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From: Pam G. Foti <PFoti@ecc.net>
Sent: Thursday, October 31, 2024 5:07 PM
To: Cobb, Stephen
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Subject: 12514 AL7210020742 089 07-11-2024 CORS WGO RSA-115 and 116 Rev 0 CMIP
Attachments: RSA-115_116 REV01 CMIP Transmittal Letter 31Oct24.pdf

Mr. Cobb,

On behalf of the US. Army Garrison - Redstone, Environmental Restoration Program, ECC is pleased to provide responses to ADEM comments and the *Revision 1, Corrective Measures Implementation Work Plan (CMIP) RSA-115, Inactive East Side Blowdown Lagoon, Test Area 5, and RSA-116, South Side Blowdown Area Lagoon at Test Area 5, Operable Unit 13*, US Army Garrison – Redstone, Madison County, Alabama, for your review. The document can be retrieved at the link below.

Rev 1 RSA 115-116 CMIP.pdf

Please confirm receipt of this email and don't hesitate to reach out if you have any issues downloading the document.

Best regards,

Pam

Pamela Foti, CHMM, PMP
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Vision Integrity Results

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Subject: 12514 AL7210020742 089 07-11-2024 CORS WGO RSA-115 and 116 Rev 0 CMIP Comment Letter

DEPARTMENT OF THE ARMY
US ARMY INSTALLATION MANAGEMENT COMMAND
HEADQUARTERS, UNITED STATES ARMY GARRISON, REDSTONE
4488 MARTIN ROAD
REDSTONE ARSENAL, ALABAMA 35898-5000

REPLY TO ATTENTION OF

Environmental Management Division October 31, 2024

Mr. Stephen A. Cobb
Chief, Land Division
Alabama Department of Environmental Management
Post Office Box 301463
Montgomery, Alabama 36130-1463

SUBJECT: Response to ADEM Comments and Revision 1, Corrective Measures Implementation Work Plan (CMIP) RSA-115, Inactive East Side Blowdown Lagoon, Test Area 5, and RSA-116, South Side Blowdown Area Lagoon at Test Area 5, Operable Unit 13, US Army Garrison – Redstone US Army Garrison – Redstone, Madison County, Alabama

Reference:

a. The Installation Restoration Program at Redstone Arsenal, Alabama, AMIM-REP-ER (EPA ID AL7 210 020 742).

b. Resource Conservation and Recovery Act Corrective Action Program at Redstone Arsenal, Alabama (EPA ID AL7 210 020 742).

c. Redstone Arsenal's Alabama Hazardous Wastes Management and Minimization Act Hazardous Waste Storage Facility/Thermal Treatment/Solid Waste Management Unit Corrective Action (AHWMMA) Permit dated July 19, 2021.

d. ADEM Review Comments Dated July 11, 2024: Revision 0, Corrective Measures Implementation Work Plan (CMIP) RSA-115, Inactive East Side Blowdown Lagoon, Test Area 5, and RSA-116, South Side Blowdown Area Lagoon at Test Area 5, Operable Unit 13, dated October 30, 2023.

Dear Mr. Cobb:

This letter transmits responses to ADEM comments on the subject document and the Revision 1, Corrective Measures Implementation Work Plan (CMIP) RSA-115, Inactive East Side Blowdown Lagoon, Test Area 5, and RSA-116, South Side Blowdown Area Lagoon at Test Area 5, Operable Unit 13, US Army Garrison – Redstone, Madison County, Alabama

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Copies of this correspondence are being furnished to Mr. William Overstreet, and Mr. Richard Janett with Alabama Department of Environmental Management. Copies are also provided to Mr. Robert Pope, Superfund and Emergency Management Division USEPA Region 4, and Mr. Cesar Zapata, Land, Chemicals and Redevelopment Division USEPA Region 4.

My point of contact for this request is Ms. Kajuana Rice, Environmental Management Division, 256-313-0368 or email Kajuana.d.rice.civ@army.mil.

Sincerely,

Clint Howard

Clint Howard
Chief, Installation Restoration Branch

Enclosure

Rev. 1
Corrective Measures Implementation Plan RSA-115, Inactive East Side Blowdown Lagoon at Test Area 5 and RSA-116, South Side Blowdown Lagoon at Test Area 5 Operable Unit 13

ENVIRONMENTAL REMEDIATION SERVICES
U.S. ARMY GARRISON-REDSTONE ARSENAL

October 2024

Prepared for:

U.S. ARMY ENVIRONMENTAL COMMAND
Southeast-Environmental Service and Support Division
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Professional Geologist Certification

"I certify that I am a qualified groundwater scientist who has received a baccalaureate degree in geology and have sufficient training and experience in groundwater hydrology and related fields, as demonstrated by Alabama registration and completion of accredited university courses that enable me to make sound professional judgments regarding groundwater monitoring and contaminant fate and transport. I further certify that I have technically reviewed this report."

By:

Jason Hughes



Jason Hughes, PG
Registered Professional Geologist
Alabama P.G. No.: 1118

Date:

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ACRONYMS AND ABBREVIATIONS

1,3-DNB	1,3-dinitrobenzene
2-NT	2-nitrotoluene
2,6-DNT	2,6-dinitrotoluene
3-NT	3-nitrotoluene
µg/L	microgram per liter
AAC	Alabama Administrative Code
ADEM	Alabama Department of Environmental Management
AEIRG	Alabama Environmental Investigation and Remediation Guidance
AHWMMA	Alabama Hazardous Wastes Management and Minimization Act
APTIM	Aptim Federal Services, LLC
ARBCA	Alabama Risk-Based Corrective Action
Army	United States Army
bgs	below ground surface
BRA	baseline risk assessment
BSV	background screening value
CFR	Code of Federal Regulations
CG	cleanup goal
CMA	corrective measure alternative
CMI	corrective measures implementation
CMIP	Corrective Measures Implementation Plan
CMO	Corrective Measure Objective
COC	constituent of concern
COPC	constituent of potential concern
COPEC	constituent of potential environmental concern
CSM	conceptual site model
DAF	dilution-attenuation factor
DoD	United States Department of Defense
ECC	Environmental Chemical Corporation
ERA	environmental risk assessment
EUR	Environmental Use Restriction
HDPE	high-density polyethylene
HGL	HydroGeoLogic, Inc.
HHRA	human health risk assessment
HQ	hazard quotient
IELCR	individual excess lifetime cancer risk
IROD	Interim Record of Decision
IRP	Installation Restoration Program
ISCO	in situ chemical oxidation
ISEB	in situ enhanced biodegradation

ACRONYMS AND ABBREVIATIONS

IWGW	installation-wide groundwater
LUC	land use control
MCL	maximum contaminant level
MDC	maximum detected concentration
MICC	Mission and Installation Contracting Command
MNA	Monitored Natural Attenuation
NEUR	Notice of Environmental Use Restriction
PAH	polycyclic aromatic hydrocarbon
PSL	preliminary screening level
PSV	preliminary screening value
QCP	Quality Control Plan
RBTL	risk-based target level
RCRA	Resource Conservation and Recovery Act
RCRA Permit	Alabama Hazardous Wastes Management and Minimization Act Hazardous Storage Facility/Thermal Treatment/Solid Waste Management Unit Corrective Action Permit
Rev.	Revision
RFI	Resource Conservation and Recovery Act Facility Investigation
RM	risk management
RSA	Redstone Arsenal
RSL	Regional Screening Level
SAC	Site Access Control
SLERA	screening level ecological risk assessment
SSL	soil screening level
SVOC	semi-volatile organic compound
SWMU	solid waste management unit
TCE	trichloroethene
TCL	target compound list
TeCA	1,1,2,2-tetrachloroethane
UDMH	unsymmetrical dimethyl hydramine
U.S.	United States
USAEC	United States Army Environmental Command
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

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EXECUTIVE SUMMARY

Environmental Chemical Corporation (ECC), on behalf of the U.S. Army Garrison–Redstone, has prepared this Corrective Measures Implementation (CMI) Work Plan for Redstone Arsenal (RSA)-115 (Inactive East Side Blowdown Lagoon at Test Area 5) and RSA-116 (South Side Blowdown Lagoon at Test Area 5), Madison County, Alabama, under the management of the United States Army Environmental Command (USAEC). Due to their close proximity and similar historical operations and nature of contamination, a combined CMIP for both RSA-115 and RSA-116 is appropriate and will streamline the implementation of corrective measures. The Mission and Installation Contracting Command (MICC) has contracted ECC under Contract Number W9124J-18-D-0004, Delivery Order W9124J-22-F-0045 to perform environmental remediation and restoration and program management services at RSA under the Resource Conservation and Recovery Act (RCRA) Corrective Action program in accordance with RSA's Alabama Hazardous Wastes Management and Minimization Act Hazardous Waste Storage Facility/Thermal Treatment/Solid Waste Management Unit (SWMU) Corrective Action Permit, last modified 12 August 2022 (United States Environmental Protection Agency [USEPA] ID # AL7 210 020 742) (Alabama Department of Environmental Management [ADEM], 2022). This CMI Work Plan has been developed to provide technical guidance for implementing the corrective measures selected for RSA-115 Inactive East Side Blowdown Lagoon at Test Area 5, and RSA-116 South Side Blowdown Lagoon at Test Area 5, located within Operable Unit 13.

