial indicating the conclusion of the entry and sign and date the page. Begin a new page for each day's activities.

Recording of field notes takes one or more of three general forms: tabulations, sketches and descriptions. Allow space for computations, if appropriate.

Sketches add much to clarify the true meaning of field notes; use liberally, where appropriate. They may be drawn to an approximate scale and important details may be exaggerated for clarity. Small rulers and triangles are useful aids in making sketches. Measurements should be noted directly on the sketch or keyed to relevant tabular data. Legibility is key to the usefulness of a sketch. The sketch must be drawn clearly and large enough to be understandable.

Tabulations and or sketches should be supplemented with descriptions, or descriptions may be stand-alone elements of the field book. The description may be brief if the intent is to clarify a measurement, or it may be a lengthy narrative if it is to be used in the future to reconstruct a field scenario.

All aspects of sample collection and handling as well as visual observations shall be documented in the field logbook. Review the SOW and the QAPP, as they may require collection of specific information items in addition to those noted below. Information that should be recorded in the field logbook includes:

<u>Mobilization</u>

- Date and time of fieldwork (start time and end time)
- Page number, starting at 1 for each day and including the total number of pages of notes for the day (e.g., "page x of y" or "x/y", where x is the current page number and y is the total number of pages for the day)
- Personnel on site (subcontractors, visitors and ATI personnel)
- Weather conditions (temperature, precipitation, sun/cloud cover, humidity, etc.)
- Daily safety briefing time and subject
- Additional training/briefings
- Task list for fieldwork
- Vehicle and equipment identification including model numbers and sizes, where applicable
- Reference field forms, if used

Field Equipment

- Sample collection equipment
- Field analytical equipment
- Equipment used to make physical measurements in the field
- Calibration data for field sampling, field analytical and field physical measurement equipment, as appropriate
- Property numbers of equipment, as available

Sampling Activities

- Sampling station/location identification
- Matrix sampled
- Sample identification
- Date and time of sample collection
- Method of collection
- Number and type of containers
- Sample preservation (including ice)
- Sample collection equipment
- Physical description of sample
- Maps or sketches of sampling locations
- Description of the sample and the sample collection procedure
- Diagram(s) of the process
- Identification of the sampler(s) and their duties (e.g., calibration, collection, packing)

Health and Safety

- Health and safety exposure monitoring
- Explanation of any safety violations and how conditions detrimental to safety were resolved
- Accidents/incidents, including response actions and notifications

Referencing Forms and Electronic Files

- Electronic data should be tracked within field logbooks; include electronic file name and description and/or instrument type and serial number, as applicable
- Electronic data may include:
    - Digital photographs; note subject matter in field logbook and include time and date of photographs
    - GPS data; include time and date stamp plus control point name and location
    - Forms in electronic media; include form name and description
    - Geophysical data

- The individual responsible for a form also is responsible for its reference in the field logbook

Quality Control

- Comprehensive summary of daily activities
- Documentation of any client direction
- Explanation of deviations from procedures (SOW, Uniform Federal Policy Quality Assurance Project Plan), including who directed the deviations, how they were implemented
- QC findings and resolutions
- Identification of any nonconformances, including who was notified and how the non-conformances were corrected
- Description of any delays (weather, unauthorized personnel on site, equipment failures, etc.). Indicate the names/number of individuals affected and timeframe impacted.
- Erasures are not permitted in field logbooks. Numbers or entries recorded incorrectly should be lined out and the corrected values or information inserted. If entire pages are to be replaced, they should be crossed out neatly without obscuring any information and referenced to the substituted pages. All such corrections should be initialed and dated.

5.0 ASSOCIATED DOCUMENTS

- Uniform Federal Policy-Quality Assurance Project Plan

6.0 INFORMATION CONTACTS

- ATI Project Manager
- ATI Field Quality Manager

UTILITY CLEARANCE: SOP FO-011

1.0 OBJECTIVE / BACKGROUND

This standard operating procedure (SOP) describes the utility mark-out/clearance process to be followed prior to initiating any intrusive subsurface activities. Along with the process, the SOP describes what to look for during intrusive work activities. The document should be shared with field project team members prior to going into the field, and may be used to develop scopes of work for utility clearance subcontractors.

2.0 RESPONSIBLE PARTIES

- All ATI field employees and subcontractors

3.0 ACRONYMS AND DEFINITIONS

- APWA – American Public Works Association
- DPT – Direct push technology
- MIP – Membrane Interface Probe
- PM – Project Manager
- SOP – Standard Operating Procedure

4.0 PROCEDURES/GUIDELINES FOR UTILITY CLEARANCE

4.1 PRIOR TO MOBILIZING TO THE FIELD

Prior to mobilizing to perform subsurface activities, the state Call Before You Dig service must be called and the utility companies under the one-call service must mark out their utility lines. For the United States, calling 811 automatically routes the caller to the one call center in that area.

The 811 service **must** be called prior to any intrusive work. States require notices of **not less than a prescribed number of hours or business days**, exclusive of Saturdays, Sundays, state holidays and federal holidays so that utility services have time to effectively mark the areas. Have the following general information ready when you call:

1. Name
2. Telephone/Fax Number
3. The mailing address of the caller's company (<u>not to be confused with the excavation site address</u>)
4. Work Date and Time
5. County and Town/Community. The county and town/community (or nearest town) where the work is to be performed
6. Worksite address, if applicable

7. Nearest Intersection or Cross Street/Road
8. Length, Direction and Depth of Excavation
9. When possible, mark the work site with white to provide the exact location where utilities need to mark their underground facilities
10. Purpose of work
11. Identify for whom the work is being done
12. Contact Name and Phone Number

While on the phone with the one-call service, make sure to collect the following information and document it in the project files.

1. **Members Notified**. Identity of utility members notified will be provided to the caller. Retain a copy of this in the project files and keep it onsite while intrusive work is being performed.
2. **Case Reference Number**. An identification/ticket number associated with the call for future reference if needed. Retain a copy of this in the project files and keep it onsite while intrusive work is being performed.

Utility members are required to notify the contact person by fax or e-mail if they do not have any utilities at the work area. The Site Safety Coordinator should retain a copy of this in the project records and keep it onsite while intrusive work is being performed.

Serious penalties including fines can be levied if the one call service is not contacted before excavation activities occur.

4.2 MOBILIZATION TO THE FIELD

1. The location(s) where intrusive work will occur should be identified by pre-marking at the site at least 2 weeks prior to arrival of the subcontractors to the site. Each location shall be pre-marked according to Table 1. It is important to take access issues (i.e. whether the site has enough space for heavy equipment to move into and operate within) into consideration while pre-marking.

Table 1 – Pre-Marking Requirements	
Planned Subsurface Activity	Pre-Marking Notation
Borehole (diameter up to 12”)	Place white spray paint “X” on location.
Borehole (diameter from 12” up to 48”)	Mark center of planned boring location and mark a circle up to three times the planned diameter of the boring with white spray paint.
Elongated Trench	Mark planned centerline of trench and a minimum of 3 feet beyond planned width of trench with white spray paint. **Do not trench outside of the marked areas!**
Other excavations	Mark planned shape of excavation and a minimum of 3 feet beyond planned excavation limit. **Do not excavate outside of the marked areas!**

2. Upon arriving at the site, for the pre-marking effort, the field team leader will make sure to note in the field logbook the persons participating and that the verification was provided (if required). The field logbook should also note any potential conflicts with the utility location and the decision reached regarding the conflict.
3. At the discretion of the PM and Site Health and Safety Coordinator, a third-party utility service may also be engaged to perform an independent survey of the utility marking performed by the one call service members.
4. The utility locator should scan the area designated for intrusive work. Additional areas, if necessary, to be cleared by the utility locator should also be pre-marked according to Table 1. Note that utility location process does have limitations on what can be detected. The limitations are presented in Table 2.

Table 2 – Limitations of Utility Locating	
Limitation	**Description**
General	Accessibility to the pipe or utility for inducing a magnetic field.
Material Type	Plastic, concrete, clay, asbestos cement, and cast iron are not traceable.
General	Age and external condition of the pipe
General	Complexity of site with multiple utilities in close proximity.

1. The area that is cleared by the utility locator for intrusive work (e.g., proposed intrusive work area plus buffer areas) should be clearly marked using spray paint, flagging, or pin flags.
2. All utilities in the area where intrusive work is to be performed should be marked out on the ground by the utility locator using the American Public Works Association (APWA) Uniform Color Code (Attachment 1).
3. A copy of the utility clearance signoff sheet and the Safe Work Permit must be provided to ATI after all areas where intrusive work is planned have been cleared. The sign-off sheet should document the location of underground utilities and obstructions in the immediate area of the intrusive work.

4.3 DURING INTRUSIVE WORK

The following should be completed before commencing intrusive work:

1. Verify that all public utility companies have identified the presence of utilities with marking paint or have provided a response back indicating the absence of utilities in the area. To verify what the utility markings on the ground indicate, use the color code in Attachment 1. **If utilities have not been marked out properly or a negative response has not been confirmed, do not perform intrusive work in that area. Contact the appropriate companies and request that they mark their utility line or verify that they have no utility lines in that area.**
2. If private utilities are present, review the utility clearance signoff sheet to verify that the location has been cleared for intrusive work. Also, review the markings on the ground and compare this against the document provided by the utility locator that indicates the utilities in the area. **If markings are missing, or the sign-off sheet or site observations indicate that cleared areas may contain utilities, do not perform any intrusive work until you have contacted the utility locator and they have marked the missing utility line(s).**
3. Share utility clearance documentation with the subcontractor during the tailgate meeting.
4. If there are numerous utility lines around the area where intrusive work is to be performed, it is mandatory that soft digging or hand excavation should be performed down to 5 feet below ground surface prior to the commencement of the other intrusive activities. Planned intrusive activity using direct push technology (DPT) rods, Membrane Interface Probe (MIP) tools, drill rods, drill augers, excavator buckets, etc., shall be preceded by use of a hand auger or a soft-dig technique (e.g., using air or water pressure to break up subsurface material in conjunction with vacuum extraction) to 5 feet below ground surface prior to commencement of the other intrusive activities.
5. Intrusive work can only be performed in the cleared area. If intrusive work needs to be performed outside of the cleared area the appropriate utility locator(s) must clear the new location. If the new area cleared involves private utilities, an addendum to the initial utility clearance signoff sheet should be provided.

6. While performing intrusive work, monitor for signs of an encounter with a utility line. These signs include, but are not limited to, changes in fill material, gravel, sand, warning tape, plastic, or metal. If it is believed that a utility was struck, stop work, call the appropriate personnel, and document this in field book. If any danger exists, evacuate workers and bystanders to a safe area and notify emergency personnel.

5.0 NOTES

- Striking a utility such as an energized power line or gas pipeline can potentially cause death or serious injury to site workers, bystanders, and/or inhabitants of nearby buildings, as well as potentially causing catastrophic property damage from fires or explosions. Damage to various underground utilities could also result in service interruptions to residences and businesses as well as potential environmental impacts.
- Safety is paramount; always err on the side of caution when in doubt about encountering utilities during intrusive work.
- Utility clearance tickets expire. Ensure that the intrusive activities are conducted before the ticket expiration, as well as before any surface markings fade or pin flags are removed. If necessary, repeat the actions in this SOP.

6.0 ASSOCIATED DOCUMENTS

- Site Specific Safety and Health Plan
- Uniform Federal Policy-Quality Assurance Project Plan

7.0 INFORMATION CONTACTS

- The ATI Project and/or Program Manager

ATTACHMENT 1: APWA UNIFORM COLOR CODE

APWA UNIFORM COLOR CODE

FOR MARKING
UNDERGROUND UTILITY LINES

- PROPOSED EXCAVATION
- TEMPORARY SURVEY MARKINGS
- ELECTRIC POWER LINES, CABLES, CONDUIT AND LIGHTING CABLES
- GAS, OIL, STEAM, PETROLEUM OR GASEOUS MATERIALS
- COMMUNICATION, ALARM OR SIGNAL LINES, CABLES OR CONDUIT
- POTABLE WATER
- RECLAIMED WATER, IRRIGATION AND SLURRY LINES
- SEWERS AND DRAIN LINES

Designation: D 2488 – 00

Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)[1]

This standard is issued under the fixed designation D 2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope *

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D 2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils (disturbed and undisturbed).

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (see Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 The values stated in inch-pound units are to be regarded as the standard.

1.5 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Section 8.

1.6 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]
D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]
D 1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils[2]
D 1587 Practice for Thin-Walled Tube Sampling of Soils[2]
D 2113 Practice for Diamond Core Drilling for Site Investigation[2]
D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)[2]
D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and rock as Used in Engineering Design and Construction[3]
D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)[2]

3. Terminology

3.1 *Definitions*—Except as listed below, all definitions are in accordance with Terminology D 653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:
Cobbles—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and
Boulders—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.1 *clay*—soil passing a No. 200 (75-μm) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a clay is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid

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[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

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[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 04.09.

***A Summary of Changes section appears at the end of this standard.**

limit falls on or above the "A" line (see Fig. 3 of Test Method D 2487).

3.1.2 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

coarse—passes a 3-in. (75-mm) sieve and is retained on a ¾-in. (19-mm) sieve.

fine—passes a ¾-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.3 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.4 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.5 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.6 *sand*—particles of rock that will pass a No. 4 (4.75-mm) sieve and be retained on a No. 200 (75-µm) sieve with the following subdivisions:

coarse—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

medium—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-µm) sieve.

fine—passes a No. 40 (425-µm) sieve and is retained on a No. 200 (75-µm) sieve.

3.1.7 *silt*—soil passing a No. 200 (75-µm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line (see Fig. 3 of Test Method D 2487).

4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Fig. 1a and Fig. 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols.*

Dual Symbol—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D 2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12 % fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

Borderline Symbol—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D 2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D 2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D 2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test results for typical soils of each type with their visual and manual characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is not necessary to follow all of the procedures in this practice for every sample. Soils which appear to be similar can be grouped together; one sample completely described and identified with the others referred to as similar based on performing only a few of the descriptive and identification procedures described in this practice.

5.7 This practice may be used in combination with Practice D 4083 when working with frozen soils.

NOTE 5—Notwithstanding the statements on precision and bias contained in this standard: The precision of this test method is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing. Users of this test method are cautioned that compliance with Practice D 3740 does not in itself assure reliable testing. Reliable testing depends on several factors; Practice D 3740 provides a means for evaluating some of those factors.

6. Apparatus

6.1 *Required Apparatus*:

6.1.1 *Pocket Knife or Small Spatula*.

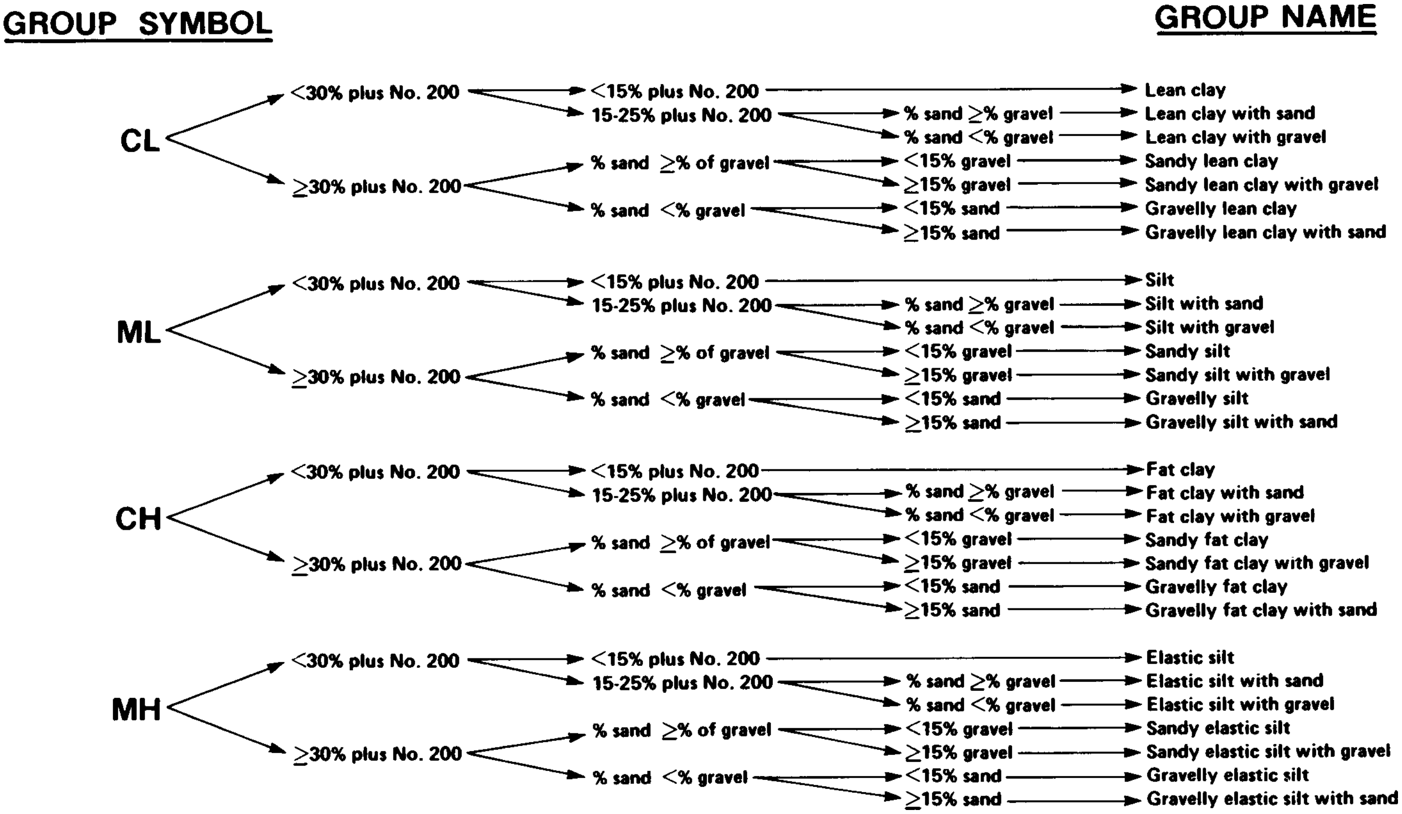
6.2 *Useful Auxiliary Apparatus*:

6.2.1 *Small Test Tube and Stopper* (or jar with a lid).