RSA-115, Inactive East Side Blowdown Lagoon at Test Area 5, and RSA-116, South Side Blowdown Lagoon at Test Area 5, are located in the southern portion of Redstone Arsenal, within groundwater units RSA-156 and RSA-157. RSA-115 consists of an unlined holding lagoon that was used for cooling water discharged during test firing of rocket engines at Test Stand 8877, and RSA-116 consists of a lined holding lagoon that was used for cooling water discharged during test firing of rocket engines at Test Stand 8879. Both sites are currently inactive. Although test firings are not currently being conducted, Test Stand 8879 is operational and may resume at any time at RSA-116.

RCRA Facility Investigations (RFIs) were performed at RSA-115 and RSA-116 to evaluate potential environmental impacts from historical activities. The RFIs concluded that the Army's historical operations at RSA-115 and RSA-116 have resulted in groundwater contamination that poses an unacceptable risk to human health if groundwater were to be used as a source of potable drinking water. This CMI Work Plan describes the corrective measures selected to address remaining groundwater contamination at RSA-115/116. The groundwater constituents to be addressed by the corrective measures at RSA-115/116 are listed in **Exhibit ES-1**.

Exhibit ES- 1. Site-Related Groundwater Constituents of Concern (COCs)

RSA-115 Site-Related COCs in Groundwater	RSA-116 Site-Related COCs in Groundwater
Metals	
Aluminum [3] Arsenic Vanadium [2]	None
Perchlorate	
Perchlorate	Perchlorate
Explosives	
1,3-Dinitrobenzene [2] 2,6-Dinitrotoluene 2-Nitrotoluene Nitrobenzene [2] Nitroglycerin [2]	1,3-Dinitrobenzene [2] 2-Nitrotoluene 3-Nitrotoluene [3] Nitrobenzene [3] Nitroglycerin [3]

Semi-Volatile Organic Compounds (SVOCs)	
Benzo(a)anthracene [3] Bis(2-ethylhexyl)phthalate Naphthalene [2] Pentachlorophenol Unsymmetrical dimethyl hydramine (UDMH) [1]	Bis(2-ethylhexyl)phthalate Naphthalene [2] Unsymmetrical dimethyl hydramine (UDMH) [1]
Volatile Organic Compounds (VOCs)	
Benzene Bromomethane [2] Trichloroethene	1,1,2,2-Tetrachloroethane Trichloroethene

Notes:
1. UDMH is a COC because the constituent is in the Conceptual Site Model (CSM) of the site, the analytical detection limit exceeded the groundwater preliminary screening value (PSV), and risks from this constituent cannot be calculated until appropriate toxicity values are developed for this constituent.
2. The maximum detected concentration (MDC) for each of these constituents exceeded its PSV and/or background screening value (BSV). However, none of these constituents were determined to be a risk driver in the cumulative risk assessment.
3. The MDC for each of these constituents exceeded its PSV. However, none of these constituents were determined to be a risk driver in the cumulative risk assessment and the MDC did not exceed the cleanup goal (CG).

No further action is required for soils at RSA-115 and RSA-116.

Corrective measure alternatives to address the groundwater constituents of concern (COCs) were developed to meet the corrective measures objective for groundwater at RSA-115/ 116 and include:

- **Alternative 1-** No Action for groundwater
- **Alternative 2-** Monitored Natural Attenuation (MNA) with Land Use Controls (LUCs)

Alternative 2, MNA with LUCs, is recommended as the preferred corrective measure for groundwater as it appropriately addresses the groundwater COCs at RSA-115/116. Alternative 2 would protect human health and achieve the Corrective Measures Objective (CMO) by maintaining the existing LUCs that prohibit potable use of groundwater at RSA-115/116. Periodic groundwater monitoring will be conducted to track the progress of natural attenuation for groundwater COCs. Closure for sites RSA-115 and RSA-116 will be achieved when the concentrations of groundwater COCs reach the cleanup goals.

1.0 INTRODUCTION

Environmental Chemical Corporation (ECC), on behalf of the U.S. Army Garrison–Redstone, has prepared this Corrective Measures Implementation (CMI) Work Plan for Redstone Arsenal (RSA)-115 (Inactive East Side Blowdown Lagoon at Test Area 5) and RSA-116 (South Side Blowdown Lagoon at Test Area 5), Madison County, Alabama, under the management of the United States Army Environmental Command (USAEC). Due to their close proximity and similar historical operations and nature of contamination, a combined CMIP for both RSA-115 and RSA-116 is appropriate and will streamline the implementation of corrective measures. The Mission and Installation Contracting Command (MICC) has contracted ECC under Contract Number W9124J-18-D-0004, Delivery Order W9124J-22-F-0045 to perform environmental remediation and restoration and program management services at RSA under the Resource Conservation and Recovery Act (RCRA) Corrective Action program in accordance with RSA's Alabama Hazardous Wastes Management and Minimization Act Hazardous Waste Storage Facility/Thermal Treatment/Solid Waste Management Unit (SWMU) Corrective Action Permit, dated 12 August 2022 (hereinafter referred to as the Permit) (United States Environmental Protection Agency [USEPA] ID # AL7 210 020 742) (ADEM, 2022). This CMI Work Plan has been developed to provide technical guidance for implementing the remaining corrective measures selected for RSA-115 Inactive East Side Blowdown Lagoon at Test Area 5, and RSA-116 South Side Blowdown Lagoon at Test Area 5, located within Operable Unit 13 (**Figure 1-1).**

This CMI Work Plan incorporates applicable elements of the Permit (ADEM, 2022) and the most recent edition of the Alabama Environmental Investigation and Remediation Guidance (AEIRG) (ADEM, 2017b). This CMI Work Plan is submitted to fulfill in part the requirements listed in Section VI.E of the Permit. This CMI Work Plan protects human health and the environment from hazardous constituents at concentrations exceeding applicable limits.

1.1 PURPOSE

The purpose of this CMI Work Plan is to describe the corrective measures selected to address groundwater contamination at RSA-115/116. The nature and extent of contamination were presented in the Revision 3 RCRA Facility Investigation (RFI) Report for RSA-115 (APTIM, 2020a) and the Revision 4 RFI Report for RSA-116 (APTIM, 2020b), approved by ADEM in letters dated October 19, 2020 and May 26, 2021, respectively.

An Alabama Risk Based- Corrective Action (ARBCA) evaluation for human health and a Screening-Level Ecological Risk Assessment (SLERA) were prepared for RSA-115 and RSA-116 in each of their respective RFI Reports. The ARCBA evaluations and SLERAs concluded that:

- At RSA-115, no constituents of concern (COCs) were identified for soil. At RSA-116, exposure to soil alone does not pose an unacceptable health threat to the commercial worker, construction worker, or hypothetical residential receptor by direct exposure pathways. Therefore, no further action is required for soil at either site.
- Nine COCs in groundwater were detected at concentrations that require action based on the results of the risk assessment:
    - At RSA-115, arsenic, perchlorate, 2,6-dinitrotoluene (DNT), 2-nitrotoluene (NT), bis(2-ethylhexyl)phthalate, pentachlorophenol, benzene, and trichloroethene (TCE) in groundwater pose an unacceptable health threat and require action.
    - At RSA-116, perchlorate, 2-NT, bis(2-ethylhexyl)phthalate, 1,1,2,2-tetrachloroethane (TeCA), and TCE in groundwater pose an unacceptable health threat and require action.
- Nine other constituents were detected in groundwater at RSA-115 and/or RSA-116 at concentrations exceeding preliminary screening values (PSVs) but were not determined to be risk

drivers in the cumulative risk assessment. As such, none of these nine constituents require corrective actions; however, at ADEM's request, the following constituents will be included as groundwater COCs:

  - RSA-115: Aluminum, vanadium, 1,3-DNB, nitrobenzene, nitroglycerin, bromomethane, benzo(a)anthracene, and naphthalene.
  - RSA-116: 3-NT, nitrobenzene, nitroglycerin, and naphthalene.

- Unsymmetrical dimethyl hydrazine (UDMH) is identified as a groundwater COC at both sites because the laboratory detection limit exceeds the PSV. Because no appropriate toxicity values were available, UDMH was not evaluated in the risk assessment.
- No ecological hazards were present and further evaluations of ecological hazards at RSA-115/ 116 are not warranted (APTIM, 2020a, b).

The CMO selected for RSA-115/116 is as follows:

- Prevent human exposure to site groundwater contaminated with COCs that exceed their groundwater CGs via any exposure route (ingestion, inhalation, or dermal contact).

The Army recommends the implementation of corrective measures that include establishment of a groundwater monitoring program for monitored natural attenuation (MNA) and land use controls (LUCs). MNA and associated reporting will track the progress of passive natural attenuation processes for COCs in groundwater, while LUCs will protect potential human receptors from interactions with contaminated groundwater.

This CMI Work Plan describes the technical approach and rationale for the activities that will be performed prior to and during implementation of the recommended groundwater corrective measures for RSA-115/116.