6.2.2 *Small Hand Lens*.

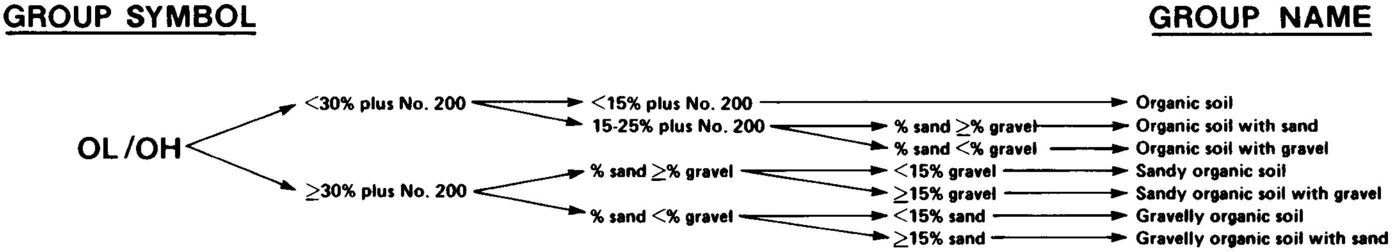
7. Reagents

7.1 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean water from a city water



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 1 b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)

supply or natural source, including non-potable water.

7.2 *Hydrochloric Acid*—A small bottle of dilute hydrochloric acid, HCl, one part HCl (10 *N*) to three parts water (This reagent is optional for use with this practice). See Section 8.

8. Safety Precautions

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If solution comes into contact with the skin, rinse thoroughly with water.

8.2 **Caution**—Do not add water to acid.

9. Sampling

9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

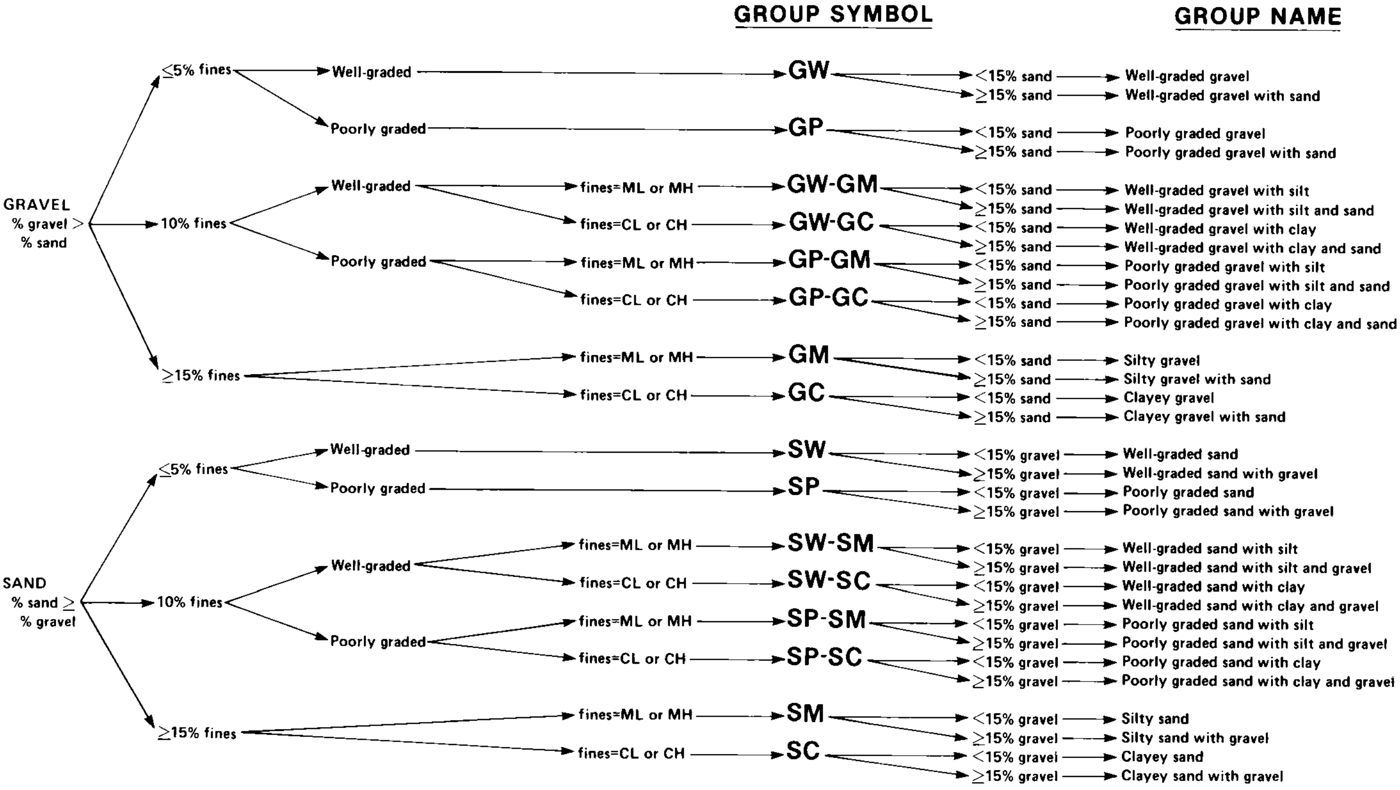
NOTE 6—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D 1452, D 1587, or D 2113, or Test Method D 1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 7—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in accordance with the following schedule:

Maximum Particle Size, Sieve Opening	Minimum Specimen Size, Dry Weight
4.75 mm (No. 4)	100 g (0.25 lb)
9.5 mm (3⁄8 in.)	200 g (0.5 lb)
19.0 mm (3⁄4 in.)	1.0 kg (2.2 lb)
38.1 mm (1½ in.)	8.0 kg (18 lb)
75.0 mm (3 in.)	60.0 kg (132 lb)



NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)

NOTE 8—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceeding schedule.

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

10. Descriptive Information for Soils

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color shall be described for moist samples. If the color represents a dry condition, this shall be stated in the report.

10.4 *Odor*—Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum product, chemical, and the like), it shall be described.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 3.

10.6 *HCl Reaction*—Describe the reaction with HCl as none, weak, or strong, in accordance with the critera in Table 4. Since calcium carbonate is a common cementing agent, a report of its presence on the basis of the reaction with dilute hydrochloric acid is important.

10.7 *Consistency*—For intact fine-grained soil, describe the consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 5. This observation is inappropriate for soils with significant amounts of gravel.

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 6.


(a) Rounded (b) Angular


(c) Subrounded (d) Subangular

FIG. 3 Typical Angularity of Bulky Grains

TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)

The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively.

Flat	Particles with width/thickness > 3
Elongated	Particles with length/width > 3
Flat and elongated	Particles meet criteria for both flat and elongated

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 7.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.1.2 and 3.1.6. For example, about 20 % fine to coarse gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.6. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening that the particle will pass. For example, maximum particle size, 1½ in. (will pass a 1½-in. square opening but not a ¾-in. square opening).

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum dimension, 18 in. (450 mm).

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. "Hard" means particles do not crack, fracture, or crumble under a hammer blow.

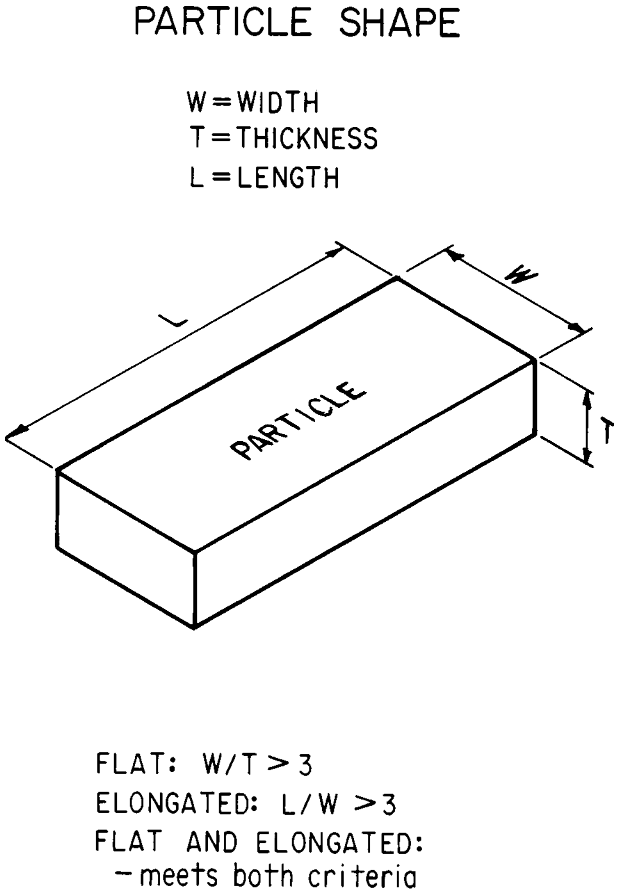


FIG. 4 Criteria for Particle Shape

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering

TABLE 3 Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

TABLE 4 Criteria for Describing the Reaction With HCl

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

TABLE 5 Criteria for Describing Dilatancy

Description	Criteria
Very soft	Thumb will penetrate soil more than 1 in. (25 mm)
Soft	Thumb will penetrate soil about 1 in. (25 mm)
Firm	Thumb will indent soil about ¼in. (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very hard	Thumbnail will not indent soil

TABLE 6 Criteria for Describing Toughness

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

TABLE 7 Criteria for Describing Dilatancy

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout

hole, caving of trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpretation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as a highly organic soil and shall be identified as peat, PT, and not subjected to the identification procedures described hereafter.

12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually, for a loose sample, or mentally, for an intact sample before classifying the soil.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 9—Since the percentages of the particle-size distribution in Test Method D 2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by dry weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry weight, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 10—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not to be considered in the total of 100 % for the components.

13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more fines. Follow the procedures for identifying fine-grained soils of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-grained soils of Section 15.

14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

14.2 *Dry Strength*:

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about ½ in. (12 mm) in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 60°C.

14.2.3 If the test specimen contains natural dry lumps, those that are about ½ in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 11—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accorance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 *Dilatancy*:

14.3.1 From the specimen, select enough material to mold into a ball about ½ in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 *Toughness*:

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about ⅛ in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about ⅛ in. The thread will crumble at a diameter of ⅛ in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 10.

14.5 *Plasticity*—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an *inorganic* or an *organic* fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

TABLE 8 Criteria for Describing Toughness

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface
Very high	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 9 Criteria for Describing Dilatancy

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing

TABLE 10 Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

TABLE 11 Criteria for Describing Plasticity

Description	Criteria
Nonplastic	A ⅛-in. (3-mm) thread cannot be rolled at any water content
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

14.7 *Identification of Inorganic Fine-Grained Soils*:

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

NOTE 12—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D 2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	None	High

14.8 *Identification of Organic Fine-Grained Soils*:

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 13—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words "with sand" or "with gravel" (whichever is more predominant) shall be added to the group name. For example: "lean clay with sand, CL" or "silt with gravel, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percentage of gravel, use "with sand."

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words "sandy" or "gravelly" shall be added to the group name. Add the word "sandy" if there appears to be more sand than gravel. Add the word "gravelly" if there appears to be more gravel than sand. For example: "sandy lean clay, CL", "gravelly fat clay, CH", or "sandy silt, ML" (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percent of gravel, use "sandy."

15. Procedure for Identifying Coarse-Grained Soils
(Contains less than 50 % fines)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words "with clay" or "with silt" to indicate the plasticity characteristics of the fines. For example: "well-graded gravel with clay, GW-GC" or "poorly graded sand with silt, SP-SM" (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words "with gravel" or "with sand" shall be added to the group name. For example: "poorly graded gravel with sand, GP" or "clayey sand with gravel, SC" (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words "with cobbles" or "with cobbles and boulders" shall be added to the group name. For example: "silty gravel with cobbles, GM."

16. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 14—*Example: Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

NOTE 15—Other examples of soil descriptions and identification are given in Appendix X1 and Appendix X2.

NOTE 16—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

Trace—Particles are present but estimated to be less than 5 %
Few—5 to 10 %
Little—15 to 25 %
Some—30 to 45 %
Mostly—50 to 100 %

TABLE 13 Checklist for Description of Soils

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
    Gravel—fine, coarse
    Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

For intact samples:

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D 2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

APPENDIXES

(Nonmandatory Information)

X1. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

X1.1 The following examples show how the information required in 16.1 can be reported. The information that is included in descriptions should be based on individual circumstances and need.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—About 75 % fine to coarse, hard, subangular gravel; about 25 % fine to coarse, hard, subangular sand; trace of fines; maximum size, 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength, rapid dilatancy, and low toughness; about 15 % fine, hard, subrounded gravel, a few gravel-size particles fractured with hammer blow; maximum size, 25 mm; no reaction with HCl (Note—Field sample size smaller than recommended).

In-Place Conditions—Firm, stratified and contains lenses of silt 1 to 2 in. (25 to 50 mm) thick, moist, brown to gray; in-place density 106 lb/ft^3; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor; weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry strength and slow dilatancy; wet; maximum size, coarse sand; weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—About 75 % fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to subangular sand; about 10 % silty nonplastic fines; moist, brown; no reaction with HCl; original field sample had about 5 % (by volume) hard, subrounded cobbles and a trace of hard, subrounded boulders, with a maximum dimension of 18 in. (450 mm).

X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may be used as a descriptive system applied to materials that exist in-situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, and the like).

X2.2 Materials such as shells, crushed rock, slag, and the like, should be identified as such. However, the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incororated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. (50 to 100-mm) pieces of shale from power auger hole, dry, brown, no reaction with HCl. After slaking in water for 24 h, material identified as “Sandy Lean Clay (CL)”; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand; about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; “Poorly Graded Sand with Silt (SP-SM)”; about 90 % fine to medium sand; about 10 % nonplastic fines; dry, reddish-brown, strong reaction with HCl.

X2.4.3 *Broken Shells*—About 60 % gravel-size broken shells; about 30 % sand and sand-size shell pieces; about 10 % fines; “Poorly Graded Gravel with Sand (GP).”

X2.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; “Poorly Graded Gravel (GP)”; about 90 % fine, hard, angular gravel-size particles; about 10 % coarse, hard, angular sand-size particles; dry, tan; no reaction with HCl.

X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics, it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when the percentage of fines is estimated to be between 45 and 55 %. One symbol should be for a coarse-grained soil with fines and the other for a fine-grained soil. For example: GM/ML or CL/SC.

X3.1.2 A borderline symbol may be used when the percentage of sand and the percentage of gravel are estimated to be about the same. For example: GP/SP, SC/GC, GM/SM. It is practically impossible to have a soil that would have a borderline symbol of GW/SW.

X3.1.3 A borderline symbol may be used when the soil could be either well graded or poorly graded. For example: GW/GP, SW/SP.

X3.1.4 A borderline symbol may be used when the soil could either be a silt or a clay. For example: CL/ML, CH/MH, SC/SM.

X3.1.5 A borderline symbol may be used when a fine-grained soil has properties that indicate that it is at the boundary between a soil of low compressibility and a soil of high compressibility. For example: CL/CH, MH/ML.

X3.2 The order of the borderline symbols should reflect similarity to surrounding or adjacent soils. For example: soils in a borrow area have been identified as CH. One sample is considered to have a borderline symbol of CL and CH. To show similarity, the borderline symbol should be CH/CL.

X3.3 The group name for a soil with a borderline symbol should be the group name for the first symbol, except for:

CL/CH lean to fat clay
ML/CL clayey silt
CL/ML silty clay

X3.4 The use of a borderline symbol should not be used indiscriminately. Every effort shall be made to first place the soil into a single group.

X4. SUGGESTED PROCEDURES FOR ESTIMATING THE PERCENTAGES OF GRAVEL, SAND, AND FINES IN A SOIL SAMPLE

X4.1 *Jar Method*—The relative percentage of coarse- and fine-grained material may be estimated by thoroughly shaking a mixture of soil and water in a test tube or jar, and then allowing the mixture to settle. The coarse particles will fall to the bottom and successively finer particles will be deposited with increasing time; the sand sizes will fall out of suspension in 20 to 30 s. The relative proportions can be estimated from the relative volume of each size separate. This method should be correlated to particle-size laboratory determinations.

X4.2 *Visual Method*—Mentally visualize the gravel size particles placed in a sack (or other container) or sacks. Then, do the same with the sand size particles and the fines. Then, mentally compare the number of sacks to estimate the percentage of plus No. 4 sieve size and minus No. 4 sieve size present. The percentages of sand and fines in the minus sieve size No. 4 material can then be estimated from the wash test (X4.3).

X4.3 *Wash Test (for relative percentages of sand and fines)*—Select and moisten enough minus No. 4 sieve size material to form a 1-in (25-mm) cube of soil. Cut the cube in half, set one-half to the side, and place the other half in a small dish. Wash and decant the fines out of the material in the dish until the wash water is clear and then compare the two samples and estimate the percentage of sand and fines. Remember that the percentage is based on weight, not volume. However, the volume comparison will provide a reasonable indication of grain size percentages.

X4.3.1 While washing, it may be necessary to break down lumps of fines with the finger to get the correct percentages.

X5. ABBREVIATED SOIL CLASSIFICATION SYMBOLS

X5.1 In some cases, because of lack of space, an abbreviated system may be useful to indicate the soil classification symbol and name. Examples of such cases would be graphical logs, databases, tables, etc.

X5.2 This abbreviated system is not a substitute for the full name and descriptive information but can be used in supplementary presentations when the complete description is referenced.

X5.3 The abbreviated system should consist of the soil classification symbol based on this standard with appropriate lower case letter prefixes and suffixes as:

Prefix:	Suffix:

s = sandy	s = with sand
g = gravelly	g = with gravel
	c = with cobbles
	b = with boulders

X5.4 The soil classification symbol is to be enclosed in parenthesis. Some examples would be:

Group Symbol and Full Name	Abbreviated
CL, Sandy lean clay	s(CL)
SP-SM, Poorly graded sand with silt and gravel	(SP-SM)g
GP, poorly graded gravel with sand, cobbles, and boulders	(GP)scb
ML, gravelly silt with sand and cobbles	g(ML)sc

SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition ($1993^{\epsilon 1}$) that may impact the use of this standard.

(1) Added Practice D 3740 to Section 2.

(2) Added Note 5 under 5.7 and renumbered subsequent notes.

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FIELD FORMS

HTRW DRILLING LOG

DISTRICT

HOLE NUMBER

1. COMPANY NAME

2. DRILLING CONTRACTOR

SHEET 1 OF SHEETS

3. PROJECT

4. LOCATION

5. NAME OF DRILLER

6. MANUFACTURER'S DESIGNATION OF DRILL

7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT

8. HOLE LOCATION

9. SURFACE ELEVATION

10. DATE STARTED

11. DATE COMPLETED

12. OVERBURDEN THICKNESS

15. DEPTH GROUNDWATER ENCOUNTERED

13. DEPTH DRILLED INTO ROCK

16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED

14. TOTAL DEPTH OF HOLE

17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE
						%

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR

LOCATION SKETCH/COMMENTS

SCALE:

PROJECT

HOLE NO

ENG FORM 5056-R, AUG 94

(Proponent: CECW-EG)

EQUIPMENT MAINTENANCE
AND CALIBRATION RECORD

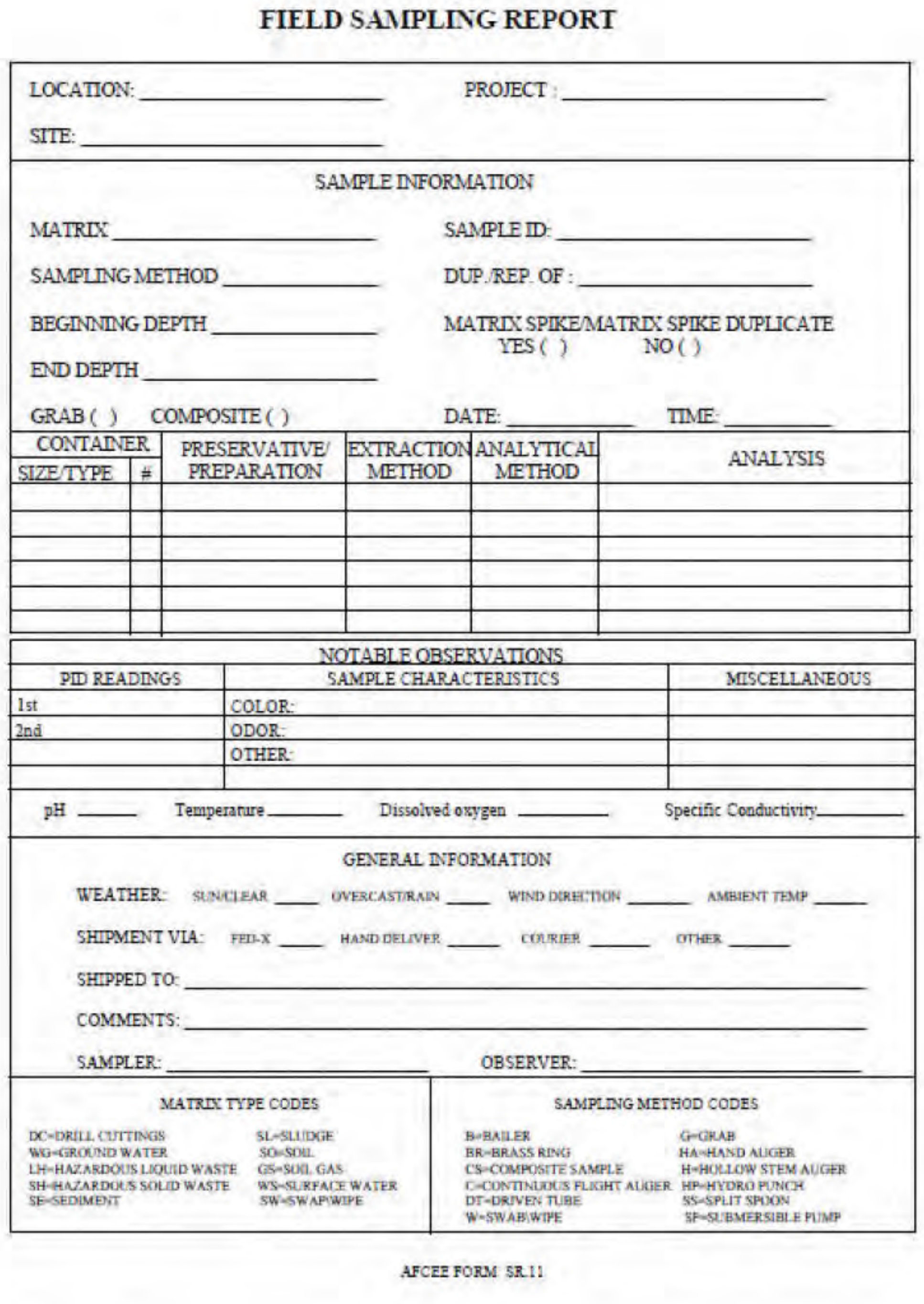
Contract/Project: ____________________ Equipment Description: ____________________

Activity: ____________________ Equipment ID: ____________________

Equipment Serial No.:

Calibration Date	Parameter	Standard Used (Concentration)	Lot Control No / Expiration Date	Post Calibration Reading	Comments Pass/Fail	Signature

Maintenance Performed: ____________________



FIELD SAMPLING REPORT

LOCATION: ______________________ PROJECT : ______________________

SITE: ______________________

SAMPLE INFORMATION

MATRIX ______________________ SAMPLE ID: ______________________

SAMPLING METHOD ______________ DUP./REP. OF : ______________________

BEGINNING DEPTH ______________ MATRIX SPIKE/MATRIX SPIKE DUPLICATE
YES ( ) NO ( )

END DEPTH ______________________

GRAB ( ) COMPOSITE ( ) DATE: ____________ TIME: __________

CONTAINER		PRESERVATIVE/ PREPARATION	EXTRACTION METHOD	ANALYTICAL METHOD	ANALYSIS
SIZE/TYPE	#				

NOTABLE OBSERVATIONS

PID READINGS	SAMPLE CHARACTERISTICS	MISCELLANEOUS
1st	COLOR:	
2nd	ODOR:	
	OTHER:	

pH ______ Temperature ________ Dissolved oxygen _________ Specific Conductivity_________

GENERAL INFORMATION

WEATHER: SUN/CLEAR _____ OVERCAST/RAIN _____ WIND DIRECTION _______ AMBIENT TEMP ______

SHIPMENT VIA: FED-X _____ HAND DELIVER ______ COURIER _______ OTHER _______

SHIPPED TO: ____

COMMENTS: ____

SAMPLER: ______________________ OBSERVER: ______________________

MATRIX TYPE CODES		SAMPLING METHOD CODES	
DC=DRILL CUTTINGS	SL=SLUDGE	B=BAILER	G=GRAB
WG=GROUND WATER	SO=SOIL	BR=BRASS RING	HA=HAND AUGER
LH=HAZARDOUS LIQUID WASTE	GS=SOIL GAS	CS=COMPOSITE SAMPLE	H=HOLLOW STEM AUGER
SH=HAZARDOUS SOLID WASTE	WS=SURFACE WATER	C=CONTINUOUS FLIGHT AUGER	HP=HYDRO PUNCH
SE=SEDIMENT	SW=SWAP\WIPE	DT=DRIVEN TUBE	SS=SPLIT SPOON
		W=SWAB\WIPE	SP=SUBMERSIBLE PUMP

AFCEE FORM SR.11

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APPENDIX B

LABORATORY STANDARD OPERATING PROCEDURES

1.0 Scope and Application

1.1 This standard operating procedure (SOP) provides instructions for the concentration, and if necessary, cleanup, of solvent extracts of organic compounds from water samples, soil samples, TCLP leachates, and SPLP leachates. This SOP is based on SW-846 Methods 3510C, 3520C, 3540C, 3546, 3550B, 3550C, 3620C, 3630C, 3660B, 3665A, ASTM Method D7065-11, and EPA 600 Series methods.

1.2 The determinative methods and extraction methods used in conjunction with this procedure are listed in Attachment 1.

1.3 This procedure does not include the extraction steps. See the following SOPs for the applicable extraction procedures:

DV-OP-0006:	Extraction of Aqueous Samples by Separatory Funnel, SW-846 3510C and EPA 600 Series
DV-OP-0008:	Extraction of Aqueous Samples by Continuous Liquid/Liquid Extraction (CLLE) by Method SW-846 3520C, and Method 625 and ASTM Method D7065-11
DV-OP-0010:	Soxhlet Extraction of Solid Samples, SW-846 3540C
DV-OP-0015:	Microwave Extraction of Solid Samples, SW-846 3546
DV-OP-0016:	Ultrasonic Extraction of Solid Samples, SW-846 3550B and 3550C
DV-OP-0021:	Extraction of Aqueous Samples by Continuous Liquid/Liquid Extraction (CLLE) by Method SW-846 3520C for Low-Level NDMA by GC/CI/MS/MS

NOTE: This SOP does not include the concentration steps of extracts for Herbicides by method 8151A or Herbicides by method 8321. See DV-OP-0011 and DV-LC-0014 respectively.

2.0 Summary of Method

Sample extracts are concentrated to a specific final volume using an S-EVAP, N-EVAP, or Turbo-Vap. Some methods require a solvent exchange. If necessary, various clean-up techniques are performed before the extract is sent for analysis.

3.0 Definitions

Refer to the Glossary of the TestAmerica Denver Quality Assurance Manual (QAM) and policy DV-QA-003P, Quality Control Program, for definitions of general analytical and QA/QC terms.

3.1 **Extraction Holding Time:** The elapsed time expressed in days from the date of sample collection to the date the extraction starts. The holding time is tracked in the laboratory LIMS system, and is the primary basis of prioritizing work.

3.2 **Preparation Batch:** A group of up to 20 samples that are of the same matrix and are processed together in the same extraction event using the same procedure and lots of reagents and standards.

3.3 **Method Comments:** The Method Comments are used to communicate to the bench level chemists special requirements and instructions from the client. See WI-DV-0032

3.4 **Quality Assurance Summary (QAS):** Certain clients may require extensive specific project instructions or program QC, which are too lengthy to fit conveniently in the special instructions/Method Comments field in LIMS. In those situations, laboratory Project Managers describe the special requirements in a written QAS to address these requirements. QASs are posted on a public drive for easy accessibility by all lab employees. Normally QASs are introduced to analysts in an initial project kick-off meeting to be sure that the requirements are understood.

4.0 Interferences

Chemical and physical interferences may be encountered when analyzing samples using this method.

4.1 Method interferences may be caused by contaminants in solvents, reagents, glassware, and other processing apparatus that lead to discrete artifacts. All these materials must be routinely demonstrated to be free from interferences under conditions of the analysis by running laboratory method blanks as described in the Quality Control section. Specific selection of reagents may be required to avoid introduction of contaminants.

4.2 Visual interferences or anomalies (such as foaming, emulsions, odor, more than one layer of extract, etc.) must be documented.

4.3 The most common interference is laboratory contamination, which may arise from impure reagents, dirty glassware, improper sample transfers, dirty work areas, etc. Be aware of potential sources of contamination and take appropriate measures to minimize or avoid them.

4.4 Due to the low reporting limits and the potential for contamination, the extracts that are to be analyzed for NDMA by 8270D_SIM_LL must be concentrated in glassware designated for that method. K-D flasks, concentrator tubes, stem-less glass funnels, and Snyder columns will be clearly marked and segregated for this purpose.

5.0 Safety

Employees must abide by the policies and procedures in the Environmental Health and Safety Manual, Radiation Safety Manual and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, nitrile gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.1 Specific Safety Concerns or Requirements

5.1.1 In order to limit the emission of methylene chloride, TestAmerica Denver uses a solvent recovery system. The system condenses and collects methylene chloride that has been evaporated off the sample extracts while on the S-EVAP.

5.1.1.1 Each analyst must inspect the system before using it to ensure the collection tubes are in good condition, the in-process tanks are not full, and the chiller is operating correctly.

5.1.1.2 While concentrating methylene chloride or methylene chloride / acetone extracts on the S-Evap, the analyst must check the level of the solvent collected in the in-process tanks at a frequency to ensure the tank will not be overfilled. A tank will not be filled more than 90%. The analyst may use a timer set at 30 minute intervals to help remind the analyst to check the level of the solvent collected in the in-process tanks.

5.1.1.3 The solvent recovery system will never be used for the collection of ether due to the potential danger to analysts if the system were to fail during operation.

5.1.2 Glasswool is a carcinogen and therefore should be handled in a hood to avoid inhalation of dust.

5.2 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Material	Hazards	Exposure Limit (1)	Signs and Symptoms of Exposure
Acetonitrile	Flammable Irritant Poison	40 ppm TWA	Exposure may cause cyanide poisoning resulting in reddening of the skin and eyes and pupil dilation. Effects of overexposure are often delayed due to the slow formation of cyanide ions in the body. May cause nose and throat irritation, flushing of the face, tightening of the chest. Also may cause headache, nausea, abdominal pain, convulsions, shock.
Hexane	Flammable Irritant	50 ppm TWA	Causes irritation to eyes, skin and respiratory tract. Aspiration hazard if swallowed. Can enter lungs and cause damage. May cause nervous system effects. Breathing vapors may

Material	Hazards	Exposure Limit (1)	Signs and Symptoms of Exposure
			cause drowsiness and dizziness. Causes redness and pain to the skin and eyes.
Methanol	Flammable Irritant Poison	200 ppm TWA	Methanol evaporates at room temperature. Inhalation, ingestion and/or eye and skin contact can all possibly cause light-headedness, nausea, headache, and drowsiness. Prolonged exposure can lead to permanent blindness.
Acetone	Flammable	1000 ppm-TWA	Inhalation of vapors irritates the respiratory tract. May cause coughing, dizziness, dullness, and headache.
Mercury	Corrosive Irritant Highly Toxic	0.05 mg/m^3 TWA	May be fatal if inhaled. May cause respiratory tract irritation. May be harmful if absorbed through skin. May cause skin irritation.
Methylene Chloride	Irritant Carcinogen	25 ppm TWA 125 ppm STEL	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting, and headache. Causes irritation, redness, and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.

(1) Always add acid to water to prevent violent reactions.
(2) Exposure limit refers to the OSHA regulatory exposure limit.

6.0 Equipment and Supplies

NOTE 1: All glassware used in this procedure is cleaned following SOP# DV-OP-0004. In addition, the glassware is rinsed with methylene chloride immediately prior to use. Rotate glassware; do **not** use specific glassware or positions for the MB and LCS/LCSD.

NOTE 2: Due to the low reporting limits and the potential for contamination, the extracts that are to be analyzed for NDMA method 8270D_SIM_LL and PAHs by method 8270C_SIM_LL must be concentrated in glassware designated for that method. K-D flasks, glass funnels, concentrator tubes, and snyder columns will be clearly marked and segregated for this purpose.

6.1 All equipment IDs for any support equipment (pipettes, thermometers, etc.) must be recorded in the batch record.

6.2 Kuderna-Danish (K-D) flasks.

6.3 Concentrator tubes for K-D flasks, un-graduated, approximately 10 mL.

6.4 Concentrator tubes for K-D flasks, graduated at 1mL, calibration checked before use following the steps detailed in DV-QA-0008.

6.5 Snyder columns, 3-ball with ground glass joints at top and bottom

6.6 Manual, adjustable positive-displacement pipette and bottle-top re-pipettor, used to dispense 1 to 20 mL. Calibration is checked following the steps detailed in DV-QA-0008.

6.7 Extract Storage Vials – variety of sizes, clear and amber

6.8 Pasteur pipettes – 6 inch and 9 inch in length.

6.9 Stem-less glass funnels

6.10 Glass wool, baked at 400°C for four hours.

6.11 Boiling Chips – contaminant free, approximately 10/40 mesh Teflon®, PTFE. For concentrating extracts to a final volume greater than 1mL.

6.12 Boiling Chips – contaminant free, carborundum #12 granules, for concentrating extracts to a 1mL final volume. These boiling chips are sufficiently small as to not add any error to the 1mL final volume.

6.13 Solvent Recovery System – includes re-circulating chiller, set no higher than 12°C, cooling condensers, Teflon® PTFE tubing and In-Process Tanks with quick-connect attachments

6.14 S-Evap, thermostat controlled water bath

6.15 N-Evap, thermostat controlled water bath with regulated nitrogen supply

6.16 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on R:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.1 Methylene Chloride

Each lot of solvent is tested following CA-Q-S-001 or before it is put into use. QA personnel post the list of approved lots at solvent storage areas. For solvents packaged in

CYCLETAINERS, that have not been previously tested per CA-Q-S-001, the first batch of samples prepared with a new lot of solvent is monitored and reported to the QA group per the instructions in CA-Q-S-001 DV-1. If any problems are identified, use of the solvent is suspended until further testing can be done and determines the solvent is acceptable.

7.2 Hexane

For solvents packaged in bottles, each lot of solvent is tested following CA-Q-S-001 before it is put into use. QA personnel post the list of approved lots at solvent storage areas. For solvents packaged in CYCLETAINERS, the first batch of samples prepared with a new lot of solvent is monitored and reported to the QA group per the instructions in CA-Q-S-001 DV-1. If any problems are identified, use of the solvent is suspended until further testing can be done and determines the solvent is acceptable.

7.3 Methanol, HPLC Grade

Each lot of solvent is tested following CA-Q-S-001 before it is put into use. QA personnel post the list of approved lots at solvent storage areas.

7.4 Acetone

Each lot of solvent is tested following CA-Q-S-001 before it is put into use. QA personnel post the list of approved lots at solvent storage areas.

7.5 Acetonitrile

Each lot of solvent is tested following CA-Q-S-001 DV-1 before it is put into use. QA personnel post the list of approved lots at solvent storage areas.

7.6 Baked Sodium Sulfate, 12-60 mesh

Heat sodium sulfate in a 400°C oven for at least four hours.

7.7 Sulfuric Acid, Concentrated

For use in PCB extract clean-up.

7.8 Florisil Solution, (FlorisilSol)

Add 900mL of hexane to a Class A graduated cylinder. Add 100 mL of Acetone to the same graduated cylinder for a final volume of 1000 mL. Pour the mixture into a 1 L amber bottle.