1.2 REDSTONE ARSENAL LOCATION AND DESCRIPTION

RSA occupies approximately 38,300 acres in Madison County, Alabama. RSA is bounded on the north and east by the city of Huntsville, on the west by the city of Madison, on the west and southwest by Wheeler National Wildlife Refuge, and on the south by the Tennessee River. Huntsville has a population of nearly 217,000; Madison County's population is approximately 399,000. Approximately 330 military families reside in government quarters on RSA and approximately 40,000 government employees and contractors work at the facility. The primary mission of RSA is the development, acquisition, testing, fielding, and sustainment of aviation and missile weapon systems. Most of the installation tenants support this effort; however, RSA is also home to such diverse activities as training for handling explosives and ordnance devices, Defense Intelligence Agency activities, and the production of iron carbonyl. RSA is home to over 70 different tenant organizations.

1.3 RSA-115/116 SITE DESCRIPTION, HISTORY, AND PHYSICAL DESCRIPTION

RSA-115 and RSA-116 are located in the southern portion of RSA, approximately 2 miles south of Buxton Road and approximately 0.8 mile north of the Tennessee River (**Figure 1-1**). RSA-115 is approximately 800 feet to the east-northeast of RSA-116 (**Figure 1-2**). **Sections 1.3.1** and **1.3.2** provide brief descriptions and site histories for each of the two sites. Because this CMI Work Plan focuses on groundwater corrective measures, the physical descriptions of the sites focus on geology and hydrogeology.

1.3.1 RSA-115

1.3.1.1 Site Description

RSA-115, the inactive East Side Blowdown Lagoon at Test Area 5, is a 0.78-acre site at Test Area 5 and lies within groundwater units RSA-156/157. The lagoon occupies an area of 7,500 square feet (approximately 0.17 acre) within the 0.78-acre site approximately 300 feet east-northeast of the Attitude Test Stand (Building 8877) (**Figure 1-3**).

The site is located on a level area within Test Area 5 and bordered to the south by Arsenal Road and to the east by Raspberry Road, both paved roads. A concrete flume, which transported the cooling water used during the tests to the lagoon, leads from the test stand at Building 8877 to the earthen lagoon. The lagoon is unlined and bounded on three sides by an earthen berm and surrounded by young pine trees. The inactive lagoon at RSA-115 is usually dry and is covered with sparse vegetation, likely due to exposed fractured sandstone and lack of soil.

1.3.1.2 History

The lagoon was used as a holding basin for cooling water discharged during test firing of Redstone rocket engines from Attitude Test Stand 8877. Tests were conducted up to five times a week during the 1960s, using a kerosene-based fuel. Subsequent testing during the development of the Lance rocket between 1964 and 1970 utilized UDMH as the primary active fuel ingredient and nitric acid as the primary oxidant. Between 1975 and 1990, a variety of rocket motors were tested at the site. The concrete flume transported cooling water used during tests to the earthen lagoon to ultimately evaporate or seep into the ground. Cooling water may have contained dissolved solid rocket propellant and rocket engine exhaust.

The blowdown lagoon has been generally inactive since the mid-1980s. The test stand associated with this lagoon is now used exclusively for static tests, which do not require a blowdown lagoon. The concrete flume that carried water from the test stand is not functional and is inactive. Reportedly, the lagoon never held cooling water because of poor integrity, and it is reported that no plans exist to line and refit the lagoon for use in the future (Parsons Engineering Science, Inc. [Parsons], 1995).

1.3.1.3 Geology and Hydrogeology

The overburden in the lagoon is very shallow, generally less than 1 foot thick, and consists of sandy clay with some silt and gravel. The overburden outside of the lagoon is approximately 7 feet thick and consists of predominantly reddish-brown clays with some silt, sand, and/or limestone fragments (APTIM, 2020a).

Groundwater beneath the site generally occurs in two groundwater vertical zones entirely within bedrock, and flow is governed by the orientation and interconnectivity of bedrock fractures. Depth to water in the shallow bedrock ranged from 39.81 feet bgs (N115-RS467) to 44.68 feet bgs (N115-RS468) during the April 2020 sampling event (APTIM, 2020a). Depth to water in the deep bedrock ranged from 120.19 feet bgs (115-RS2492) to 148.03 feet bgs (115-RS2411) during the January 2019 sampling event (APTIM, 2020a). The shallow bedrock and deep bedrock groundwater vertical zones are poorly connected hydraulically (Parsons, 1997). Given the difficulty in predicting joint and fracture patterns from the existing well control, potentiometric surface maps in this type of flow regime do not necessarily predict flow directions. Groundwater flow in this area is fully discussed in the RSA-156/157 groundwater unit RFI report (APTIM, 2019) and summarized in the RFI Report for RSA-115 (APTIM, 2020a). Potentiometric surface maps for both groundwater zones are shown on **Figures 1-4** and **1-5**, respectively.

RSA-115 is situated on a northerly trending ridge that is likely underlain by a groundwater divide (APTIM, 2019). Groundwater on the eastern side of the ridge appears to be controlled by topography and to move east-southeast; groundwater on the western side of the ridge appears to move west-southwest. However,

the general direction of groundwater flow of the water table is south towards the Tennessee River, the regional drain for this aquifer.

1.3.2 RSA-116

1.3.2.1 Site Description

RSA-116, the South Side Blowdown Lagoon at Test Area 5, is a triangular, lined lagoon, approximately 0.7 acres in size, within the 2.4-acre site at Test Area 5 and lies within groundwater units RSA-156/157. The lagoon is approximately 500 feet west of Test Stand 8879 (**Figure 1-6**).

The site is located south of Buxton and Pershing Roads, on the south side of Test Area 5, in a ravine within a heavily wooded area. The ravine is a topographically low feature trending roughly north to south, which received rainfall runoff from the surrounding slopes. Initially, the lagoon was created by constructing an earthen dam 35 feet in height and 40 feet in width across the unlined ravine. A concrete flume transported cooling water from the test stand and entered the lagoon on the east side. Although the concrete flume is present within the site boundary, the concrete flume is not included as part of the permitted site.

1.3.2.2 History

The lagoon began operation in the mid-1960s as a holding basin for cooling water discharged during test firing of rocket engines at Test Stand 8879. Tests were conducted as frequently as once every 10 days. Cooling water from the test stand was discharged to a concrete apron that channeled the water to the concrete flume and ultimately to the lagoon. Cooling water may have contained dissolved rocket propellant and rocket engine exhaust from UDMH as the active fuel ingredient and nitric acid as the primary oxidant. It is also reported that JP-1 and JP-4 fuels were used. Site personnel reported that TCE was used regularly as a solvent on the test stand until the mid- to late 1970s (ADEM, 2008).

Natural drainage also continued to enter the lagoon, as the ravine entered the lagoon from the north. Water contained in the lagoon was allowed to evaporate or seep into the soil. If water levels in the lagoon were too high, water was allowed to flow over the spillway on the west side of the dam or released through an 18-inch-diameter drainpipe at the base of the dam. The discharged water followed the ravine south to the Tennessee River, approximately 1 mile downstream.

In 1993, the lagoon was regraded, expanding its size from approximately 0.5 acre to approximately 0.6 acre. The purpose of the lagoon expansion was to facilitate the addition of a high-density polyethylene (HDPE) liner. The HDPE material, 0.080 millimeter thick, was designed and manufactured specifically for containment of liquids in hydraulic structures (Parsons, 1999). A containment berm was constructed surrounding the lagoon to prevent surface runoff from entering the lagoon. In addition, an 8-foot-high chain-link fence was installed around the lagoon to prevent unauthorized access.

The site is currently inactive. Test firings are not currently being conducted, although the facility is operational and may resume at any time. The concrete flume is not currently in use. Leaf litter and broken pieces of tree branches are present in the flume, and cracks exist in the concrete base and sidewalls in some places along the flume. Vegetation from outside the flume is growing down into it along various sections. Water levels in the lagoon fluctuate based on precipitation events and evaporation; however, accumulated water is periodically pumped out to maintain the water levels.

1.3.2.3 Geology and Hydrogeology

The lithologic logs of soil from well borings installed at RSA-116 indicate native soils consist of predominantly red-to yellow-brown clays with some silt, sand, and/or limestone fragments. Based on depth of auger refusal, thickness of the overburden ranges from approximately 1 to 24 feet (APTIM, 2020b).

Groundwater beneath the site is entirely within bedrock, and its flow is governed by the orientation and interconnectivity of bedrock fractures. Potentiometric surface maps in this type of flow regime do not necessarily predict flow directions.

Depth to groundwater at RSA-116 in March 2019 ranged from 17.04 feet below ground surface (bgs) at N116-RS463 to 118.96 feet bgs at 116-RS2492; the overall average groundwater depth across all wells at the site and multiple synoptic water level events was 54.41 feet bgs (APTIM, 2020b). December 2014 and March 2019 groundwater data collected at the site show a southwesterly gradient across the site and beneath the lagoon. Regionally, groundwater flow direction at RSA-116 is controlled by topography in the form of steep slopes and ridges, which divert flow to the south-southwest towards the Tennessee River, the regional drain for this aquifer. Groundwater flow in this area is fully discussed in the RSA-156/157 groundwater RFI report (APTIM, 2019) and summarized in the RFI Report for RSA-116 (APTIM, 2020b). Potentiometric surface maps for both groundwater zones are shown on **Figures 1-7** and **1-8**, respectively.