7.9 Florisil Cartridges,

Purchased ready to use. 1000 mg in 6 mL tube. Stored in a desiccator after opening. Restek part number 24034 or equivalent.

7.10 Anhydrous Silica Gel, 60-100 mesh, (SiGel60-100UA)

Sigma Aldrich part number 23799-1KG or equivalent

7.11 Activated Anhydrous Silica Gel, 60-100 mesh, (Active SilGel)

Bake Silica Gel from Section 7.10 above at 400°C for at least 4 hours. Store in a desiccator.

8.0 Sample Collection, Preservation, Shipment and Storage

8.1 Sample extracts waiting to be concentrated are stored refrigerated at 0°C - 6°C in glass bottles or flasks and capped with Teflon-lined lids or aluminum foil. Final sample extracts are stored in glass vials with Teflon-lined lids. See Table 3 for details on storage vial types. Final concentrated extracts are stored refrigerated at 0°C - 6°C. Extracts have a holding time of 40 days from the date of extraction to the date of analysis.

8.2 All sample extracts, before or after concentration, are stored separately from standards.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply. For SOPs that address only preparation, QC acceptance limits on the analytical results are not included. Refer to the appropriate SOP that describes the determinative method.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, *Quality Control Program*.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), etc., are described in TestAmerica Denver policy DV-QA-024P, *QA/QC Requirements for Federal Programs*. This procedure meets all criteria for DoD QSM 5.0 unless otherwise stated. Any deviation or exceptions from QSM 5.0 requirements must have prior approval in the project requirements.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Initial Performance Studies

Before analyzing samples, the laboratory must establish a method detection limit (MDL). In addition, an initial demonstration of capability (IDOC) must be performed by each analyst on the instrument he/she will be using. On-going proficiency must be demonstrated by each analyst on an annual basis. See Section 12.0 for more details on detection limit studies, initial demonstrations of capability, and analyst training and qualification.

9.3 Batch Definition

Batches are defined at the sample preparation stage. The batch is a set of up to 20 samples of the same matrix, plus required QC samples, processed using the same procedures and reagents within the same time period. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. The method blank must be run on each instrument that is used to analyze samples from the same preparation batch. See QC Policy DV-QA-003P for further details.

9.4 Method Blank (MB)

At least one method blank must be processed with each preparation batch. The method blank for batches of aqueous samples consists of reagent water, and for batches of soil samples, consists of Ottawa sand, both of which are free of any of the analyte(s) of interest. The method blank for batches of TCLP and SPLP leachates consists of leach fluid. The method blank is processed and analyzed just as if it were a field sample.

9.5 Laboratory Control Sample (LCS)

9.5.1 At least one LCS must be processed with each preparation batch. For aqueous sample batches, the LCS consists of reagent water to which the analyte(s) of interest are added at known concentration. For soil sample batches, the LCS consists of Ottawa sand to which the analyte(s) of interest are added at a known concentration. For TCLP and SPLP leachates, the LCS consists of leach fluid to which the analyte(s) of interest are added at known concentration. The LCS is carried through the entire analytical procedure just as if it were a sample.

9.5.2 EPA Methods 608, 610, 614, and 625 require a LCS at a 10% frequency. In other words, one LCS is required for a batch of 10 or less samples. A LCSD is required for a batch of 11 or more samples.

9.6 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

9.6.1 One MS/MSD pair must be processed with each preparation batch. A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. It is prepared in a manner similar to the LCS, but uses a real sample matrix in place of the blank matrix. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked exactly as the MS) that is prepared and analyzed along with the sample and matrix spike. Some programs allow spikes to be reported for project-related samples only. Samples identified as field blanks cannot be used for the MS/MSD analysis.

9.6.2 EPA Methods 608, 610, 614, and 625 require one matrix spike for every 10 samples. If the batch has more than 10 samples, then two matrix spikes must be performed. The two matrix spikes are to be performed on two different samples.

9.6.3 If insufficient sample volume is available for MS/MSD, an NCM must be written and a LCSD must be prepared.

9.7 Surrogate Spikes

Every calibration standard, field sample, and QC sample (i.e. method blank, LCS, LCSD, MS, and MSD) is spiked with surrogate compounds.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must be documented in an NCM, with a cause and corrective action described.

10.3 Critical Procedural Considerations

NOTE: Rotate glassware; do **not** use specific glassware or positions for the MB and LCS/LCSD.

10.3.1 As stated throughout this SOP, analysts must review Method Comments and any applicable QASs before starting work. This review is also documented on the Organic Extraction Checklist (see WI-DV-0009).

10.3.2 Analyst must focus on using clean technique throughout this procedure. Any parts or pipettes that come into direct contact with dirty surfaces should be cleaned or disposed of before coming into contact with the sample.

10.3.3 According to the type of sample and any cleanup procedures needed, different final solvents and volumes will be required. Refer to WI-DV-0009 for the appropriate final solvents and final volumes.

10.4 Refer to WI-DV-0009 to determine if the extract is to be concentrated by the Kuderna-Danish / N-Evap method described in Section 10.5 and 10.6, or the Turbo-Vap method described in Section 10.6.6

10.5 Concentration by the Kuderna-Danish Method (S-evap)

10.5.1 Refer to WI-DV-0009. If the extract is to be concentrated to a 1 mL final volume, use a 1 mL graduated concentrator tube. For extracts that are to be concentrated to any other final volume, use an un-graduated concentrator tube.

10.5.2 Assemble the Kuderna-Danish concentrator by attaching the appropriate concentrator tube to the 500 mL K-D flask with a clip. Make sure the attachment is firm at the joint. While wearing cut-resistant gloves, tighten the joint with your fingertips and thumb. Do NOT over-tighten. Refer to Attachment 3 for configuration of the Kuderna-Danish concentrator.

NOTE: Due to the low reporting limits and the potential for contamination, the extracts that are to be analyzed for NDMA by method 8270D_SIM_LL and PAHs by method 8270C_SIM_LL must be concentrated in glassware designated for those methods. K-D flasks, concentrator tubes, and Snyder columns will be clearly marked and segregated for this purpose.

10.5.3 Rinse the apparatus with methylene chloride. Discard the rinse solvent into the appropriate waste container. Care should be taken to ensure all surfaces of the glass are coated with solvent.

10.5.4 If the extract is to be concentrated to a 1 mL final volume, add 2-3 carborundum granules to the K-D concentrator. If the extract is to be concentrated to a final volume greater than 1 mL, add 1-2 Teflon® boiling chips to each K-D concentrator.

10.5.5 If the sample extracts have not been filtered through sodium sulfate at the time of extraction, or if the sample extract have visible water, then the extracts must be dried at this point. Plug a glass funnel with baked glass wool and add approximately 1 teaspoon of baked sodium sulfate. Rinse the funnel and the sodium sulfate with methylene chloride and place it on top of the K-D. During the quantitative transfer in section 10.5.6 the extract will be filtered through the sodium sulfate.

NOTE 1: Glass wool dust is a carcinogen and therefore glass wool should only be handled in a hood to avoid inhaling any glass particles. Once covered with sodium sulfate, it can be removed from the hood.

NOTE 2: If the extract contains more water than can be easily removed by filtering through 1 teaspoon of sodium sulfate, either more sodium sulfate can be used or a solvent-rinsed separatory funnel can be used to separate the water out of the extract. A NCM should be prepared if this is necessary.

10.5.6 Quantitatively transfer the sample extract to the K-D flask. Transfer the sample label to the K-D flask. Perform a quantitative transfer of the extract by rinsing the sample extract container with methylene chloride and adding the rinse solvent to the K-D. If the extract is being filtered through sodium sulfate, be sure to rinse the sodium sulfate well to ensure no target compounds are left on the sodium sulfate. Allow the solvent to drain from the sodium sulfate into the K-D flask then discard the sodium sulfate.

10.5.7 Turn a three-ball Snyder column upside down and rinse with methylene chloride, then rinse the bottom joint with methylene chloride. Attach the Snyder column to the top of the K-D concentrator as shown in Attachment 3.

10.5.8 Place the K-D concentrator on a s-evap water bath so that the tip of the receiver tube is submerged. The water level should not reach the joint between the concentrator tube and the K-D flask. Refer to WI-DV-0009 for the correct water bath temperature. Record both the observed and the corrected temperature on the benchsheet.

10.5.9 For extracts that are methylene chloride or 50/50 methylene chloride/acetone, attach the solvent recovery system tube to the top of the Snyder column. At the appropriate rate of distillation, the balls will actively chatter but the chambers should not flood.

NOTE 1: For extracts for analysis for low-level NDMA by method 8270D_SIM_LL and PAHs by 8270C_SIM_LL, the solvent recovery system will not be used to avoid possible contamination.

NOTE 2: At this time, a timer may be set for 30 minute intervals as a reminder to check the in-process solvent tanks.

10.5.10 If the method does not require a solvent exchange, skip to Section 10.5.12. If the method requires a solvent exchange, continue on to Section 10.5.11.

10.5.11 If the method requires a solvent exchange at this time, detach the solvent recovery system tube from the top of the Snyder column and add the appropriate exchange solvent through the top of the Snyder column. The exchange solvent should be added when the extract has concentrated to a level that it forms a quarter-sized pool of solvent in the bottom of the K-D. Refer to WI-DV-0009 for details of exchange solvents and volumes. Mark the K-D flask and sample label to indicate the exchange has been performed. There is no need to re-attach the solvent recovery system at this time as the majority of the methylene chloride has already been evaporated and collected.

10.5.12 Continue to concentrate the sample on the s-evap water bath back down to 10-15 mL, or just below the K-D and concentrator tube joint. At this point the boiling sample is just barely splashing above the top of the receiver tube.

NOTE: It is very important not to concentrate to dryness as analytes will be lost. Some of the analyses, especially for 8270 and 8015, are especially temperature sensitive and the sample should be taken off the water bath as soon as possible to avoid losing analytes. The 8081 surrogate TCMX is fairly volatile and can be lost if the extract is allowed to concentrate too low either before or after hexane exchange. If the analyst has concerns that the extract might have concentrated too low, they should notify their supervisor and/or write a NCM.

10.5.13 Remove the K-D concentrator from the water bath. Rinse the Snyder column down with a minimal amount of solvent. If the extract was exchanged, use the exchange solvent to perform the rinse, otherwise use methylene chloride.

10.5.14 Allow the extract to cool to room temperature, about 10 minutes.

10.5.15 After the extract is allowed to cool, if the level of the extract is above the level of the concentrator tube joint, add a fresh boiling chip and return the K-D concentrator to the water bath.

10.5.16 After the extract is cool, remove the snyder column. Remove the clip holding the K-D flask and concentrator tube together. Use a Kim-wipe to dry the water off of the joint area so that water does not get into the extract. Remove the concentrator tube from the K-D flask and rinse the lower K-D flask joint into the concentrator tube with methylene chloride or the appropriate exchange solvent.

10.6 Nitrogen Evaporation (N-Evap) to Final Concentration.

10.6.1 N-evap needles should be cleaned weekly by soaking overnight in methylene chloride. This is documented in the N-evap needle log-book.

10.6.2 At the beginning of each shift, the N-evap needles should be wiped clean with a Kim-wipe soaked in methylene chloride to remove any potential contamination. If a needle comes in contact with an extract, then it needs to be cleaned before being used on the next extract.

10.6.3 Place the concentrator tube on the nitrogen evaporator. The temperature of the water bath should be at least 5°C below the boiling temperature of the solvent being evaporated (See Attachment 2). Lower the needle down to the sample so that a small dimple forms on the surface of the solvent. The stream of nitrogen should be gentle enough that it does not cause the extract to splash. Record both the observed and the actual temperature on the benchsheet.

10.6.4 During the course of the evaporation, rinse the sides of the concentrator tube with approximately 1 mL of clean solvent. The rinse should occur when the solvent gets close to the final volume. Concentrate the solvent to just below the final volume and remove from the nitrogen evaporator.

10.6.5 Transfer the extract into the appropriate vial. Refer to WI-DV-0009 for the appropriate final volume and correct vial.

10.6.5.1 If the extracts are to have a final volume of 1 mL, they should be in 1 mL graduated concentrator tubes. Using a Pasteur pipette, or a solvent wash bottle, add the appropriate solvent to the tube until the extract meniscus reaches the 1 mL gradation. Then using the Pasteur pipette transfer the extract to a labeled 2 mL amber glass vial.

10.6.5.2 For extracts with a final volume greater than 1mL, the vials should be calibrated using the manual, adjustable positive-displacement pipette or bottle-top re-pipettor. Document the pipette ID used on the batch record. Pipette the correct volume of clean solvent into the vial and mark the bottom of the meniscus with a thin marker. Discard the solvent. Transfer the extract into the vial using a Pasteur pipette and rinse the concentrator tube with solvent. Transfer the rinse to the vial. Bring the meniscus of the solvent up to the marked line. Cap with a Teflon-lined cap.

NOTE 1: The final concentration and volume measurement steps are critical. Use care when concentrating and make certain that the final volume measurement is accurate.

NOTE 2: Some extracts might not concentrate down to the required final volume. If the extract is very dark and viscous, or an oil layer or precipitate starts to form, a higher final volume can be used. This should be documented in an NCM.

10.6.6 After the extract has been transferred to the appropriate vial, rinse the concentrator tube with methylene chloride before washing per DV-OP-0004. This is important to remove any residual contamination.

10.7 TurboVap Method

10.7.1 Turn on the TurboVap and adjust the water temperature to 40°C. Turn the nitrogen supply on. Record both the observed and the actual temperature on the benchsheet.

10.7.2 Switch the endpoint sensor to "Manual".

10.7.3 Adjust the water bath level. The water level should be at least 1 inch above the extract level.

10.7.4 Turn on the nitrogen gas and adjust the gas pressure to approximately 12 psi. Lower pressure may be used if needed to prevent samples from splashing out of the TurboVap tubes.

10.7.5 Rinse the TurboVap tube with methylene chloride or the solvent the extract is in. Discard the waste.

10.7.6 Transfer the sample to the TurboVap tube. For 8141 soils extracted by soxhlet, dry the extract first by filtering through a funnel with baked sodium sulfate. Rinse the sample extract container with clean solvent and transfer to the TurboVap tube. Do not fill the TurboVap tubes over the fill line or approximately ¾ full.

10.7.7 Place the TurboVap tube into the TurboVap and turn on nitrogen to the position the tube is in.

10.7.8 Close the lid. You should be able to see the sample extracts swirling in the tubes.

NOTE: **If the extract splashes when the nitrogen flow starts, transfer a portion of the extract back into the original extract container, or lower the gas pressure.**

10.7.9 As the extract concentrates, transfer the remainder of the extract in to the appropriate Turbovap tube. Rinse the sample container with a few milliliters of methylene chloride or appropriate solvent and transfer to the Turbovap tube.

10.7.10 During the concentration rinse the Turbovap tube walls with a few milliliters of solvent 1 or 2 times.

10.7.11 If a solvent exchange is required, concentrate to about 5 mL and add the exchange solvent. After the exchange solvent is added, swirl the extract to make sure the extract is well mixed. Concentrate back down to slightly less than the appropriate volume. Refer to Attachment 3 for details of exchange solvents and final volumes.

10.7.12 Transfer the extract into the appropriate vial.

10.7.12.1 Currently, the TurboVap is only used to concentrate extracts with final volumes greater than 1 mL. Ask the supervisor for guidance if a project requires a 1 mL final volume by TurboVap.

10.7.12.2 For extracts with a final volume greater than 1 mL, the vials should be calibrated using the manual, adjustable pipette or bottle-top re-pipettor. Document the pipette ID used on the batch record. Pipette the correct volume of clean solvent into the vial and mark the bottom of the meniscus with a thin marker. Discard the solvent. Transfer the extract to the vial using a Pasteur pipette and rinse the concentrator tube with solvent. Transfer the rinse to the vial. Bring the meniscus of the solvent up to the marked line. Cap with a Teflon-lined cap.

10.7.12.3 Rinse the Turbovap tube with methylene chloride 2-3 times before washing. Turbovap tubes are not baked. They are cleaned in accordance with DV-OP-0004. If the Turbovap tubes need to be used again before they are dry, rinse with acetone to dry the Turbovap tube.

10.8 Cleanup Techniques

NOTE: If any sample in a batch requires a clean-up, the batch QC must also undergo the same clean-up technique.

10.8.1 Florisil Cartridge Cleanup

Florisil can be used to remove low-medium molecular weight polar hydrocarbon interfering compounds from pesticide extracts. The laboratory will use Florisil cleanups whenever water extracts have any color, whenever soil extracts have any color darker than a Post-It® Note, or whenever there is clear evidence of interferences, such as significant interfering peaks in the RT range for the target pesticide compounds or failing sample surrogate recoveries. Extracts that are to be analyzed for kepone will not be florisil cleaned, because florisil will remove kepone from the extract.

NOTE: Florisil cartridge performance checks are conducted for every lot of Florisil before use. Add 1.0 mL of the Florisil check solution described in Attachment 4 to a pre-rinsed Florisil cartridge. Following the procedure described below, load and elute the 1mL of check solution through the Florisil cartridge. Bring the final volume back down to 1.0 mL in hexane. The test sample must show 80-115 % recovery of the controlled analytes with < 5% trichlorophenol recovery, and no peaks interfering with target compounds can be detected. The non-controlled analytes will be monitored for problems, but do not have to pass the 80-115% limits. If the check fails, repeat the test. If the re-check fails, contact QA for guidance.

10.8.1.1 Clean the manifold and ports

Prior to each use, the top and underside of the manifold lid must be wiped down with hexane and a Kim-wipe to prevent any cross-contamination. The manifold ports must be left open and placed in a jar with fresh acetonitrile, in a sonication bath for a minimum of 30 minutes. The jar used in the soak and sonication of the ports must be replaced weekly to ensure it does not spread contamination. This is documented in the Organic Extraction Weekly Cleaning Logbook.

10.8.1.2 Place one Florisil cartridge into the vacuum manifold for each extract. Make sure all valves are closed.

10.8.1.3 Add approximately 6 mL of hexane to each cartridge by filling the tube.

10.8.1.4 Slowly open the valves to allow a few drops of hexane to pass through, then close the valve and allow the hexane to soak the cartridge for at least 5 minutes.

10.8.1.5 Slowly open the valves again and allow the hexane to drain through the cartridge but close the valve when the solvent level is right above the glass frit. Do not allow the cartridges to go dry. If cartridges go dry, repeat the conditioning step.

10.8.1.6 Remove the manifold top and place one clean, labeled 16 x 125 mm disposable glass test tube in each position for each of the samples. Replace the manifold top. Make sure that the solvent line from each cartridge is placed inside the appropriate tube.

10.8.1.7 Add exactly 2.0 mL of the concentrated extract to the appropriate Florisil cartridge. Turn the valve to the on position.

10.8.1.8 Allow the extract to gravity drip through the cartridge. The flow through the cartridges should be drop-wise, not streaming.

10.8.1.9 Just before the extract level drops below the glass frit, fill the cartridge with (90:10) Florisil solution. Allow this to pass through the cartridge, then just before it falls below the glass frit again, fill the cartridge again with (90:10) Florisil solution.

10.8.1.10 Allow all of the 90:10 solution to gravity drip through the cartridges.

10.8.1.11 After visible solvent has been allowed to gravity drip through the cartridge, apply the vacuum to pull remaining solvent through cartridge, typically no more than 5 seconds.

NOTE: Do not use the vacuum to recover solvent from the cartridge before gravity drip is complete. Doing so could result in the interfering compounds that should be retained in the packing to come through into the cleaned extract.

10.8.1.12 Remove the tubes from the vacuum manifold and concentrate them back down to just below 2.0 mL on the nitrogen evaporator. Quantitatively transfer the extract to a 4mL vial that has been calibrated to hold 2.0 mL and bring the extracts up to the 2.0 mL calibration mark with hexane.

10.8.1.13 Discard the used cartridges.

10.8.2 Sulfur Removal

NOTE: This step is typically performed by the instrument analyst, as it is performed after extracts are concentrated to final volume.

Sulfur can be removed by one of three methods: mercury, copper, or tetrabutylammonium sulfite (TBA), according to laboratory preference. If the sulfur concentration is such that crystallization occurs in the concentrated extract, centrifuge the extract to settle the crystals, and carefully draw off the sample extract with a disposable pipette, leaving the excess sulfur in the centrifuge tube. Transfer the extract to a clean concentrator tube before proceeding with further sulfur cleanup.

10.8.2.1 Sulfur Removal with Elemental Mercury

NOTE: Use Mercury in a hood and sparingly in order to minimize exposure and disposal costs.

10.8.2.1.1 Transfer approximately 2 mL of sample extract into a clean Teflon-sealed vial.

10.8.2.1.2 Add one to three drops of mercury to the extract vial and seal.

10.8.2.1.3 Shake well for 15-30 seconds. If prolonged shaking is required, use a mechanical shaker.

10.8.2.1.4 Remove the extract from the mercury using a disposable pipette and transfer to a clean vial.

10.8.2.1.5 If the mercury turns black, sulfur was present. Decant or pipette off the extract to a clean vial and repeat the procedure by adding one to three drops of fresh mercury. Do this until the mercury does not turn black.

10.8.2.1.6 If the extract is cloudy, filter the extract through a 1um disposable syringe filter.

10.8.2.1.7 Properly dispose of the mercury waste.

10.8.2.2 Sulfur Removal with Copper Powder

NOTE: This technique requires the copper powder to be very reactive, as demonstrated by a bright and shiny appearance. A pre-cleaned, activated copper may be purchased from a valid vendor. If manual preparation of reactive copper is performed, take care to remove all traces of acid in order to prevent degradation of some analytes.

10.8.2.2.1 Weigh out copper into a 20 mL VOA VIAL assuming two grams of copper needed per sample.

10.8.2.2.2 Remove oxides by treating with 10% nitric acid.

10.8.2.2.3 Rinse the copper with DI organic-free water three times to remove all traces of acid.

10.8.2.2.4 Rinse the copper with acetone and dry under a stream of nitrogen.

10.8.2.2.5 Add approximately 2 grams of the copper powder to a 2 mL vial with approximately 1ml of sample extract and shake vigorously on a mechanical shaker for at least one minute.

10.8.2.2.6 After phase separate, draw off extract and transfer to a clean vial.

10.8.3 Sulfuric Acid Cleanup

NOTE: This step is typically performed by the instrument analyst, as it is performed after extracts are concentrated to final volume.

10.8.3.1 Add 1 mL of concentrated sulfuric acid to approximately 2 mL of sample extract in a Teflon capped vial.

CAUTION: There must be no water or acetone present in the extract or the reaction may shatter the sample container.

10.8.3.2 Vortex for about 5 seconds and allow to settle. (Centrifuge if necessary)

10.8.3.3 Remove the sample extract (top layer) from the acid using a Pasteur pipette and transfer to a clean vial.

CAUTION: It is not necessary to remove all the extract since the final volume is already determined. Transferring any amount of sulfuric acid along with the extract will result in extremely rapid degradation of the chromatographic column

10.8.3.4 If the sulfuric acid layer becomes highly colored after shaking with the sample extract, transfer the hexane extract to a clean vial and repeat the cleanup procedure until color is no longer being removed by the acid, or a maximum of 5 acid cleanups.

10.8.3.5 Properly dispose of the acid waste.

10.8.4 Silica Gel Clean-up for DRO extracts

10.8.4.1 Samples requiring silica gel clean-up for the Oklahoma DRO method should follow the procedure in section 10.8.4.1, which includes the addition of a reverse surrogate. Samples requesting silica gel clean-up for other DRO methods should follow the procedure in section 10.8.4.1.2, which does not include an additional surrogate.

10.8.4.1.1 If the sample is logged for method 3630C_M, concentrate the extract and all associated QC to slightly below 1 mL on the N-Evap. Add 100uL of the "SilicaGelSurr" standard to each extract and then bring the extracts to a 1 mL final volume with methylene chloride. Transfer to the appropriate final extract vial per section 10.6. Proceed to section 10.8.4.2.

10.8.4.1.2 If the sample is not logged for method 3630C_M but silica gel clean-up is still requested, no further surrogate is added. Concentrate to 1 mL final volume normally per section 10.6. Proceed to section 10.8.4.2.

NOTE: Please note that some projects require analysis of extract that has been silica gel cleaned as well as analysis of extract that has not been cleaned. Due to the limited final volume of the extract, samples requiring analysis of both cleaned and un-cleaned extract must be extracted twice, and in separate batches with separate QC.

10.8.4.2 Add approximately 0.05 g of activated silica gel to the extract, cap, and vortex for approximately 15 seconds. Allow the silica gel to settle.

10.8.4.3 Transfer the extract to a new vial, leaving the silica gel behind. Submit for analysis.

10.9 Documentation

All observations are recorded either directly into LIMS or on the hard-copy benchsheets. Any hand-written data recorded on the hard-copy benchsheets are transferred into LIMS before extracts are delivered to the analytical group. The hard-copy benchsheets are then saved and scanned into pdf files and sent to QA for archiving.

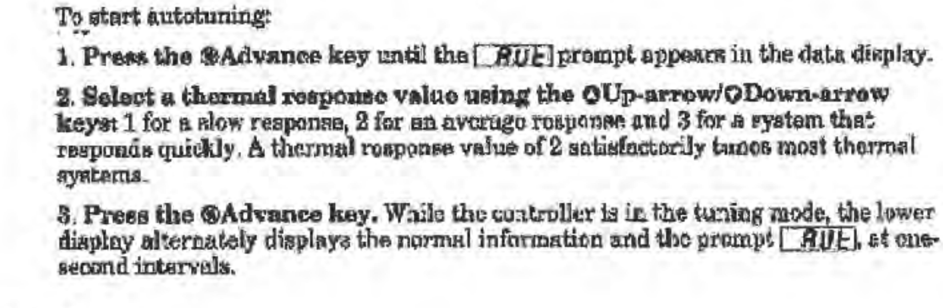
10.10 Maintenance

10.10.1 The chiller that operates the solvent recovery system should be checked periodically to ensure the water level is sufficient.

10.10.2 The SPE ports and valves used in the florisil are open and placed in a jar with fresh acetonitrile, in a sonication bath for a minimum of 30 minutes. The jar used in the soak and sonication of the ports must be replaced weekly to mitigate the risk of contamination. This is documented in the Organic Extraction Weekly Cleaning Logbook.

10.10.3 The N-Evap needles are removed once a week and soaked overnight in a jar of methylene chloride. This is documented in the Organic Extraction Weekly Cleaning Logbook.

10.10.4 The water bath used in the concentration of extracts has a thermostat that occasionally needs auto-tuned to keep the bath temperature within a narrow range. Record both the observed and the actual temperature on the benchsheet.



To start autotuning:

1. Press the ®Advance key until the [AUt] prompt appears in the data display.

2. Select a thermal response value using the ○Up-arrow/○Down-arrow keys: 1 for a slow response, 2 for an average response and 3 for a system that responds quickly. A thermal response value of 2 satisfactorily tunes most thermal systems.

3. Press the ®Advance key. While the controller is in the tuning mode, the lower display alternately displays the normal information and the prompt [AUt], at one-second intervals.

10.11 Troubleshooting

Unusual sample matrix may cause problems. If the extracts do not behave normally, contact a supervisor or senior analyst if you are unsure how to proceed. Document all observations and anomalies in a NCM.

11.0 Calibration

Not applicable to this procedure. See the determinative methods for calibration of the analytical instrumentation.

12.0 Method Performance

12.1 Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to the laboratory's MDL policy in CA-Q-S-006. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency.

12.2 Demonstration of Capabilities

All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows.

12.2.1 Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid- level calibration.

12.2.2 Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

12.2.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. TNI 2009 requires consecutive passing results. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

12.2.4 Until the IDOC is approved by the QA Manager (or designee); the trainer and trainee must be identified in the batch record.

12.2.5 Further details concerning demonstrations of proficiency are described in SOP DV-QA-0024.

12.3 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. A new analyst must be working under documented supervision prior to approval of the IDOC. Documentation that a new analyst is performing under supervision must be entered into the batch record (View Batch Information) until that analyst's IDOC has been approved by the QA Manager (or designee). See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

13.0 Pollution Control

It is TestAmerica's policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in Section 13 of the Corporate Safety Manual for

"Waste Management and Pollution Prevention."

14.0 Waste Management

14.1 All waste will be disposed of in accordance with Federal, State, and local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this procedure, the policies in section 13, "Waste Management and Pollution Prevention", of the Environmental Health & Safety Manual, and DV-HS-001P, "Waste Management Plan."

14.2 The following waste streams are produced when this method is carried out:

14.2.1 Methylene chloride – Waste Stream B

14.2.2 Flammable Solvents – Waste Stream C

14.2.3 1:1 MeCl2:Acetone – Waste Stream CA

14.2.4 Solid waste/sodium sulfate – Waste Stream D

14.3 Radioactive waste, mixed waste, and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Waste Coordinator for proper management of these materials.

NOTE: Radioactive, mixed waste and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

15.0 References / Cross-References

15.1 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition and all promulgated updates, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, January 2005.

15.1.1 Method 3510C, Separatory Funnel Liquid-Liquid Extraction, Revision 3, December 1996.

15.1.2 Method 3520C, Continuous Liquid-Liquid Extraction, Revision 3, December 1996.

15.1.3 Method 3550B, Ultrasonic Extraction, Revision 2, December 1996.

15.1.4 Method 3550C, Ultrasonic Extraction, Revision 3, February 2007.

15.1.5 Method 3540C, Soxhlet Extraction, Revision 3, December 1996.

15.1.6 Method 3546, Microwave Extraction, Revision 0, February 2006.

15.1.7 Method 3620C, Florisil Cleanup, Revision 3, February 2007.

15.1.8 Method 3660B, Sulfur Cleanup, Revision 2, December 1996.

15.1.9 Method 3660A, Sulfur Cleanup, Revision 1, July 1992.

15.1.10 Method 3665A, Sulfuric Acid/Permagante Cleanup, Revision 1, December 1996.

15.1.11 Method 3630C, Silica Gel Cleanup, Revision 3, December 1996.

15.2 Code of Federal Regulations, Title 40 – Protection of the Environment, Part 136 – Guidelines Establishing Test Procedures for the Analysis of Pollutants, Appendix A – Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater

15.2.1 Method 608, Organochlorine Pesticides and PCBs.

15.2.2 Method 610, Polynuclear Aromatic Hydrocarbons.

15.2.3 Method 614, The Determination of Organophosphorus Pesticides in Municipal and Industrial Wastewater

15.2.4 Method 625, Base/Neutrals and Acids.

15.3 ASTM D7065-11, Standard Test Method for Determination of Nonylphenols, Bisphenol A, p-tert-Octylphenol, Nonylphenol Monoethoxylate, and Nonylphenol Diethoxylate in Environmental Waters by Gas Chromatography Mass SpectrometryMethod Modifications:

16.0 Modifications

16.1 Method SW-846 3665A calls for the clean-up to be performed using 1:1 Sulfuric Acid:H_2O. This procedure calls for the clean-up to be performed using concentrated sulfuric acid.

16.2 ASTM D7065-11 calls for the samples to be concentrated to a 0.5 mL final volume. This procedure calls for a 1 mL final volume.

16.3 Method SW-846 3620C calls for the florisil lot check to be performed using a standard containing the some pesticides at various concentrations from 5 ug/L to 50 ug/L. Per the source method, 1 mL of the standard is diluted to 2 mL (for concentrations between 2.5 ug/L and 25 ug/L) and the cleanup is then carried out and the cleaned extract concentrated to 1 mL for a final concentration of 5 ug/L to 50 ug/L. This procedure calls for the lot check to be performed using a standard containing all the pesticides at the same concentration of 50 ug/L. 1 mL of this standard is cleaned up without prior dilution and then concentrated back down to 1 mL.

16.4 Method SW-846 3620C states that the florisil lot check passes if the pesticide recoveries are between 80% and 110% recovery. This procedure says the lot check passes if the pesticide recoveries are between 80% and 115%. This is done to match the CCV control limits.

16.5 Method SW-846 3620C states that the florisil lot check is to be performed using a standard containing the 2,4,5-Trichlorophenol at 0.1 ug/L. Per the source method, 0.5 mL of this standard is diluted to 2 mL (for a concentration of 0.025 ug/L) and the cleanup is then carried out and the cleaned extract concentrated to 1 mL for a concentration of 0.05

ug/L. This procedure calls for the lot check to be performed using a standard containing 2,4,5-trichlorophenol at 100 ug/L. 1 mL of this standard is cleaned up without prior dilution and then concentrated back down to 1 mL.

16.6 Method SW-846 3620C Section 11.1.3 states to condition the florisil cartridge with 4 mL of hexane. This procedure calls for 5 mL of hexane to be used. This is done for convenience.

16.7 Method SW-846 3630C calls for the silica gel clean-up to be performed with a column or SPE cartridge. This procedure calls for the silica gel to be added directly to the extract and mixed. The reverse surrogate used indicates if the clean-up is effective.

17.0 Attachments

Attachment 1: Determinative and Extraction Methods Used in Conjunction with this SOP.
Attachment 2: Boiling Points of Solvents
Attachment 3: Kuderna-Danish Concentrator
Attachment 4: Florisil Check Solution

18.0 Revision History

- Revision 14, dated 31 January 2020
  - Annual Review
- Revision 13, dated 30 November 2018
  - Annual Review
  - Addition note to section 1.3 indicating correct SOP reference for concentration of 8321 herbicides.
  - Updated condenser setting information in section 6.13 to reflect current practice.
  - Updated note in section 10.5.9 to reflect current practice.
  - Adjusted wording in section 10.8.1.2 to clarify "extracts" rather than "samples."
  - Minor language adjustments insections 10.8.1.11 and 10.8.1.12 to clarify the application of the vacuum during recovery of florisil-cleaned extracts.
  - Added notes to sections 10.8.2 and 10.8.3 to specify that these steps are typically performed my instrument analysts.
  - Updated section 10.8.4 to provide clarification and reflect current practice.
  - Updated reference to Laboratory MDL Procedure CA-Q-S-006.
- Revision 12, dated 31 October 2017
  - Annual Review
- Revision 11, dated 31 October 2016
  - Added the paragraph referencing the QAM for general definitions in Section 3.0
  - Added the requirement to document the ID of pipettes used in Sections 6.1, 10.6.5.2 and 10.7.12.2.
  - Updated Section 10.1 to reflect current practices
  - Added the specification of using the S-evap for concentration in Sections 10.5, 10.5.8 and 10.5.12
  - Added the requirement to document both the observed and actual temperature in Sections 10.6.3 and 10.10.4
- Revision 10 dated 31 December 2015
  - Updated formatting and numbering throughout the document
  - Revised method code references to reflect current practice

  - Numbered NOTES where there were multiples (Sections 6.0, 10.4.5, 10.4.9, 10.5.5.2)
  - Updated drive reference in Section 6.1
  - Updated "Reagent Grade Chemicals" definition in Section 7.0 to be consistent with other SOPs
  - Added statement in Section 8 to specify that extracts are stored separately from standards
  - Updated Section 9.1 to be consistent with other SOPs
  - Added new section 10.2 for consistency with other SOPs
  - Added NOTE to Section 10.3
  - Added a requirement to Section 10.6.6 to rinse all concentrator tubes with methylene chloride before washing
  - Removed the reference to South Carolina in Section 10.8.2. The laboratory no longer holds certification for South Carolina by this method
  - Updated Section 12 to be consistent with other SOPs
  - Added NOTE to Section 14.3
  - Revised the concentration of 2,4,5-Trichlorophenol in the Florisil Check Solution described in Attachment 4.
    - The compound used to be at a concentration of 0.1 ug/mL in the standard
    - It is now at a concentration of 0.5 ug/mL
    - One mL of the standard is used in the Florisil check procedure, resulting in 0.5 µg of the compound loaded onto the 6 g of Florisil
  - Removed references to DV-MS-0005 in Section 1 and Attachment 1, the laboratory no longer performs this procedure
- Revision 9 dated 31 December 2014
  - Section 5.1.1.2 and Section 10.4.9 were revised to match current practice on the use of the solvent recovery system.
  - Section 6.1 Computer Software and Hardware was added.
  - Section 7.6 Baked Sodium Sulfate was revised to match current practice and the latest revision of CA-Q-S-001 DV-1.
  - Section 7.11 was revised to correct the TAL Reagent ID.
  - Section 9.1 was revised to include the statement "This procedure meets all criteria for DoD QSM 5.0 unless otherwise stated".
  - Section 9.4, 9.5, 9.6, and 9.7 were revised to remove information on Acceptance Criteria and Corrective Action. This information can be found in the analytical and QA SOPs.
  - Section 10.4.5 was revised to instruct the analyst to use approximately 1 teaspoon of sodium sulfate to dry extracts. This was done to limit the extract's exposure to sodium sulfate which can cause low recoveries for some acid compounds. A note was also added to this section to instruct the analyst to use more sodium sulfate or a separatory funnel to remove water if a teaspoon of sodium sulfate is not sufficient.
  - The Note in Section 10.4.12 was revised to instruct the analyst to write an NCM and/or notify their supervisor if they have a concern that an extract concentrated too low.
  - Section 10.7.1 Florisil Clean-up was revised to give guidance on what to do if the florisil check fails.
  - Section 10.7.1 was revised to instruct the analyst to not use the vacuum to pull all of the solvent from the cartridge. This was done to prevent interfering compounds and 2,4,5-TCP from eluting off of the cartridge.