1.4 DOCUMENT ORGANIZATION

This CMI Work Plan is organized into the following six chapters:

- **Chapter 1.0** presents the purpose and overview of the document and includes brief site history and descriptions and environmental setting, including the geology and hydrogeology associated with the sites.
- **Chapter 2.0** presents additional background information about the sites, including investigations and reporting history, nature and extent of contamination, fate and transport, site risks, and the CSM.
- **Chapter 3.0** describes the basis for the action, including the CMO, CGs, and the selected corrective measures.
- **Chapter 4.0** presents the planned CMI activities necessary to complete the corrective measures at RSA-115/ 116.
- **Chapter 5.0** describes the potential for contingencies that could arise during execution of the corrective measures described herein.
- **Chapter 6.0** provides the references that contributed to the preparation of this CMI Work Plan.

The following plans and supporting documentation are included as appendices to this CMI Work Plan:

- **Appendix A:** Mann Kendall Analysis
- **Appendix B:** Risk-Based Target Level Calculations
- **Appendix C:** Groundwater Monitoring Plan
- **Appendix D:** Regulatory Concurrence Letters
- **Appendix E:** Redstone Arsenal RCRA Permit Modification Request
- **Appendix F:** Corrective Measures Implementation Schedule
- **Appendix G:** Quality Control Plan
- **Appendix H:** Site Safety and Health Plan
- **Appendix I:** Notice of Environmental Use Restriction

As the Army implements the corrective measures using support contractors, variations from this CMI Work Plan may be proposed prior to or during field activities. Proposed changes will be submitted by the construction contractor to the Army as field variances for approval prior to implementation as part of the corrective measures process. As part of their approval process, the Army will discuss applicable field variances with ADEM to determine if the variance process is suitable for documenting the proposed changes, or whether revisions to the CMI Work Plan along with a permit modification may be needed. Any variances will be documented and included with the CMI report for the sites.

2.0 INVESTIGATION RESULTS

This chapter presents additional background information for RSA-115/116, including the investigation history, nature and extent of contamination, fate and transport summary, human health and ecological risks, and the final CSM.

2.1 CHRONOLOGY OF RSA-115/ 116 ACTIVITIES

Environmental investigations have been conducted at RSA-115 and RSA-116 since 1991. Since then, the following investigations have been conducted for these sites:

- Visual Site Inspection (Geraghty and Miller, Inc. 1991)
- RFI for RSA-115 and RSA-116 (Parsons, 1995)
- Supplemental RFI for RSA-115 (Parsons, 1997)
- Baseline Risk Assessment for OU-13, OU-12 (RSA-140), and OU-7 (RSA-129 and RSA-58) (Parsons, 1998)
- Focused Feasibility Study for RSA-115 and RSA-116 (Parsons, 1999)
- Basewide spring/seep sampling (Shaw, 2004)
- Redstone Arsenal RCRA Facility Assessment (ADEM, 2008)
- RSA-156/157 Groundwater Unit RFI (APTIM, 2019)
- RSA-115 RFI Report (Revision 3) (APTIM, 2020a)
- RSA-116 RFI Report (Revision 4) (APTIM, 2020b).

Complete discussions of these previous site investigations are available in the RFI Report for each site (APTIM, 2020a,b). A brief summary of their findings is presented in the sections below.

2.1.1 Pre-RFI Investigations

A visual site inspection was conducted at RSA in 1991 to identify, describe, and evaluate potential solid waste management units and areas of concerns (Geraghty and Miller, Inc. 1991). During the inspection, the lagoons at both RSA-115 and RSA-116 were observed to be dry and covered in sparse vegetation. The report concluded that the potential for a release was high on both sites.

A bedrock groundwater monitoring well was subsequently installed in 1991 and sampled by Parsons during a pre-RFI investigation. Phase I and II RFI activities were then performed at the site between 1992 and 1993, including a geophysical survey, installation of an additional bedrock well, surface and subsurface soil samples, and groundwater samples. Results are detailed in the final Phase II RFI Report submitted in February 1995 (Parsons, 1995).

In 1998, Parsons collected additional data to support a Baseline Risk Assessment (BRA) for RSA-116 (Parsons, 1998). No additional samples were needed from RSA-115 to support a BRA or Feasibility Study. A human health risk assessment (HHRA) and environmental risk assessment (ERA) were completed, and no further action was recommended for soil at RSA-115 and RSA-116. The results of the HHRA and ERA did, however, recommend TCE and vinyl chloride as final COCs in groundwater. The FS was subsequently submitted in 1999, indicating preferred alternatives for remedial action were long-term groundwater monitoring and use restrictions at RSA-116 and no further action at RSA-115 (Parsons, 1999).

2.1.2 RCRA Facility Investigations

Multiple RFI activities have been performed at RSA-115/116 since 2008. In 2008 and 2013, these investigation activities were part of a larger investigation of both RSA as a whole (ADEM, 2008) and groundwater units RSA-156/157 (APTIM, 2019). RFI activities specific to RSA-115/116 occurred from 2013 to 2020. The usable data set from those investigation activities and used in the risk assessments in the latest RFI reports for RSA-115/116 included the following:

- For RSA-115:
  - Nine surface soil samples (2014)
  - Nine subsurface soil samples (2014)
  - One spring sample from one location (2017)
  - Thirty-eight (38) groundwater samples:
    - Twenty-three (23) in 2014/2015/2016
    - Five in 2017
    - Six in 2019
    - Four in 2020

- For RSA-116:
  - Sixteen (16) surface soil samples (2013/2014)
  - Thirty-one (31) subsurface soil samples (2013/2014)
  - One spring sample from one location (2017)
  - One stormwater (lagoon) sample (2013)
  - Forty-four (44) groundwater samples:
    - Twenty-seven (27) in 2014/2015/2016
    - Four in 2017
    - Twelve (12) in 2019
    - One in 2020

2.2 NATURE AND EXTENT OF CONTAMINATION

This section summarizes the nature and extent of contaminants in soil, spring water, surface (lagoon) water, and groundwater at RSA-115 and RSA-116. This section draws from the nature and extent analysis contained in the RFI Report for each site (APTIM, 2020a,b).

In general, environmental media samples were analyzed for target compound list (TCL) volatile organic compounds (VOCs), TCL semi-volatile organic compounds (SVOCs), with low-level polycyclic aromatic hydrocarbons (PAHs), explosives, perchlorate, and target analyte list metals. Specific analytes and analytical results are detailed in the RFI Reports (APTIM, 2020a,b). The RFI Reports concluded that data contained therein were adequate for evaluating the nature and extent of contamination at RSA-115/ 116. Only groundwater was identified as a medium of concern at each site; therefore, a more detailed description of data is provided for groundwater, while only a brief summary of the nature and extent of soil, spring water, and lagoon stormwater contamination is presented in this section.

2.2.1 Soil

No metals, VOCs, explosives, or perchlorate were detected at concentrations above their respective PSVs in surface and subsurface soil samples collected in 2013/2014 at RSA-115 and RSA-116. In addition, concentrations of VOCs and SVOCs in soil samples did not exceed RSA-specific dilution-attenuation factor $(DAF)_4$ soil screening levels (SSLs) (Shaw, 2011) at either site.

At RSA-116, two PAHs, benzo(a)pyrene and dibenz(a,h)anthracene, were detected at concentrations exceeding their PSVs. The benzo(a)pyrene concentration exceeded its PSV in one subsurface soil sample and the dibenz(a,h)anthracene concentration exceeded its PSV in two subsurface soil samples collected in the southwest corner of the lagoon (APTIM, 2020b). The exceedances have been laterally and vertically delineated by samples with concentrations below PSVs collected below these sample intervals and from surrounding locations.

2.2.2 Spring Water

Two spring samples were collected at two springs for RFI activities at RSA-115 and RSA-116 in 2017, one each from the throats of Spring RSP-1186 and Spring RSP-1190. Spring water samples were analyzed for VOCs, SVOCs with low-level PAHs, explosives, and perchlorate. All metals were detected at concentrations below BSVs and PSVs or determined to be naturally occurring from the site-to-background comparison. No VOCs, SVOCs, explosives, or perchlorate were detected in spring water samples at concentrations above their respective PSVs.

2.2.3 Lagoon Stormwater (RSA-116)

The lagoon at RSA-115 is usually dry, and no surface water samples were collected from this site.

The lagoon at RSA-116 is an isolated, lined, engineered lagoon that is disconnected from any flowing water body and thus, is not considered as waters of the U.S. or waters of the state. It also lacks the necessary soils and hydric plants to make it a jurisdictional wetland. In addition, it is managed to prevent the development of aquatic communities. Its steep sides, consisting of liner material, do not encourage wildlife use of the lagoon. Accordingly, the water in the lagoon is considered stormwater and the lagoon is not evaluated as a surface water body (APTIM, 2020b).