  - Section 10.7.1 and Attachment 4 Florisil Check Solution were revised to indicate which compounds are controlled and which compounds are monitored. In addition, surrogate compounds were added to the solution.
  - Section 10.7.1 and 10.9 were revised to instruct the analyst to soak the SPE ports in a jar with the valves open instead of disassembling the valves.
  - Section 10.7.3 was revised to instruct the analyst to perform the clean-up on approximately 2mL of extract. This was done to match current practice.
  - Section 10.7.4 Silica Gel Clean-up and Sections 15.1 and 16.0 were revised to match current practice.
  - Section 10.9 Maintenance was revised to include instructions on how to tune the water bath thermostat.
  - Attachment 3 – Concentration Summary was removed and replaced with WI-DV-0009. All other Attachments were re-numbered.
- Revision 8 dated 13 December 2013
  - The procedure was revised to include ASTM D7065-11.
  - The procedure was revised to include steps for silica gel clean-up for DRO extracts.
  - Section 7 was revised to include details on the Florisil Solution and Florisil cartridges. These details were lacking in previous revisions.
  - Section 10.4.2 was revised to give more detail on how to safely tighten the ground glass joint between the KD and concentrator tube.
  - Section 10.6.3 was revised to give more detail about the required water level in the Turbo-Vap.
  - Maintenance and Troubleshooting sections were added as Sections 10.8 and 10.9.
  - Section 16 was revised to include method modifications from SW-846 3620C.
  - Attachment 1 was updated to reflect the current SOPs in use in the laboratory.
  - Attachment 3 was updated.
- Revision 7 dated 5 December 2012
  - Section 5 and Section 10.4.5 were revised to instruct the analysts to handle glass wool in a hood to avoid breathing in the dust.
  - Revised Section 10.4.8 to instruct the analysts to document both the observed and corrected temperatures.
  - Section 10.7.1.11 was revised to describe in more detail how the florisiled extracts are taken to the 2 mL final volume.
  - Section 14.2 was revised to include the waste stream for 1:1 MeCl2:Acetone – Waste Stream CA.
  - Attachment 1 was revised to include DV-OP-0015 as an acceptable extraction for Diesel Range Organics.
  - Attachment 3 was revised to include details on 8081/3510_LL concentration steps.
- Revision 6.0 dated 14 October 2011
  - The procedure was revised to remove instructions on how to concentrate and clean up extract for method 8070 and 607. TestAmerica Denver no longer supports these methods.
  - Section 1.3 was corrected to give the correct SOP number to Extraction of Aqueous Samples by Continuous Liquid/Liquid Extraction (CLLE) by Method SW-846 3520C for Low-Level NDMA by GC/CI/MS/MS.
  - Section 7.5 was revised to state acetonitrile is tested before use. Previously this solvent was not tested before use.

- The procedure was revised to include instructions that all extracts for analysis by method 8081, 8082, or 608 to be hexane exchanged only after concentration on the S-Evap. Previously the SOP instructed analysts to add the hexane exchange before the S-Evap for extracts that were concentrated by microwave extraction. This resulted in poor hexane exchanges, therefore the extracts are now concentrated before the exchange.
- The procedure was revised to instruct analysts not to use the solvent recovery system when concentrating samples for analysis of low-level NDMA by GC/CI/MS/MS. This was done to eliminate a possible source of contamination in this ppt level analysis.
- The procedure was revised to instruct analysts to use concentrated sulfuric acid in the acid clean up of PCB extracts.
- The procedure was revised to clarify the exact steps used in the sulfur removal with mercury.

Earlier revision histories have been archived and are available upon request.

Attachment 1.

Determinative and Extraction Methods Used in Conjunction with this SOP

Method Description	Determinative Method	Determinative Method SOP	Extraction Method	Extraction Method SOP
Diesel Range Organics & Jet Fuels	SW-846 8015B, 8015C, 8015D, California LUFT Method, & AK102 & AK103, NW-TPH, OK DRO	DV-GC-0027	WATER: SW-846 3510C, AK102 AK103 NW-TPH OK DRO SOIL: SW-846 3550B/C SW-846 3546 AK102, AK103 NW-TPH OK DRO	WATER: DV-OP-0006 SOIL: DV-OP-0016 or DV-OP-0015
Chlorinated Pesticides	SW-846 8081A, 8081B & EPA Method 608	DV-GC-0020 DV-GC-0016	WATER: SW-846 3510C SOIL: SW-846 3550B/C SW-846 3546	WATER: DV-OP-0006 SOIL: DV-OP-0016 or DV-OP-0015
Polychlorinated Biphenyls	SW-846 8082, 8082A EPA Method 608	DV-GC-0021 DV-GC-0016	WATER: SW-846 3510C SOIL: SW-846 3550B/C SW-846 3546	WATER: DV-OP-0006 SOIL: DV-OP-0016 or DV-OP-0015
Organo-phosphorus Pesticides	SW-846 8141A, 8141B, & EPA Method 614	DV-GC-0017	WATER: SW-846 3510C SOIL: SW-846 3540C	WATER: DV-OP-0006 SOIL: DV-OP-0010
Polynuclear Aromatic Hydrocarbons	SW-846 8310 & EPA Method 610	DV-LC-0009	WATER: SW-846 3510C SOIL: SW-846 3550B/C	WATER: DV-OP-0006 SOIL: DV-OP-0016
Semi-volatiles by GC/MS	SW-846 8270C, 8270D & EPA 625	DV-MS-0011 DV-MS-0012	WATER: SW-846 3510C SW-846 3520C SOIL: SW-846 3550B/C	WATER: DV-OP-0006 or DV-OP-0008 SOIL: DV-OP-0016
Low-Level Semi-Volatiles by GC/MS	SW-846 8270C	DV-MS-0011	WATER: SW-846 3520C	WATER: DV-OP-0008
Polynuclear Aromatic Hydrocarbons by GC/MS SIM	SW-846 8270C SIM	DV-MS-0002	WATER: SW-846 3510C SOIL: SW-846 3550B/C SW-846 3546	WATER: DV-OP-0008 SOIL: DV-OP-0016 or DV-OP-0015
Isotope Dilution Analysis of n-Nitrosodimethylamine by GCMS SIM using LVI	SOP	DV-MS-0015	WATER: SW-846 3520C SOIL: SW-846 3550B/C	WATER: DV-OP-0021 SOIL: DV-OP-0016

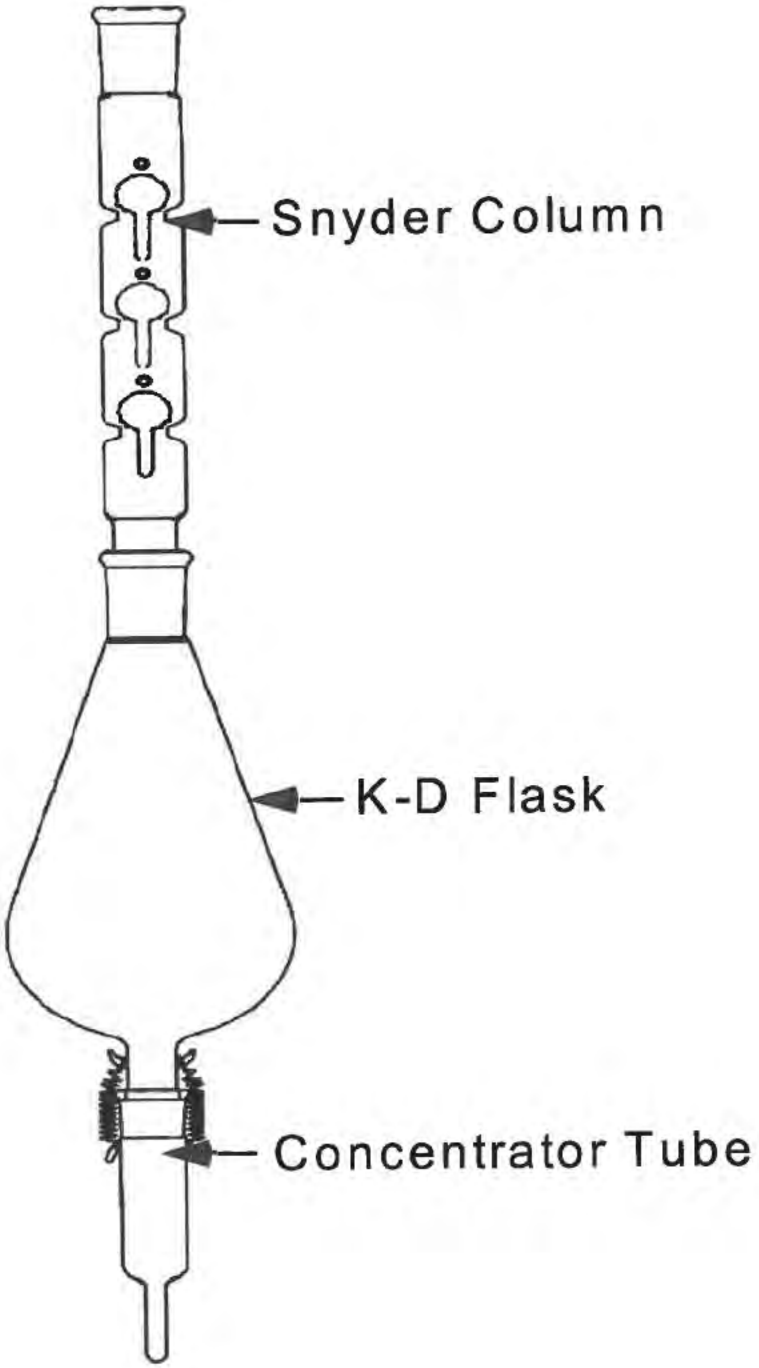
Attachment 2.

Boiling Points of Solvents

Solvent	Boiling Point (°C)
Methylene chloride	40
Acetone	56
Hexane	69
Methanol	65
Acetonitrile	82

Attachment 3.

Kuderna-Danish Concentrator



Attachment 4.

Florisil Check Solution
Prepared in Hexane

Compound	Concentration	Control
2,4,5-Trichlorophenol	0.05ug/mL	Y
Alpha-BHC	0.05ug/mL	Y
Alpha-Chlordane	0.05ug/mL	N
Aldrin	0.05ug/mL	N
Beta-BHC	0.05ug/mL	N
Dieldrin	0.05ug/mL	Y
Endosulfan I	0.05ug/mL	Y
Endosulfan II	0.05ug/mL	N
Endosulfan sulfate	0.05ug/mL	N
Endrin	0.05ug/mL	Y
Endrin Aldehyde	0.05ug/mL	N
Endrin Ketone	0.05ug/mL	N
Gamma-BHC	0.05ug/mL	Y
Gamma-Chlordane	0.05ug/mL	N
Heptachlor	0.05ug/mL	Y
Heptachlor expoxide	0.05ug/mL	N
Methoxychlor	0.05ug/mL	Y
4,4-DDD	0.05ug/mL	Y
4,4-DDE	0.05ug/mL	N
4,4-DDT	0.05ug/mL	Y
Tetrachloro-m-xylene	0.02ug/mL	Y
Decachlorobiphenyl	0.02ug/mL	Y

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Eurofins TestAmerica Laboratories, Inc.
TestAmerica Denver
4955 Yarrow Street
Arvada, CO 80002

Phone: 303-736-0100
Fax: 303-431-7171

Electronic Copy Only

Title: Microwave Extraction of Solid Samples by Method [SW-846 3546]

Approvals (Signature/Date):

	5/4/20	Doug Gomez for R.P	5/3/20
Heather Fiedler Technical Specialist	Date	Reed Pottruff Health & Safety Manager / Coordinator	Date
Roxanne Sullivan	5/4/20	Scott Hall	5/4/20
Roxanne Sullivan Quality Assurance Manager	Date	Scott Hall Laboratory Director	Date

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1.0 Scope and Application

1.1 This SOP is applicable to the solvent extraction of organic compounds from solid samples using microwave energy to produce elevated temperature and pressure conditions in a closed vessel containing the sample and organic solvent. This procedure achieves analyte recoveries equivalent to those from soxhlet or sonications methods, but uses less solvent. This SOP is based on SW-846 Method 3546.

1.2 The determinative methods used in conjunction with this procedure are listed in Table 1. This extraction procedure may be used for additional methods when appropriate solvents and spiking mixtures are used.

1.3 This procedure does not include the concentration and cleanup steps. See SOP DV-OP-0007, Concentration of Organic Extracts, for those details.

2.0 Summary of Method

A measured weight of sample, typically 15 g, is solvent extracted using a microwave extractor.

3.0 Definitions

Refer to the Glossary of the TestAmerica Denver Quality Assurance Manual (QAM) and policy DV-QA-003P, Quality Control Program, for definitions of general analytical and QA/QC terms.

3.1 **Extraction Holding Time**: The elapsed time expressed in days from the date of sample collection to the date the extraction starts. The holding time is tracked in the laboratory LIMS system, and is the primary basis of prioritizing work.

3.2 **Preparation Batch**: A group of up to 20 samples that are of the same matrix and are processed together in the same extraction event using the same procedure and lots of reagents and standards

3.3 **Method Comments:** The Method Comments are used to communicate to the bench level chemists special requirements and instructions from the client. Please reference WI-DV-0032 for details on Method Comments.

3.4 **Quality Assurance Summary (QAS)**: Certain clients may require extensive specific project instructions or program QC, which are too lengthy to fit conveniently in the Method Comments field in LIMS. In these situations, laboratory Project Managers describe the special requirements in a written QAS to address these requirements. QASs are posted on a public drive for easy accessibility by all lab employees. Normally, QASs are introduced to analysts in an initial project kick-off meeting to be sure that the requirements are understood.

3.5 **Aliquot**: A part that is a definite fraction of a whole; as in “take an aliquot of a sample for testing or analysis.” In the context of this SOP, “aliquot” is also used as a verb, meaning to take all or part of a sample for preparation, extraction, and/or analysis.

4.0 Interferences

4.1 Chemical and physical interferences may be encountered when analyzing samples using this method.

4.2 Sodium sulfate is not used in the extraction vessel. This is because salts are known to super heat when exposed to microwave energy. Samples are extracted without the addition of sodium sulfate, but the extracts are dried with sodium sulfate after the extraction, before concentration of the extracts. If the sample is excessively wet the aliquot can be divided among two or three extraction vessels and the extracts combined prior to concentration.

4.3 Method interferences may be caused by contaminants in solvents, reagents, glassware, and other processing apparatus that lead to discrete artifacts. All these materials must be routinely demonstrated to be free from interferences under conditions of the analysis by running laboratory method blanks as described in the Quality Control section of this SOP (Section 9). Specific selection of reagents may be required to avoid introduction of contaminants.

4.4 Visual interferences or anomalies (such as foaming, emulsions, odor, etc.) must be documented.

4.5 The most common interference is laboratory contamination, which may arise from impure reagents, dirty glassware, improper sample transfers, dirty work areas, etc. Be aware of potential sources of contamination and take appropriate measures to minimize or avoid them.

4.6 Paint chips are an especially difficult matrix to extract. Oftentimes the paint chips dissolve or partially dissolve in solvents and therefore can ruin glassware and extraction vessels. It is the laboratory's experience that paint chips are best extracted by method SW-846 3580 instead of 3550C or 3546.

5.0 Safety

Employees must abide by the policies and procedures in the Environmental Health and Safety Manual, Radiation Safety Manual and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coats and closed-toe, nonabsorbent shoes are a minimum.

5.1 Specific Safety Concerns or Requirements

5.1.1 A post-run cool down must be used after each extraction to prevent the possibility of operator burns. Pressure builds up in the closed vessel at high temperatures. Care should be taken when opening the vessel when it is above room temperature.

5.1.2 Samples that contain metal fragments or metal components of any kind should not be extracted by this procedure. These samples should be extracted by method SW-846 3550C instead. Care should be taken to inspect samples carefully as they are aliquotted.

5.1.3 Eye protection that satisfies ANSI Z87.1 (as described in the Corporate Safety Manual), laboratory coat, and appropriate gloves must be worn while performing this procedure. Nitrile gloves shall be worn when handling solvents; latex gloves may be worn when handling samples only; and cut resistant gloves shall be worn when washing glassware.

5.2 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. Note: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table. A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Material (1)	Hazards	Exposure Limit (2)	Signs and Symptoms of Exposure
Methylene Chloride	Carcinogen Irritant	25 ppm (TWA) 125 ppm (STEL)	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting, and headache. Causes irritation, redness, and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.
Acetone	Flammable	1000 ppm (TWA)	Inhalation of vapors irritates the respiratory tract. May cause coughing, dizziness, dullness, and headache.

Material [(1)]	Hazards	Exposure Limit [(2)]	Signs and Symptoms of Exposure
Nitric Acid	Corrosive Oxidizer Poison	2 ppm (TWA) 4 ppm (STEL)	Nitric acid is extremely hazardous. It is corrosive, reactive, an oxidizer, and a poison. Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract. Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color. Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.
Hexane	Flammable	50 ppm (TWA)	Prolonged or repeated contact with skin can cause defatting and dermatitis. Contact with eyes can cause redness, tearing, and blurred vision. Exposure can cause lung irritation, chest pain, and edema, which may be fatal.
(1) Always add acid to water to prevent violent reactions. (2) Exposure limit refers to the OSHA regulatory exposure limit.			