One stormwater sample was collected from the lagoon at RSA-116 in 2014 and analyzed for VOCs, SVOCs with low-level PAHs, explosives, and perchlorate. None of the analytes were detected at concentrations above the PSVs.

2.2.4 Groundwater

At RSA-115, 34 groundwater samples were collected during RFI groundwater sampling events in May/June 2014, December 2014, April 2016, June/December 2017, and January 2019 from the eight monitoring wells associated with this site and analyzed for metals, VOCs, SVOCs with low-level PAHs, explosives, and perchlorate. Additionally, 10 of the groundwater samples were analyzed for UDMH to evaluate this constituent as a chemical of analytical concern. In April 2020, four samples were collected for analysis of naphthalene only.

At RSA-116, 44 groundwater samples were collected during RFI groundwater sampling events in April/May/December 2013, July 2015, April 2016, June/December 2017, and January/February 2019 from the 11 monitoring wells associated with this site and analyzed for VOCs, SVOCs with low-level PAHs, explosives, and perchlorate. Additionally, four groundwater samples were collected from RSA-116 monitoring wells and analyzed for UDMH to evaluate this constituent as a chemical of analytical concern. In April 2020, one sample was collected for analysis of naphthalene only.

The nature and extent of COC exceedances in groundwater are summarized below. **Figures 2-1** and **2-2** present the detected concentrations of COCs in groundwater by location for RSA-115 and RSA-116, respectively. Data collected between 1992 and 2012 from previous investigations are also included on the figures to present concentration trends. These historical data are not considered to be representative of current conditions and were not used in the ARBCA.

2.2.4.1 Metals

At RSA-115, a total of 26 groundwater samples were collected from monitoring wells between 2014 and 2019 and analyzed for metals. All metals except for aluminum, arsenic, and vanadium in one deep bedrock well (115-RS2411) were present at concentrations below the BSVs and PSVs or were determined to be naturally occurring in the site-to-background comparison. Anomalously high aluminum and vanadium concentrations were detected in one well (115-RS2411). Aluminum and vanadium are used in aerospace alloys, and aluminum is a component of the rocket fuel that was burned during test firing, so these are likely sources for the anomalous concentrations. Emissions from rocket test firing would have mixed with the cooling water discharged to the unlined blowdown lagoon, and that water would have subsequently migrated to groundwater. Although the anomalous concentrations are higher than can be explained as the result of natural processes, they lie well within the background range in terms of absolute concentrations (APTIM, 2020a).

At RSA-116, a total of 28 usable groundwater samples were collected from monitoring wells between 2014 and 2019 and analyzed for metals. All metals except for lead in exit pathway well 152-RS1806b were present at concentrations below the BSVs and PSVs or were determined to be naturally occurring in the site-to-background comparison. The lead concentration detected in well 152-RS1806b (233 micrograms per liter [µg/L]) was determined to be anomalous (APTIM, 2020b). Well 152-RS1806b is located along a regional fault has the potential for historical sourcing from other locations north of RSA-116, including other sites within and adjacent to RSA-156/157 and from the past and current test range activities. This exit pathway well continues to be monitored annually as required by the Permit (ADEM, 2022).

Exceedances of the aluminum, arsenic, and vanadium PSVs were identified in a single well at RSA-115 (115-RS2411). Metals were not detected at concentrations above PSVs in wells at RSA-116. Metals were not detected at concentrations above PSVs in wells or springs downgradient of RSA-115/116 during the most recent sampling events.

2.2.4.2 VOCs

At RSA-115, 34 groundwater samples were collected between 2014 and 2019 and analyzed for VOCs. Sample results indicated that three VOCs (benzene, bromomethane, and TCE) were detected at concentrations above PSVs in wells associated with RSA-115. Benzene and TCE had detections above their PSVs in 2014 in samples collected from RSA-115 wells 115-RS2412 and 115-RS2413, respectively; however, the most recent sample data for these wells (2017/2019) indicate concentrations either below PSVs or non-detect. Bromomethane exceeded its PSV in one groundwater sample in 2019 but is delineated by bromomethane concentrations below the PSV in groundwater samples collected downgradient of that location (APTIM, 2020a).

At RSA-116, 39 groundwater samples were collected between 2014 and 2019 and analyzed for VOCs. Sample results indicated that two VOCs (TCE and 1,1,2,2-TeCA) were detected at concentrations above PSVs in wells associated with RSA-116. Samples from two RSA-116 monitoring wells had 1,1,2,2-TeCA PSV exceedances during the April/May 2014 sampling event, but there were no PSV exceedances in the subsequent December 2014 and 2017/2019 sampling events. Five groundwater samples collected from four RSA-116 monitoring wells had TCE PSV exceedances in the 2014 sampling event but only one sample (collected from well N116-RS405) exceeded the TCE PSV in the 2019 sampling event (APTIM, 2020b).

As shown on **Figures 2-1** and **2-2**, exceedances of PSVs for VOC COCs are identified in four wells at RSA-115 (115-RS2412-benzene; 115-RS2411-bromomethane; 115-RS468 and 115-RS2413 -TCE) and five wells at RSA-116 (N116-RS404, N116-RS404, N116-RS463 – TCE; and N116-RS406, N116-RS433 – 1,1,2,2-TeCA). VOC concentrations in groundwater have been delineated by VOC concentrations below their PSVs in groundwater samples collected from surrounding wells. VOCs were not detected at

concentrations above PSVs in wells or springs downgradient of RSA-115/116 during the most recent sampling events.

2.2.4.3 SVOCs/ PAHs

At RSA-115, 39 groundwater samples were collected between 2014 and 2019 and analyzed for SVOCs with low-level PAHs. Four additional samples were collected in April 2020 for naphthalene analysis only. Two PAHs (naphthalene and benzo[a]anthracene) were detected at concentrations above PSVs but were not detected at concentrations above PSVs in downgradient wells. Two non-PAH SVOCs (pentachlorophenol and bis[2-ethylhexyl]phthalate) were detected at concentrations above PSVs, but all concentrations in site wells were below the PSVs in 2017/2019 sampling events.

- **Naphthalene** - Three site wells and one cross-gradient well (116-RS2493) associated with RSA-115 had naphthalene concentrations exceeding the PSV in January 2019 (out of eight total wells sampled). Four additional samples were collected in April 2020 for naphthalene analysis only for confirmation of the results from wells that exceeded the PSV in January 2019. Naphthalene concentrations in 2020 decreased to the PSV or just slightly above the PSV in three of the four wells.

- **Benzo(a)anthracene** - Three RSA-115 groundwater samples in 2014 had concentrations of benzo(a)anthracene exceeding the PSV. A sample collected from 115-RS2800 in 2016 also exceeded the PSV for benzo(a)anthracene. The most recent sample data for these four RSA-115 wells (2017/2019) had no detections for benzo(a)anthracene.

- **Pentachlorophenol** - Pentachlorophenol was not detected in any groundwater samples in 2014. However, during 2019 sampling, pentachlorophenol was detected at an estimated concentration exceeding the PSV in a single well N115-RS432. Pentachlorophenol is considered to be delineated by groundwater samples collected downgradient of that location with concentrations below detection limits (APTIM, 2020a).

- **Bis(2-ethylhexyl)phthalate** - During 2014 sampling, bis(2-ethylhexyl)phthalate was present in two RSA-115 groundwater samples at concentrations exceeding the PSV (N115-RS468,115-RS2412). Concentrations of bis(2-ethylhexyl)phthalate were either below detection limits or below the PSV in all samples (including the two wells with 2014 exceedances) collected in the most recent 2017/2019 sampling events.

At RSA-116, 39 groundwater samples were collected between 2014 and 2019 and analyzed for SVOCs with low-level PAHs. One additional sample was collected in April 2020 for naphthalene analysis only. Two PAHs (naphthalene and benzo[a]anthracene) and one non-PAH SVOC (bis[2-ethylhexyl]phthalate) were detected at concentrations above PSVs but were not detected at concentrations above PSVs during the most recent sampling events.

- **Naphthalene** - Five site wells associated with RSA-116 had naphthalene concentrations exceeding the PSV in January 2019. One of these wells (116-RS2493) was resampled in April 2020 for naphthalene analysis only for confirmation of the results from 2019. The naphthalene concentration in 2020 decreased below the PSV.

- **Benzo(a)anthracene** - One RSA-116 groundwater sample in 2014 had a concentration of benzo(a)anthracene exceeding the PSV (N116-RS433). The most recent sample data for RS-116 (2017/2019) had no detections for benzo(a)anthracene.

- **Bis(2-ethylhexyl)phthalate** - During 2014 sampling, bis(2-ethylhexyl)phthalate was present in a sample collected from well 116-RS2492 at a concentration exceeding the PSV. Bis(2-ethylhexyl)phthalate was not detected in samples collected in the 2017/2019 sampling events.

As shown on **Figures 2-1** and **2-2**, exceedances of PSVs for SVOC COCs are identified in seven wells at RSA-115 and seven wells at RSA-116. SVOC concentrations in groundwater have been delineated by SVOC concentrations below their PSVs in groundwater samples collected from surrounding wells. SVOCs were not detected at concentrations above PSVs in wells or springs downgradient of RSA-115/116 during the most recent sampling events.