6.0 Equipment and Supplies

All equipment IDs for any support equipment (pipettes, thermometers, etc.) must be recorded in the batch record.

6.1 Equipment

6.1.1 Microwave extractor. Mars5: MarsExpress™CEM MARS® and Microwave extractor. Mars6: MarsExpress Plus™ CEM MARS®

At least once a year, power measurement calibration should be performed at 400 W, 800 W, and 1600 W. This calibration can be performed by the vender or by TestAmerica staff following the instructions in the Operations Manual for the microwave.

6.1.2 Microwave extraction vessels. 75 mL Teflon™ Express vessels with stopper and cap (CEM Corp.) in addition to 110 mL borosilicate glass tubes accompanying 110 mL Teflon™ Express Plus vessels with stopper and cap (CEM Corp).

6.1.3 Hand wrench to tighten the caps on the extraction vessels.

6.1.4 MARS 40 position carousel (CEM Corp) and 20 position carousel (CEM Corp)

6.1.5 Balance, >1400-g capacity, accurate to ± 0.1 g, calibrated daily per SOP DV-QA-0014.

6.2 Supplies

6.2.1 Media bottles, 100 mL or 250 mL capped with aluminum foil.

6.2.2 Stainless steel conical funnels

6.2.3 Ashless cellulose filter paper

6.2.4 Pipetter with disposable 1.0-mL tips, calibrated daily per SOP DV-QA-0008.

6.2.5 Metal spatulas or tongue depressors.

6.2.6 Solvent dispenser pump.

6.2.7 Filter flask.

6.2.8 Vacuum pump.

6.2.9 Washing tool for Teflon™ extractor vessels. This tool is a long thin sponge-like brush.

6.2.10 40 mL VOA vials and caps

6.3 Computer Software and Hardware

Please refer to the master list of documents, software and hardware located on R:\QA\Read\Master List of Documents\Master List of Documents, Software and Hardware.xls or current revision for the current software and hardware to be used for data processing.

7.0 Reagents and Standards

Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.1 Methylene chloride – Each lot of solvent is tested following CA-Q-S-001 or CA-Q-S-001-DV-1 before it is put into use. QA personnel post the list of approved lots at solvent storage areas.

7.2 Acetone - Each lot of solvent is tested following CA-Q-S-001 or CA-Q-S-001-DV-1 before it is put into use. QA personnel post the list of approved lots at solvent storage areas.

7.3 Hexane - Each lot of solvent is tested following CA-Q-S-001 or CA-Q-S-001-DV-1 before it is put into use. QA personnel post the list of approved lots at solvent storage areas.

7.4 Baked Sodium Sulfate, 12-60 mesh - Heat sodium sulfate in a 400°C oven for at least four hours. QA personnel post the list of approved lots at solvent storage areas.

7.5 Baked Ottawa Sand – Heat Ottawa sand in a 400°C oven for at least four hours.

7.6 35% Nitric Acid – Dilute concentrated (70%) Nitric Acid 1:1 in water.

7.7 Standards - Please reference SOP DV-OP-0020 and WI-DV-0009 for information regarding the surrogate and spike standards used in this procedure.

8.0 Sample Collection, Preservation, Shipment and Storage

Sample container, preservation techniques and holding times may vary and are dependent on sample matrix, method of choice, regulatory compliance, and/or specific contract or client requests. Listed below are the holding times and the references that include preservation requirements.

Matrix	Sample Container	Min. Sample Size	Preservation	Holding Time[1]	Reference
Soils for Method 8082A[2]	Glass with Teflon-lined lids	15 grams	Cool, $\leq$ 6°C	None	SW-846
Wipes for Method 8082A[2]	Glass with Teflon-lined lids	N/A	Cool, $\leq$ 6°C	None	SW-846
Soils for all other Methods, including 8082	Glass with Teflon-lined lids	15 grams	Cool, $\leq$ 6°C	14 days	SW-846
Wipes for all other Methods, including 8082	Glass with Teflon-lined lids	N/A	Cool, $\leq$ 6°C	14 days	SW-846

[1] Exclusive of analysis.

[2] Some regulatory agencies do not accept SW-846 Revision 4 of Chapter 4 and will require the 14 day holding time for Method 8082. The states of Alabama, California, Colorado, Connecticut, Nevada, New Jersey, Pennsylvania, and Rhode Island require the 14 day holding time for Method 8082.

9.0 Quality Control

9.1 The minimum quality controls (QC), acceptance criteria, and corrective actions are described in this section. When processing samples in the laboratory, use the LIMS Method Comments to determine specific QC requirements that apply. For SOPs that address only preparation, QC acceptance limits on the analytical results are not included. Refer to the appropriate SOP that describes the determinative method.

9.1.1 The laboratory's standard QC requirements, the process of establishing control limits, and the use of control charts are described more completely in TestAmerica Denver policy DV-QA-003P, *Quality Control Program*.

9.1.2 Specific QC requirements for Federal programs, e.g., Department of Defense (DoD), Department of Energy (DOE), etc., are described in TestAmerica Denver policy DV-QA-024P, Requirements for Federal Programs. This procedure meets all criteria for DoD QSM 5.0 unless otherwise stated. Any deviation or exceptions from QSM 5.0 requirements must have prior approval in the project requirements.

9.1.3 Project-specific requirements can override the requirements presented in this section when there is a written agreement between the laboratory and the client, and the source of those requirements should be described in the project documents. Project-specific requirements are communicated to the analyst via Method Comments in the LIMS and the Quality Assurance Summaries (QAS) in the public folders.

9.1.4 Any QC result that fails to meet control criteria must be documented in a Nonconformance Memo (NCM). The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP DV-QA-0031. This is in addition to the corrective actions described in the following sections.

9.2 Initial Performance Studies

Before analyzing samples, the laboratory must establish a method detection limit (MDL). In addition, an initial demonstration of capability (IDOC) must be performed by each analyst on the instrument he/she will be using. On-going proficiency must be demonstrated by each analyst on an annual basis. See Section 13 for more details on detection limit studies, initial demonstrations of capability, and analyst training and qualification.

9.3 Batch Definition

Batches are defined at the sample preparation stage. The batch is a set of up to 20 samples of the same matrix, plus required QC samples, processed using the same procedures and reagents within the same time period. Batches should be kept together through the whole analytical process as far as possible, but it is not mandatory to analyze prepared extracts on the same instrument or in the same sequence. The method blank must be run on each instrument that is used to analyze samples from the same preparation batch. See QC Policy DV-QA-003P for further details.

9.4 Method Blank (MB)

9.4.1 A method blank must be processed with each preparation batch. The method blank is processed and analyzed just as if it were a field sample.

9.4.2 The method blank consists of 15 g of baked Ottawa sand free of any of the analyte(s) of interest.

9.5 Laboratory Control Sample / Laboratory Control Sample Duplicate (LCS/LCSD)

9.5.1 At least one LCS must be processed with each preparation batch. The LCS is carried through the entire analytical procedure just as if it were a sample.

9.5.2 The LCS consists of 15 g of baked Ottawa sand to which the analyte(s) of interest are added at known concentration.

9.5.3 Method AK102 requires LCS and a LCSD for every batch for every spike compound.

9.6 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

9.6.1 One MS/MSD pair must be processed with each preparation batch. A matrix spike (MS) is a field sample to which known concentrations of target analytes have been added. It is prepared in a manner similar to the LCS, but uses a real sample matrix in place of the blank matrix. A matrix spike duplicate (MSD) is a second aliquot of the same sample (spiked exactly as the MS) that is prepared and analyzed along with the sample and matrix spike. Some programs allow spikes to be reported for project-related samples only. Samples identified as field blanks cannot be used for the MS/MSD analysis.

9.6.2 If insufficient sample volume is available for MS/MSD, an NCM must be written and a LCSD must be prepared.

9.6.3 DoD requires the MS/MSD to be assigned by the client. When there is no assigned MS/MSD or there is not enough sample volume provided a LCSD must be prepared.

9.7 Surrogate Spikes

Every calibration standard, field sample, and QC sample (i.e. method blank, LCS, LCSD, MS, and MSD) is spiked with surrogate compounds.

10.0 Procedure

10.1 One-time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure shall be completely documented using an NCM. The NCM is automatically sent to the laboratory Project Manager by e-mail so that the client can be notified as appropriate. The QA group periodically reviews NCMs for potential trends. The NCM process is described in more detail in SOP # DV-QA-0031. The NCM shall be filed in the project file and addressed in the case narrative.

10.2 Any deviations from this procedure identified after the work has been completed must also be documented as a nonconformance, with a cause and corrective action described.

10.3 Critical Procedural Considerations

10.3.1 As stated throughout this SOP, analysts must review the LIMS Method

Comments and any applicable QASs before starting work. This review is also documented on the Organic Extraction Checklist (see WI-DV-0009).

10.3.2 Analysts must focus on using clean technique throughout this procedure. Any parts or pipettes that come into direct contact with dirty surfaces or any other beaker or media bottle than the designated one should be cleaned or disposed of before coming into contact with the sample.

NOTE: Rotate glassware; do **not** use specific glassware, equipment or positions for the MB and LCS/LCSD.

10.4 Periodic cleaning.

10.4.1 **Mars5 Express Microwave Extractor. CEM Mars** At least once every four weeks, the extraction vessels must be cleaned using a “Clean Method” on the microwave. The method is under the User Directory with the settings that follow:

- Sample Type: Inorganic
- Control Type: Ramp to Temperature
- Power: 100%
- Ramp: 5 minutes to 180°C
- Hold: 10 minutes

10.4.2 **Mars6 Express Plus Microwave Extractor. CEM Mars** At least once every four weeks, the extraction vessels must be cleaned using a “Clean Method” on the microwave. The method is under the Classic Method, “Cleanup2” with the settings that follow:

- Sample Type: Inorganic
- Control Type: Ramp to Temperature
- Stage 1
- Power: 1600%
- Ramp: 15 minutes to 180°C
- Hold: 10 minutes
- Temperature guard : 200°C

10.4.3 Fill each tube with 30 mL of the nitric acid solution described in Section 7 and cap tightly. Place the tubes in the carousel, then run the “Clean Method”

10.4.4 Allow the vessels to cool, and then dispose of the nitric acid in waste stream J. Rinse the vessel with DI water three times.

10.4.5 Fill each tube with 30 mL of 1:1 Methylene Chloride: Acetone solution and cap tightly. Place the tubes in the carousel, then run the "Clean Method" again.

10.4.6 Allow the vessels to cool, and then dispose of the solvent in waste stream CA. Allow the vessels to air dry.

10.5 Assemble and Clean the Extraction Tubes Immediately Before Use.

10.5.1 If the microwave tube, cap, or plugs are wet, pre-rinse with acetone.

10.5.2 Rinse the microwave tube, cap and plug twice with methylene chloride. The plugs can be placed in a large glass jar to help facilitate the rinse.

10.5.3 Discard the solvent in the correct waste stream.

10.6 Aliquot Samples

10.6.1 If the sample is a soil, mix and homogenize samples according to the instructions provided in SOP DV-QA-0023, Subsampling. If the sample is a wipe, transfer the wipe to the extraction vessel.

10.6.2 Label microwave vessel with the sample ID, method, and batch number. The label needs to be flat.

NOTE: For method 8270 borosilicate glass tubes are to be used in housing the sample in addition to required QC; respectively. The Glass tubes will be inserted into the retaining vessel and capped for extraction.

This method is performed using the Mars6 Microwave only

10.6.3 Do not use specific vessels or carousel positions for the MB and LCS.

10.6.4 For each MB and LCS sample, weigh 15 g to 17 g of baked Ottawa sand into labeled VOA vials or similarly clean glass intermediate containers with a lid. Record a nominal weight of 15 g in the initial volume field, but record the actual weight to the nearest 0.1 g in the notes column.

10.6.5 For each sample and MS/MSD, weigh 15 g to 17 g of sample into labeled VOA vials or similarly clean glass intermediary containers with a lid. Record the weight to the nearest 0.1 g directly into LIMS or hand record the weight on the benchsheet.

NOTE: For wipe samples, the original sample containers that the wipes are received in should be used in place of the intermediary sample containers described above.

10.6.6 Cap the intermediary sample containers either with the appropriate lid or aluminum foil.

10.6.7 Place the labeled intermediary sample containers on a cart next to the sample container so that a second analyst can check the labels. This is documented on the Organic Extraction Checklists (See WI-DV-0009).

10.7 Prepare a bottle with a bottle-top dispenser with the appropriate solvent(s).

10.7.1 Methylene Chloride is used for soil and wipe samples for the following methods:

- SW-846 8015B
- SW-846 8015C
- SW-846 8015D
- Low-Level NDMA (8270D_SIM_LL)

10.7.2 For soil extraction by all other methods, the solvents used are acetone and methylene chloride. These are added separately.

10.7.3 For wipe samples by method 8081 and 8082, the solvent used is hexane.

10.7.4 For wipe samples by method 8270 SIM, the solvent used is a 1:1 mixture of methylene chloride and acetone.

10.8 Add Surrogate and Spike Solutions

NOTE: The standards should be allowed to come to room temperature before spiking the samples.

NOTE: The addition of spikes and surrogates to samples must be done only immediately after a second analyst has reviewed the batch. Reference work instruction WI-DV-0009.

10.8.1 Only one batch should be surrogated at a time to ensure the correct standards are used and to ensure the solvent is added as soon as possible to the samples. Document the standards and pipette(s) used on the benchsheet.

10.8.2 Using a calibrated pipette, add the appropriate volume of the appropriate working surrogate standard (see WI-DV-0009) to the intermediary container for each field sample and QC sample. Verify the ID of the standard used on the benchsheet.

10.8.3 Using a calibrated pipette, add the appropriate volume of the appropriate working spike standard (see DV-OP-0009) to the intermediary container for each field sample and QC sample. Verify the ID of the standard used on the benchsheet.

10.9 Making sure not to overflow the intermediary sample container, remove the cap, and slowly add approximately 15 mL of the appropriate solvent to the container. See below for the appropriate solvent:

NOTE: The solvent should be added as soon as possible after the addition of the surrogate and spiking standards to prevent loss of the more volatile compounds.

10.9.1 15 mL of methylene chloride is added to the container for soil and wipe samples for the following methods:

- SW-846 8015B, 8015C, and 8015D
- Low-Level NDMA (8270D_SIM_LL)

10.9.2 15 mL of acetone is added to the intermediary container for all other soil samples.

10.9.3 15 mL of hexane is added to the container for wipe samples by method 8081 and 8082, the solvent used is hexane.

10.9.4 15 mL of 1:1 methylene chloride and acetone is added to container for wipe samples by method 8270 SIM.

10.10 Mix the contents of the intermediary sample container using a spatula or wooden tongue depressor for 30 seconds. Then, cap the intermediary sample container and use a vortex mixer to mix the contents of the intermediary sample container for an additional 30 seconds. This mixing must generate a thoroughly wetted and disaggregated sample slurry. If clay clumps or other sample aggregation is evident after 1 minute of combined manual and vortex mixing, sand may be added to facilitate disaggregation, followed by an additional minute of mixing (manual + vortex as described above). If sand is added during this step, document this in an NCM.

10.11 Transfer the mixed/wetted sample to a microwave extraction vessel using three 5 mL methylene chloride rinses. This will bring the total combined solvent volume to 30 mL.

NOTE: The solvent should completely cover and saturate the sample. Additional solvent may be needed depending on the matrix of the individual sample. The sample and solvent must not fill more than 2/3 of the vessel.

NOTE: If the sample matrix appears to be unusual, or especially wet, the combined sample/solvent mixture can be equally divided between two or three separate microwave extraction vessels. The vessels will be extracted independently, but the extracts will be re-combined before concentration. This will prevent the extraction vessels from over-heating and venting if the sample is unusually wet, oily, or bulky (if a 15 g aliquot would fill the tube more than ¾ full). If the sample is split into two or three separate vessels, document this in an NCM.

NOTE: For method 8270, the mixed/wetted sample or QC will be transferred into borosilicate glass tubes. The glass tubes are then inserted into the retaining vessel and capped for extraction.

10.12 Seal the vessels by placing the plug on top of the vessel, small side down, and hand tighten the cap over the plug.

NOTE: Care should be taken to ensure that the plug, the cap, and the threads of the vessel are clean of any material or debris.

10.13 After being sealed, the vessels must be inverted several times to ensure that the material is well mixed and saturated. It is recommended that when extracting with 100% methylene chloride to vent and re-cap the vessels before continuing to relieve excess pressure and thereby preventing the vessels from venting during the extraction.

NOTE: 8270 Samples extracted using the borosilicate glass tubes will not be inverted, as this will result in the sample + solvent spilling out of the glass tube into the retaining vessel.

10.14 Load vessels into the carousel.

10.14.1 There must be at least 8 vessels in the carousel. Adding blank vessels with sand and solvent may be necessary.

10.14.2 Balance the tubes around the carousel to ensure that all samples are exposed to an equal amount of energy during the extraction. See Attachment 1 for details. Only samples using the same extraction solvent should be placed in the same carrousel and run at the same time.

10.14.3 For the vessels to be correctly loaded in the carousel the cap should completely touch the top of the carousel with no other part of the extraction vessel visible.

10.15 Place the carousel into the microwave, making sure that it sits on the turning apparatus correctly. The carousel should be able to rotate. Close the door.

10.16 Mars5 Express: The Method Menu screen should indicate “Start Current Method” as being 3546 Full Xpress. Press the green “Start/Pause” button to begin the extraction.

NOTE: If a different method is shown, go to the “Load Method” on the menu screen. Choose “User directory” and place the cursor on the desired method. Press the “Home” button to return to the main menu, where the test highlighted will appear under the “Start Current Method”.

10.16.1 The method is under the User Directory with the settings that follow:

- Sample Type: Organic
- Control Type: Ramp to Temperature
- Power: 100% (1600 W)
- Ramp: 20 minutes to 115°C
- Hold: 10 minutes

10.17 Mars6 ExpressPlus: The “One Touch Method” menu should be selected. Next, the “CEM 3546 glass 110C” method should be selected. At the bottom right hand corner of the screen should be a green “start” selection. Press the green “Start” button to begin the extraction.