2.2.4.4 Explosives

At RSA-115, 34 groundwater samples were analyzed for explosives between 2014 and 2019. Six explosive-related compounds (1,3-DNB, 2,6-DNT, 2-NT, 3-NT, nitrobenzene, and nitroglycerin) were detected at concentrations above the PSVs. Concentrations of nitroglycerin exceeded the PSV in one sample collected in June 2014 but were below detection limits in all site wells in 2019.

At RSA-116, 39 groundwater samples were analyzed for explosives between 2014 and 2019. Six explosive-related compounds (1,3-DNB, 2,6-DNT, 2-NT, 3-NT, nitrobenzene, and nitroglycerin) were detected at concentrations above the PSVs.

Figures 2-1 and **2-2** present detections of explosive compounds COCs in RSA-115 and RSA-116 wells. Explosives exceedances of PSVs are identified in five wells associated with RSA-115 and six wells associated with RSA-116. Explosives concentrations in groundwater have been delineated by the results from the most recent sampling events at RSA-115/116 site wells and downgradient monitoring wells and springs. Explosives were not detected at concentrations above PSVs in wells or springs downgradient of RSA-115/116 during the most recent sampling events.

2.2.4.5 Perchlorate

At RSA-115, 34 groundwater samples were collected for perchlorate analysis between 2014 and 2019. Perchlorate was not detected in any groundwater wells at RSA-115 at concentrations above its PSV in samples collected between 2014 and 2019. Historically, samples from one well (115-RS468) had concentrations of perchlorate above the PSV.

At RSA-116, 39 groundwater samples were collected for perchlorate analysis between 2014 and 2019. Perchlorate was detected at a concentration above its PSV in one well (116-RS2493) in 2019 in samples collected between 2014 and 2019.

Figures 2-1and **2-2** present detections of perchlorate in RSA-115 and RSA-116 wells. Perchlorate exceedances of PSVs are identified in one well associated with RSA-115 and one well associated with RSA-116. The PSV exceedances in groundwater at RSA-115 and RSA-116 have been delineated by perchlorate concentrations below the PSV in downgradient wells and springs. Perchlorate was not detected at concentrations above PSVs in wells or springs downgradient of RSA-115/116 during the most recent sampling events.

2.2.4.6 UDMH

At RSA-115, 10 groundwater samples were collected in 2014, 2015, and 2016 and analyzed for UDMH.

At RSA-116, four groundwater samples were collected in 2015 and analyzed for UDMH.

UDMH was not detected in any of the groundwater monitoring wells at RSA-115 or RSA-116. However, the analytical detection limit for UDMH exceeds its PSV.

2.3 CONTAMINANT FATE AND TRANSPORT SUMMARY

2.3.1 Soil

The detailed fate and transport evaluations for analytes detected in RSA-115 and RSA-116 soil samples are presented in the RFI Reports for each site (APTIM, 2020a,b). For all non-naturally occurring analytes detected above the RSA-specific DAF_4 SSLs (Shaw, 2011) in soil, the following additional weight-of evidence evaluations were performed:

- Presence or absence of an exceedance in groundwater
- Magnitude of exceedances in soil
- Frequency of exceedances in soil
- Spatial distribution of exceedances

Based on the results of the soil-to-groundwater migration evaluation, no further evaluation of any constituent detected in soil is warranted (APTIM, 2020a,b). These results indicate that constituents detected in soil at RSA-115 and RSA-116 do not pose a threat to groundwater from the soil-to-groundwater migration pathway.

2.3.2 Groundwater

Since the sites have been out of operation, the primary migration pathway moving contamination from the groundwater source zone has been advective flow through shallow and deep aquifer zones. Groundwater contaminant mass and concentration are reduced over time due to natural attenuation, consisting of the combined effects of physical/ abiotic attenuation mechanisms (adsorption, dilution, and sorption) and biotic attenuation.

- ***Physical/ Abiotic Attenuation Mechanisms***: Generally, dilution and dispersion cause a net decrease in contaminant concentrations at each location over time through the flow of groundwater carrying contaminant mass further from the source area. As the plume area expands, varying amounts of contaminant mass can be adsorbed to the surface of the saturated medium, with contaminants having a higher affinity to organic matter or clay minerals sorbing more productively. The degree of overall concentration reduction depends on the groundwater velocity and rate of mixing. Other abiotic processes include chemical reduction/ oxidation, dehydrochlorination, dichloroelimination, hydrolysis, hydrogenolysis, or other similar processes.
- ***Biotic/ Biochemical Attenuation Mechanisms***: Biotic attenuation mechanisms refers to a collective of naturally occurring reactions by microorganisms living within the immediate environment containing the contaminant that result in the attenuation of contaminant mass. These naturally occurring reactions can be both aerobic and anaerobic in nature.

Groundwater COCs at RSA-115/116 are expected to attenuate over time due to their relatively low concentrations and sporadic CG exceedances. The primary attenuation mechanism for the groundwater COCs at RSA-115/116 is expected to be physical attenuation (adsorption, dilution, and sorption).

To evaluate trends in COC concentrations in groundwater, a Mann-Kendall trend analysis was performed using groundwater analytical data collected between 1991 and 2020 at RSA-115 and RSA-116 monitoring wells. As stated above, detections of most of the COCs are sporadic, CG exceedances are not widespread, and there are no mappable plumes. TCE was selected for the trend analysis because historically it had the greatest number of locations with detections greater than the PSVs. TCE concentrations have been generally low over time, and the greatest concentrations of TCE were detected at the sites eight or more years ago.

Mann-Kendall analysis is a non-parametric test for linear trend that involves listing the concentrations in temporal order and computing all differences that may be formed between a given measurement and earlier measurements. The test statistic (sum of trend, S-value) is the difference between the number of strictly positive differences and the number of strictly negative differences. If there is an underlying increasing trend, then these differences will tend to be positive, indicated by a sufficiently large positive S-value. If there is an underlying decreasing trend, the S-value tends to be negative. The p-value of the correlation provides a measure of the level of significance of the statistical test. Correlations were accepted as statistically significant for p-values less than or equal to 0.05 (95% confidence level).

Results of the Mann-Kendall statistical analyses performed on TCE data are shown in **Appendix A**. Results indicate:

- At RSA-115, monitoring wells screened in bedrock (N115-RS419 and N115-RS468) and in deep bedrock (115-RS2413 and N115-RS432) do not have a statistically significant trend based on the data available, but typically exhibit negative S-values (-1 to -8) where there are six or more data points available. TCE concentrations at the four monitoring wells included in the analysis have been below the CG since late 2014. TCE concentrations are anticipated to remain low and trends to remain generally stable over time.
- At the five RSA-116 monitoring wells screened in bedrock that were analyzed (N116-RS404, N116-RS405, N116-RS406, N116-RS434, and N116-RS463), there was no statistically significant trend detected at four locations and a "Probably Decreasing" trend at one location (N16-RS406). The S-values associated with the analysis results for all but one of the five locations are very negative (-8 to -24), indicating that generally the concentrations of TCE in bedrock groundwater at RSA-116 are decreasing. One location, N116-RS463 has "No Trend" with a positive S-value of 7. The greatest concentration of TCE detected at this location was 116 µg/L in September 2014. The most recent two results for TCE at this location were non-detect (July 2015) and 43.5 µg/L in December 2017. TCE will continue to be monitored at this location and trend analysis performed under an MNA program.
- In two deep bedrock monitoring wells at RSA-116, there is a strongly decreasing (at 99.8% confidence) trend at N116-RS433 and "No Trend" with a negative S-value of 9 at N116-RS464. The greatest concentration of TCE detected at N116-RS464 was 163 µg/L in October 2011. TCE has been below the CG when analyzed ever since that date (November 2012, April 2014, December 2014, and February 2019) and is likely to remain low.

The Mann-Kendall analysis results indicate that TCE concentrations in groundwater at RSA-115 and RSA-116 are low and are generally decreasing or likely to remain relatively stable over time.

2.4 SITE RISK

An ARBCA evaluation for human health and a SLERA were performed for RSA-115 and RSA-116 as part of their respective RFI Reports (APTIM, 2020a,b). These evaluations are summarized below in **Sections 2.4.1** through **2.4.3**. The complete ARBCA evaluations for human health and the SLERAs are provided in the RFI reports.

2.4.1 Current and Potential Future Land and Resources Use

The RSA Master Plan identifies the current and future land use for RSA-115 and RSA-116 as industrial. Both sites largely consist of lagoons that formerly received discharges of rocket motor cooling water. Both sites are currently inactive.

The current use of RSA-115/116 is not residential, nor is it expected to be in the future. The residential scenario was included in the ARBCA evaluations to determine whether these sites are eligible for

unrestricted reuse in accordance with ADEM requirements. In RSA's RCRA Permit, ADEM has specified that investigations must comply with the AEIRG (ADEM, 2017b) and ARBCA guidance (ADEM, 2017a). To determine whether these sites are eligible for unrestricted reuse as defined in Alabama Administrative Code 335-5, risks to a residential site user were assessed.

2.4.2 Human Health ARBCA

The human health risk assessments for RSA-115 and RSA-116 were prepared and presented in the RFI Reports (APTIM, 2020a,b) in accordance with the ARBCA guidance (ADEM, 2017a). Each assessment consists of a three-tiered process, as follows:

- Preliminary screening level (PSL) evaluation (first tier), which involves comparing the maximum detected concentrations (MDC) of constituents of potential concern (COPCs) with PSVs. Constituents with MDCs that exceed their PSVs are designated COCs and carried to the next tier.
- Risk Management (RM)-1 evaluation (second tier); which involves a cumulative risk assessment based on ADEM (2017a) default risk models and exposure assumptions. The RM-1 evaluation was not performed for RSA-115 and RSA-116; instead, the evaluation proceeded directly to the RM-2 (tier 3) evaluation.
- RM-2 evaluation (third tier), which is similar to the RM-1 evaluation but permits the application of regulator-approved site-specific risk models and exposure assumptions.

The PSL evaluation consists of a simple comparison of site concentrations with PSVs, which accomplishes risk-based screening for direct exposure pathways and is conducted for all constituents that are determined to be site related. Inorganics with MDCs that do not exceed their BSVs or are shown in a site-to-background evaluation to be naturally occurring, are judged as not site related and are not evaluated further (Shaw, 2013). Detected organic constituents are subject to PSL evaluation. A substance was identified as a COC if the MDC was greater than its PSV. The protocol for the PSL evaluation is described in the RFI Reports for each site (APTIM, 2020a,b) and the Installation-Wide Work Plan (Shaw, 2010a).

The PSVs for soil were the USEPA (2018a) Regional Screening Levels (RSLs) based on the lower of the individual excess lifetime cancer risk (IELCR) of 1×10^{-6} or the noncancer hazard index (HI) of 0.1. Residential PSVs were selected for the RSA-115 and RSA-116 evaluations in accordance with ARBCA guidance (ADEM, 2017a) to consider corrective measures alternatives (CMAs) that would allow unrestricted land use. The PSVs for groundwater were USEPA maximum contaminant levels (MCLs) (USEPA, 2018b), if available. For analytes without MCLs, the PSVs were the USEPA tap water RSLs (USEPA, 2018a). It should be noted that the Army does not normally use MCLs in a contaminant-screening capacity. However, MCLs were used in the subject assessment to comply with AEIRG and ARBCA guidance.

The MDCs of all COPCs in soil at RSA-115 and RSA-116 fell below their PSVs; therefore, no constituents in soils were identified as COCs.

The identified groundwater COCs were brought forward for evaluation in cumulative risk assessments (RM-2 evaluations). The protocol for the RM-2 cumulative risk evaluation is presented in the RFI Reports for each site (APTIM, 2020a,b). Receptor scenarios evaluated in the cumulative risk assessment included a commercial worker, a construction worker, and a hypothetical residential receptor. Although RSA's current mission makes residential site use unlikely, a hypothetical future residential receptor was evaluated for both sites as required by ADEM (2017a) to evaluate if the site is eligible for unrestricted use as defined in Alabama Administrative Code 335-5-1-.03(r) or if LUCs will be needed as a component of the selected remedy. Groundwater was evaluated as if it were developed as a source of potable water in the future.

2.4.2.1 ARCBA Conclusions for RSA-115

No hazards or risks were estimated for soil, as no COCs in soil were identified in the PSL evaluation.

As mentioned previously, groundwater does not pose a current threat at RSA-115 because development of groundwater at the site as a potable source is precluded. However, the RM-2 evaluation (APTIM, 2020a) determined that corrective measures are warranted for the groundwater underlying RSA-115 because the MDCs for the following COCs exceed their PSVs and/or the COCs pose unacceptable risks to hypothetical future receptors if the groundwater is developed for potable use:

- Arsenic
- Perchlorate
- 2,6-DNT
- 2-NT
- Bis(2-ethylhexyl)phthalate
- Naphthalene
- Pentachlorophenol
- Benzene
- TCE
- UDMH is identified as a COC because the laboratory detection limit exceeds the PSV.

The following constituents were identified as COCs because the MDC for each exceeded its PSV and/or BSV. However, none were determined to be a risk driver in the cumulative risk assessment.

- Aluminum
- Vanadium
- 1,3-DNB
- 3-NT
- Nitrobenzene
- Nitroglycerin
- Bromomethane
- Benzo(a)anthracene.

2.4.2.2 ARBCA Conclusions for RSA-116

During the PSL evaluation for RSA-116, two constituents with concentrations exceeding their PSVs (benzo[a]pyrene and dibenz[a,h]anthracene) were identified as soil COCs for RM-2 evaluation. The RM-2 evaluation concluded that exposure to soil alone does not pose an unacceptable health threat to the commercial worker, construction worker, or hypothetical residential receptor by direct exposure pathways; therefore, no further action is needed for soil at RSA-116 (APTIM, 2020b).

As at RSA-115, groundwater does not pose a current threat at RSA-116 because development of groundwater at the site as a potable source is precluded. However, the RM-2 evaluation (APTIM, 2020b) determined that corrective measures are warranted for the groundwater underlying RSA-116 because the

MDCs for the following COCs exceed their PSVs and/or the COCs pose unacceptable risks to hypothetical future receptors if the groundwater is developed for potable use:

- Perchlorate
- 2-NT
- Bis(2-ethylhexyl)phthalate
- 1,1,2,2-TeCA
- TCE
- UDMH is also identified as a COC in groundwater because its detection limit exceeds the PSV.

The following constituents were identified as COCs because the MDC for each exceeded its PSV and/or BSV. However, none were determined to be a risk driver in the cumulative risk assessment.

- 1,3-DNB
- 3-Nitrotoluene
- Nitroglycerin
- Nitrobenzene
- Naphthalene

2.4.3 Screening-Level Ecological Risk Assessment

SLERAs were completed for RSA-115 and RSA-116 as part of the RFI Reports for each site (APTIM, 2020a,b). The SLERA for RSA-115 was conducted in accordance with the guidelines set forth in the ARBCA guidance manual (ADEM, 2017a), the Redstone Arsenal Installation-Wide Work Plan (IT, 2002), and final SLERA supplements to the Installation-Wide Work Plan (Shaw, 2010a). The Army and the USEPA frequently find preparation of a SLERA unnecessary for very small sites (less than 2 or 3 acres in size) because these sites do not support populations of those species for which site cleanups could realistically proceed. SLERAs were performed for RSA-115 and RSA-116 to comply with administrative requirements and to determine whether these sites are eligible for no further action in accordance with ADEM requirements.

2.4.3.1 SLERA Results for RSA-115

An initial comparison of the detected constituent concentrations to ecological screening values (ESVs) and BSVs identified three metals (calcium, potassium, selenium) and 3-NT as preliminary constituents of potential ecological concern (COPECs) that required further assessment. All of the other constituents detected in surface soil at RSA-115 were detected at concentrations less than their respective ESVs and/or BSVs and determined to pose negligible ecological hazards. The COPEC refinement process concluded that the metals are likely naturally occurring and/or background related and do not require further evaluation. In addition, 3-NT does not require further evaluation based on the low concentration detected in one surface soil sample that represents an area that comprises approximately 6% of the total area of RSA-115, which is not an ecologically significant area.

The SLERA concluded that no ecological hazards were present and further evaluation ecological hazards at RSA-115 was not warranted (APTIM, 2020a).

2.4.3.2 SLERA Results for RSA-116

The RSA-116 lagoon is an isolated, lined, engineered lagoon that is disconnected from any flowing water body. It lacks the necessary soils and hydric plants to make it a jurisdictional wetland and is managed to prevent the development of aquatic communities. Its steep sides do not encourage wildlife use.

An initial comparison of the detected constituent concentrations to ESVs and BSVs identified nine metals, diethyl phthalate, and di-n-butyl phthalate as preliminary COPECs that required further assessment. The COPEC refinement process concluded that all of the metals COPECs were likely naturally occurring and/or background related and did not require further evaluation. The SLERA concluded that diethyl phthalate and di-n-butyl phthalate did not require further evaluation in the SLERA because they are not within the CSM for the site and are not considered to result from previous site operations.

The SLERA concluded that no ecological hazards were present and further evaluation of ecological hazards at RSA-116 was not warranted (APTIM, 2020b).

2.5 CONCEPTUAL SITE MODELS

CSMs were developed for both RSA-115 and RSA-116 during the RFIs based on historical information, soil and groundwater data, and available site information. **Figures 2-3** and **2-4** present a visual representation of RSA-115 and RSA-116, respectively, listing potential contaminants, their likely sources, possible migration pathways, hypothetical receptors, and potentially impacted media. The potential release locations and potential contaminant types in groundwater include the following:

- Release of cooling water discharged from rocket engine test firing containing perchlorate, VOCs, explosives, metals, SVOCs/PAHs, and UDMH from the unlined lagoons in RSA-115 and RSA-116
- Release of cooling water discharged from drainage pipe/ outfall locations at RSA-116

As presented on **Figures 2-3** and **2-4**, potential receptors could be exposed to contaminated groundwater. Current human receptors are limited to commercial and construction workers. Future potential receptors include all current receptors plus, under a residential land reuse scenario, hypothetical child and adult residents.