NOTE: If a different method is shown, press the back arrow, found on the bottom left hand of the screen” until you reach the appropriate menu.

10.17.1 The method is under the CEM 3546 glass 110C" program with the settings that follow:

- Sample Type: Organic
- Control Type: Ramp to Temperature
- Stage 1
- Power: 500-1500W
- Ramp: 15 minutes to 110°C
- Hold: 15 minutes

10.17.2 When the extraction is complete, the vessels will need to return to room temperature prior to opening the vessels. The microwave will indicate the approximate temperature of the vessels.

CAUTION: If the carousel is removed from the microwave before the vessels are at room temperature, do NOT open the vessels. The vessels may be placed in a rack outside of the microwave to cool down.

10.17.3 The microwave contains a solvent sensor that will indicate the presence of solvent in the microwave and will stop the extraction. To minimize this, care needs to be taken not to overfill the vessel and to properly cap and tighten the vessel prior to extraction. If the solvent sensor indicates the presence of solvent, open the door and inspect the tops of the tubes for evidence of a solvent leak. If solvent has vented or leaked out of an extraction vessel, the sample must be re-aliquotted and the extraction started over. It is best to re-aliquot the sample into two or three separate extraction vessels to prevent over-heating again. Document this in an NCM.

10.18 Assemble and Clean Filter Funnels and Media Jars.

10.18.1 Without gloves on, fold a 18 cm diameter cellulose filter paper in quarters. Open the folds to create a cone. Place the filter paper in the bottom of a conical stainless steel funnel. Place the funnel on a 100 mL or 250 mL media bottle.

NOTE: For low-level NDMA samples by method 8270D_SIM_LL, use designated glass funnels instead of the stainless steel funnels and instead of re-usable media jars, use disposable amber bottles. This is done to prevent contamination.

10.18.2 Place approximately 1 tablespoon of baked sodium sulfate in the funnel. Rinse all surfaces of the funnel, the filter and the sodium sulfate with the extraction solvent (see Section 10.7), so all surfaces of the funnel, filter, and sodium sulfate are rinsed.

NOTE: When preparing glassware for the extraction of wipe samples, sodium sulfate is not necessary and the solvent used in the rinse should be the solvent used in the extraction of the wipe samples. (Normally hexane for methods 8081 and 8082).

10.18.3 Allow the solvent to drain completely into the media bottle. Swirl the media bottle to ensure all surfaces come into contact with the solvent. Add additional solvent to the rinse if necessary.

10.18.4 Pour the solvent out of the media bottle over the stem of the stainless steel funnel to rinse the funnel stem.

10.18.5 Discard the solvent in the correct waste stream.

10.19 Filter the Extracts

10.19.1 After the extraction method is complete and the vessels reach room temperature, quantitatively transfer the entire sample through solvent rinsed sodium sulfate funnels and into the media jar. The quantitative transfer is performed by rinsing the microwave extraction vessel at least three times with solvent.

NOTE: The quantitative rinse is vital in order to achieve good recoveries. The rinses should be significant enough that when done, the extract volume is between 75 mL and 100 mL.

NOTE: If the sample aliquot was split between two or three tubes, the extracts from all the tubes shall be combined at this time. Filter all of the extracts through the same sodium sulfate funnel and collect in the same media jar.

NOTE: During the 8270 extraction, it has been noted that solvent may be found in the retaining vessel after extractions. This contains analytes of interest and should be filtered into the funnel with the rest of the sample. Quantitatively rinse the glass tube; DO NOT rinse the retaining vessel.

10.19.2 Once the solvent has completely drained into the collection apparatus, rinse the funnel contents with 10 to 20 mL of additional solvent. Dispose of the solid sample and sodium sulfate into Waste Stream D and cap the media jar with aluminum foil.

NOTE: For 8270 extractions, dispose of the glass tube

10.20 If the extract contains visible solids, it will be necessary to filter the extract again prior to concentration.

10.21 Store the extract refrigerated at $\leq$ 6°C until concentration. Ensure that the extracts in 1:1 Methylene chloride:acetone are placed in a flammable rated refrigerator.

10.22 Handwritten notes on the benchsheet are entered into LIMS, and the transcribed data must be verified by a second person. This verification is documented on the Organic Extraction Checklists (see WI-DV-009).

10.23 All glassware and microwave tubes, plugs, and caps are washed according to DV-OP-0004.

10.24 Maintenance

10.24.1 As needed, wipe out the inside and outside of the microwave with a damp cloth.

10.24.2 See Section 10.4 for vessel cleaning.

10.24.3 At least once a year, power measurement calibration should be performed at 400 W, 800 W, and 1600 W. This calibration can be performed by the vender or by TestAmerica staff following the instructions in the Operations Manual for the microwave.

10.25 Troubleshooting

10.25.1 If it appears that the solvent sensor is malfunctioning, ensure that the sensor is aligned at a 45 degree upward angle on the back of the unit.

10.25.2 The snorkel vent should be set inside of a hood, but care should be taken so that the opening is not blocked. Make sure the snorkel does not press against the back of the hood.

11.0 Calibration

Not applicable to this procedure.

12.0 Calculations / Data Reduction

Not Applicable.

13.0 Method Performance

13.1 Method Detection Limit Study (MDL)

The method detection limit (MDL) is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to the laboratory's MDL policy in DV-QA-005P. MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; these are verified at least annually unless method or program requirements require a greater frequency.

13.2 Limit of Quantitation Verification (LOQV)

The verification of the limit of quantitation (LOQ or LLOQ) is performed quarterly for work performed according to the DOD/DOE QSM 5.0 or for programs which require the use of Method 8270D, Revision 5. A blank matrix is spiked at 1-2 the laboratory RL and carried through the entire preparation and analytical procedures. Recoveries are assessed based on historical limits.

13.3 Demonstration of Capabilities

All personnel are required to perform an initial demonstration of proficiency (IDOC) on the instrument they will be using for analysis prior to testing samples. On-going proficiency must be demonstrated annually. IDOCs and on-going proficiency demonstrations are conducted as follows.

13.3.1 Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation. The concentration of the QC check sample should be equivalent to a mid- level calibration.

13.3.2 Calculate the average recovery and standard deviation of the recovery for each analyte of interest.

13.3.3 If any analyte does not meet the acceptance criteria, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. TNI 2009 requires consecutive passing results. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

13.3.4 Until the IDOC is approved by the QA Manager (or designee); the trainer and trainee must be identified in the batch record.

13.3.5 Further details concerning demonstrations of proficiency are described in SOP DV-QA-0024.

13.4 Training Requirements

The Group Leader is responsible for ensuring that this procedure is performed by an associate who has been properly trained in its use and has the required experience. A new analyst must be working under documented supervision prior to approval of the IDOC. Documentation that a new analyst is performing under supervision must be entered into the batch record (View Batch Information) until that analyst’s IDOC has been approved by the QA Manager (or designee). See requirements for demonstration of analyst proficiency in SOP DV-QA-0024.

14.0 Pollution Control

The volume of spike solutions prepared is minimized to reduce the volume of expired standard solutions requiring hazardous waste disposal.

15.0 Waste Management

15.1 All waste will be disposed of in accordance with Federal, State, and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method, the policies in section 13 of the Environmental Health and Safety Manual for "Waste Management and Pollution Prevention", and the Waste Management procedure, DV-HS-001P.

15.2 Waste Streams Produced By This Method

15.2.1 Methylene chloride – Waste Stream B

15.2.2 1:1 MeCl2:Acetone – Waste Stream CA

15.2.3 Flammable solvent – Waste Stream C

15.2.4 Solid waste/sodium sulfate – Waste Stream D

15.2.5 Nitric Acid Waste – Waste Stream J

15.2.6 Expired Standards/Reagents – Contact Waste Coordinator for guidance

NOTE: Radioactive, mixed waste and potentially radioactive waste must be segregated from non-radioactive waste as appropriate. Contact the Radioactive Waste Coordinator for proper management of radioactive or potentially radioactive waste generated by this procedure.

16.0 References / Cross-References

16.1 SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Method 3456 Microwave Extraction, Revision 0, February 2007.

16.2 NWTPH-HCID "Hydrocarbon Identification Method for Soil and Water", Manchester Environmental Laboratory, Dept of Ecology, State of Washington.

17.0 Method Modifications:

17.1 SW-846 Method 3546 calls for samples to be either air-dried and ground or mixed with sodium sulfate prior to extraction. This procedure does not call of the air-drying of samples unless requested by the client as this may lead to loss of the more volatile compounds. Sodium sulfate is not used in the extraction vessel, rather the extracts are dried with sodium sulfate after extraction and prior to concentration. Salts are known to superheat when exposed to microwave energy.

17.2 SW-846 Method 3546 calls for samples to be aliquoted on a balance capable to weighing to 0.01 g. This SOP calls for a balance capable to weighing to 0.1 g as this is sufficient to report data to 3 significant figures.

17.3 SW-846 Method 3546 Section 1.4 states "2-20 g of material is usually necessary and can be accommodated by this extraction procedure." This SOP calls for 30-33 g of material.

17.4 SW-846 Method 3546 Section 11.7 states "Add approximately 25 mL of the appropriate solvent system to the vessel." This SOP calls for the addition of 25-30 mL of solvent.

17.5 Method NWTPH-Dx calls for samples to be extracted by method SW-846 3550C. Valid MDLs and IDOCs have been completed using both method SW-846 3550C and SW-846 3546 and they are comparable therefore method NWTPH-Dx is a possible determinative method by this procedure.

18.0 Attachments

Table 1: Determinative Methods Using Microwave Extraction

Attachment 1: Proper Carousel Loading

19.0 Revision History

- Revision 10, May 4, 2020
  - Annual Review.
- Revision 9, April 25, 2019
  - Removed all references to Alaska methods AK 102 and AK 103 as these will now be conducted with Sonication in DV-OP-0016 exclusively.
  - Annual Technical Review
- Revision 8, March 6, 2018
  - Changed nominal sample weight from 30 grams to 15 grams in accordance with the microwave extraction best practices and standardization procedure provided by corporate QA. This change is reflected in sections 2.0, 8.0, 9.4, 9.5, and 10.6.
  - Changed all references to WI-DV-009 to correct document ID: WI-DV-0009.
  - Modified sections 10.6-10.11 to specify the use of the intermediary sample container required in order to implement the microwave extraction best practices and standardization procedure provided by corporate QA.
  - Modified section 10.7.2 to clarify that acetone and methylene chloride are added separately in accordance with the microwave extraction best practices and standardization procedure provided by corporate QA.
  - Modified, added, and/or rearranged sections 10.9-10.11 in accordance with the microwave extraction best practices and standardization procedure provided by corporate QA. This change involves modifying the addition of solvents, mixing of the sample/solvent mixture, and transferring from an intermediary container into the microwave extraction vessel.
  - Updated sections 6.1.1, 6.1.2, 6.1.4, 10.4.1, 10.4.2, 10.6.2, 10.6.5, 10.11, 10.14, 10.15, 10.15.1, 10.17.1, 10.17.2 with notes to reflect the usage of the new microwave for 8270 FS, HSL list analytes only.
- Revision 7, January 31, 2017
  - Annual Technical Review
  - Added paragraph to Section 3.0 referencing the QAM for general definitions
  - Added paragraph to Section 6.0 to record IDs of pipettes and equipment
  - Updated language in Section 9.6.3 requiring LCSDs when no MS/MSD
  - Added note to Section 10.3.2 on rotating glassware/equipment/positions
  - Added current Section 13.2 defining LOQV
- Revision 6, January 31, 2016

  - Annual Technical Review
  - Updated Section 9.1 to contain verbiage consistent with other SOPs
  - Added Section 9.6.3 regarding DoD MS/MSD requirements
  - Changed the “Clean Method” frequency from two to four weeks in Section 10.4.1
  - Changed the waste stream from C to CA in Section 10.4.5
  - Section 10.5.2 changed the rinse requirement to be performed twice.
  - Added Section 10.6.3 instructing not to use specific vessels or positions for the MB and LCS.
  - Modified Section 10.6.4 weight recording requirements
  - Added Section 10.6.6 – cap with aluminum foil
  - Added the documentation of the standards and pipette used in Section 10.8.1
  - Clarified the need to punch a hole in foil when spiking to Section 10.8.2 & 10.8.3
  - Clarified the process for adding solvent to vessels in Section 10.9
  - Added the requirement to place 1:1 Methylene chloride:acetone extracts in a flammable rated refrigerator to Section 10.18
  - Revised Section 13.1 – Method Detection Limit Study (MDL)
  - Revised Section 13.2 – Demonstration of Capabilities
  - Revised Section 13.3 - Training Requirements
  - Updated Section 17.4 to reflect the addition of 25-30 mL of solvent
  - Archived all revision histories 2010 and earlier

- Revision 5, January 31, 2015
  - Annual Technical Review
  - Reformatted SOP
  - Revised Section 7.4 to remove the requirement to test the sodium sulfate before use. This was done to reflect current practice in CA-Q-S-001-DV-1.
  - Added “NWTPH DRO” to the procedure
  - Revised Section 10.5.2 to state that the plugs and caps can be rinsed in a large glass jar.
  - Added a note in Section 10.15.1 to state that for method 8270D_SIM_LL, designated glass funnels and disposable amber bottles will be used to filter the extracts.
  - Added Sections 16.2-16.5 to list AK102, AK103, and NWTPH methods as references.
  - Removed Section 17.8, redundant with 17.5.
  - Updated Table 1 to reference the correct methods and SOPs.

- Revision 4, January 31, 2014
  - Annual Technical Review
  - Revised Section 1.2 to state that the procedure may be used for additional methods when appropriate solvents are used instead of pH as there are no pH adjustments made in the procedure.
  - Removed TeflonTM lined caps from the Equipment and Supplies list in Section 6 as the lab now uses aluminum foil.
  - Added footnote to the table in Section 10 stating some regulatory agencies do not accept SW-846 Revision 4 of Chapter 4 and will require 14 day hold time for method 8082A.
  - Revised Section 9.1.2 to state that this procedure meets all criteria of DoD QSM 5.0.
  - Revised Section 9.4 to clarify that one method blank is processed with each batch.

  - Removed “Acceptance Criteria” and “Corrective Action” information from Sections 9.4, 9.5, 9.6, and 9.7. This information can be found in the analytical SOPs.
  - Added a bullet point in Section 10 to clarify that any deviations discovered after the procedure is performed are to be documented in an NCM.
  - Revised Section 10 to remove the instruction to place the label towards the bottom of the vessel. This is not necessary. Also removed the requirement that the label must include the date. The label includes the batch number, which is unique and the date of extraction is recorded in the batch.
  - Revised the procedure to state the periodic acid cleaning of the tubes should be done at least once every two weeks instead of weekly.
  - Removed methods “NWTPH DRO” and “Okla_DRO” from the procedure. The lab does not perform microwave extraction for these methods at this time.
  - Added sub-sections for Maintenance and Troubleshooting to Section 10 per DoD QSM 5.0.
  - Added low-level NDMA and 8015D as a possible analytical method to Section 10 and to Table 1
  - Removed 8310 as a possible analytical method in Table 1.
  - Added Attachment 1 to give instructions on how to properly load the vessels in the carousel.

- Revision 3, January 31, 2013
  - Annual Technical Review
  - Sections 4.2 and 10.5.4 were revised to remove the optional addition of sodium sulfate to the samples before extraction. It was determined that the better option when dealing with wet samples is to split the sample into two or three tubes and re-combine the extracts before concentration.
  - Section 4 was revised to add instructions on how to deal with paint chip samples.
  - Section 5 was revised to add comments about the dangers of metal fragments in samples.
  - Section 6 was revised to include the requirement that the Power Measurement Calibration procedure be performed on the unit every year.
  - Section 8 was revised to update the hold times for Method SW-846 8082A.
  - Section 10.8 was revised to give more detail on how full the extraction vessel should be once solvent has been added.
  - Section 10.13.1 was revised to allow the carousel to be removed from the microwave unit before the vessels are cool so long as the vessels are not opened.
  - Section 10.15.1 was revised to add a note about the importance of quantitative transfers and rinses while filtering the extracts.
  - Section 10.15.1 was revised to add instructions to combine all extracts from samples that were originally split across two or three tubes.
  - Section 15 was revised to include the waste stream CA.
  - Added the Note to Table 1

- Revision 2.0, January 31, 2012
  - Annual Technical Review
  - Updated Section 4.2 and Section 10.5.4 to describe when sodium sulfate should be used in the extraction vessel.
  - Updated Section 6.0 to allow the use of aluminum foil to cap 100mL and 250mL media jars.

  - Updated Section 6.1 to include details on computer software and hardware.
  - Updated Section 7.0 to include details on the purity of reagents and standards.
  - Updated Section 9.1.4 and Section 10.1 to more accurately reflect the NCM process.
  - Corrected grammatical and formatting errors
  - Updated Section 10.3 to include a solvent cleaning after the weekly acid cleaning.
  - Updated Section 10.5.4, Section 10.7.2, and Section 10.7.3 to include an option to split the sample aliquot into two separate microwave vessels.
  - Updated Section 10.10 and 10.13.2 to give details on how to prevent vessels from over-heating and venting and steps to be taken if venting does occur.
  - Updated Section 10.16 to accurately reflect how the laboratory handles extracts with suspended sediment.
  - Updated Section 10.19 to reference SOP DV-OP-0004 on how to clean the microwave vessels.

- Revision 1 dated 01 Jan 2011
  - Added 8270C SIM as a valid determinative method by microwave extraction.
  - Changed the procedure to call for the extract to be filtered thru a conical steel funnel lined with cellulose filter paper instead of a glass funnel with glass wool. This was done to help remove sediment from the extracts.
  - Removed details about the surrogate and spike standards used in the extraction. This information can now be found in DV-OP-0020.
  - Added instructions to Section 7 on how to prepare the nitric acid solution used in the weekly cleaning of the tubes.
  - Changed the solvent used in the extraction of samples for method 8081 and 8082. The samples are now extracted in a 1:1 Mixture of MeCl2:Acetone instead of a 1:1 Mixture of MeCl2:Hexane.
  - Revised the procedure in Section 10.5 for aliquotting samples to state that 30 to 33g of sample should be used instead of 30±2g and that the weight should be recorded to the nearest 0.1g instead of the nearest mg.

Earlier revision histories have been archived and are available upon request.