3.0 DECISION SUMMARY

The RFI reports for RSA-115 and RSA-116 (APTIM, 2020a,b) concluded that the Army's historical operations at these sites have resulted in releases of small amounts of contaminants in surface media that pose no leaching threat to groundwater or unacceptable threat to human health or the environment. COCs are present in groundwater beneath the sites and pose unacceptable risks if groundwater were to be used as a source of potable drinking water. This chapter identifies the CMO based on the results of the RFIs and provides CGs that can be used in evaluating alternatives that rely on reduction in concentrations to achieve the CMO.

3.1 BASIS FOR THE ACTION

A fate and transport evaluation, a HHRA ARBCA evaluation, and a SLERA were performed as part of the RSA-115 and RSA-116 RFI Reports (APTIM, 2020a,b). The RFI Reports concluded that future potable use of groundwater from RSA-115/116 could potentially pose an unacceptable threat to human health. While there is no current potable use of groundwater at RSA-115/116 and such use is currently controlled by LUCs, future potable use of groundwater must be considered in the ARBCA process to ensure protectiveness of the remedy and to promote resource conservation (ADEM, 2017). Corrective actions are therefore needed to address groundwater at RSA-115/116.

3.1.1 Corrective Measure Objective

Based on the results of the RFI Reports for each site (APTIM, 2020a,b), the CMO for both RSA-115 and RSA-116 is to:

- Prevent human exposure to site groundwater contaminated with COCs that exceed their groundwater CGs via any exposure route (ingestion, inhalation, or dermal contact).

3.1.2 Applicable Regulations

In considering corrective measures, various laws and regulations (state and federal) may apply. Consideration of applicable laws and regulations may affect the alternative evaluation and selection. The following laws and regulations relevant to RSA groundwater and its potential for potable use are:

- Safe Drinking Water Act of 1974 non-zero MCL goals and MCLs (40 Code of Federal Regulations [CFR] Part 141).
- Alabama MCLs (ADEM Administrative Code r. 335-7-2).

Federal MCLs have generally been adopted by Alabama. As a result, Federal MCLs are used as CGs for groundwater unless superseded by a State MCL. When a contaminant does not have a Federal or State MCL, a CG is developed based on risk as discussed below in **Section 3.1.4**.

Other laws and regulations may affect alternative evaluation and selection. **Table 3-1** lists federal and state guidance and regulations that may potentially be applicable to the RSA-115/116 corrective measures.

3.1.3 Identification of the Area and Volume of Contaminated Media Requiring Corrective Measures

Historical COC PSV exceedances in groundwater are presented on **Figures 2-1** and **2-2.** The distribution of groundwater COC PSV exceedances indicates the following:

- PSV exceedances for metals constituents are limited to one deep bedrock well in RSA-115 (115-RS2411), with no PSV exceedances in wells or springs downgradient of RSA-115/ 116.

- Perchlorate exceedances of the PSV are limited to one well associated with RSA-115 and one well associated with RSA-116. Perchlorate was not detected at concentrations above its PSV in wells or springs downgradient of RSA-115/116 during the most recent sampling events.
- VOC, SVOC/ PAH, and explosives PSV exceedances have been reported in multiple wells across both RSA-115/ 116, with no detections above PSVs in downgradient wells or springs.

3.1.4 Cleanup Goals for the Corrective Measures

CGs are risk-based target levels that are protective of human health and the environment. As noted in **Section 3.1.2**, Federal MCLs have generally been adopted as CGs for those substances that have them, which include arsenic, bis(2-ethylhexyl)phthalate, benzene, pentachlorophenol, and TCE in groundwater at RSA-115/116. The CG for perchlorate is based on the MCL of 15 µg/L. CGs for the remaining constituents are based on risk considerations. The risk-based CGs for RSA-115/116 were developed in accordance with ADEM guidance, where an IELCR of 1E-05 is assumed for the target cumulative cancer risk level and an HI of 1.0 is assumed as the target hazard limit (ADEM, 2008).

The USEPA RSL calculator was used to calculate CGs based on potable use of groundwater. Tapwater RSLs based on a target IELCR of 1E-06 and hazard quotient (HQ) of 0.1 were used in the initial calculation. Next, the tapwater RSLs were used to calculate risk-based target levels (RBTLs). The initial IELCR of 1E- 06 was multiplied by the number of carcinogens (number of risks) and the HQ of 0.1 was multiplied by the number of noncarcinogens using the ratio approach (Method 3) outlined in the ADEM ARBCA guidance using the following equations to achieve a cumulative risk of 1×10^{-5} and a target noncarcinogenic HI of 1:

$$RBTL_{coc} = \underline{T}apwater\ RSL_{coc}/1E\text{-}06 \times 1E\text{-}05/Number\ of\ risks$$

and

$$RBTL_{coc} = \underline{T}apwater\ RSL_{coc} \times 10/Number\ of\ noncarcinogens$$

The results of the calculations are included in Appendix B. As discussed above, federal MCLs have generally been adopted by Alabama and have been used as CGs for groundwater for constituents with MCLs. The CG for perchlorate is 15 µg/L. For constituents without MCLs, the RBTLs were calculated using the equations identified above. The "number of risks or number of noncarcinogens" were modified from the initial calculations by subtracting the number of COCs with MCLs. **Table 3-2** summarizes the results. The derivation of CGs for RSA-115/116 groundwater COCs is presented in Appendix B.

3.2 SCOPE AND ROLE OF THE RESPONSE ACTION

The environmental concerns at RSA are extremely complex, with work underway at over 300 sites in RSA's Installation Restoration Program. To ensure protection from exposure to potentially contaminated groundwater under these sites and elsewhere on RSA, an Installation-Wide Groundwater (IWGW) Interim Record of Decision (IROD) has been approved for LUCs (Shaw, 2007 and 2009b). This IROD selected LUCs for groundwater as the interim remedy. LUCs have been implemented to prevent potable use of groundwater and manage non-potable uses such that exposure to contaminated groundwater is minimized (Shaw, 2009b). The IROD LUCs are interim in nature and will remain in place for the groundwater under RSA-115/116 until a final remedy has been selected in the Decision Document for RSA-115/116. In accordance with the provisions of the IWGW IROD, as implemented via Army's Site Access Control (SAC) program, the installation of wells for drinking water is prevented on sites without a final remedy, and all requests for the installation of wells for industrial processes or agricultural purposes on RSA are subject to Army review and approval.

The overall strategy for cleanup at RSA has been presented to the regulators in two cleanup strategy documents, the IWGW Cleanup Strategy (Shaw, 2009a) and the Installation-Wide Strategy for Cleanup of Impacted Wetlands (Shaw, 2010b). The overall RSA cleanup strategy includes the following elements:

1) Expedite evaluation and release of surface media sites to allow for efficient, mission-related property reuse.
2) Expedite cleanup of sources area at surface media sites and secondary sources of ongoing groundwater contamination, including dense non-aqueous phase liquids.
3) At SWMUs without approved decision documents, exposures to surface media will be managed through the use of the Army's SAC program, and exposure to groundwater that may result in unacceptable risks will be prevented or managed as required by RSA's IWGW IROD.
4) Coordinate the evaluation of groundwater units and their associated surface sites so that approval of groundwater RFIs is not delayed by unresolved surface media site issues.
5) Design and implement an installation-wide monitoring network to monitor remedial progress and ensure that the selected remedies are protective of human health and the environment on a long-term basis.

The corrective measures for RSA-115/ 116 are consistent with this strategy. The selected remedy will provide protection of human and ecological receptors and achieve the CMO by maintaining the existing LUCs that prohibit potable use of groundwater at RSA-115/116. Upon attainment of the CGs for the COCs in groundwater, the proposed corrective measures will result in a no further action status for RSA-115/116.

3.3 CORRECTIVE MEASURES EVALUATION AND SELECTION

The following information summarizes the screening of technologies, potential alternatives, and selection of the corrective measures for groundwater at RSA-115/ 116.

3.3.1 Corrective Measures Technology Screening

To address the site-related COCs identified as requiring action in groundwater at RSA-115/116, the following technologies are considered and discussed in detail in the following subsections:

- No Action
- Monitored Natural Attenuation (MNA)
- LUCs
- In Situ Enhanced Biodegradation (ISEB)
- In Situ Chemical Oxidation (ISCO).

3.3.1.1 No Action

No action means that no corrective measures, engineering or administrative controls, or monitoring would be taken to address site hazards. Given the existing site conditions at RSA-115/116, "no action" would not meet the stated CMO, and therefore is not an effective alternative. However, this alternative is retained to establish a baseline for the comparison of anticipated hazard reduction and costs to other retained alternatives.

3.3.1.2 Monitored Natural Attenuation

Natural attenuation refers to naturally occurring processes that act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in a particular environmental medium. Natural attenuation processes include biodegradation, dispersion, dilution, adsorption, volatilization and chemical or biological stabilization or destruction of contaminants (Interstate Technology and Regulatory Council [ITRC] 2007). MNA is implemented to track the natural attenuation processes and their effectiveness in achieving the CMO for a site. MNA is more likely to be accepted as a corrective measure by regulatory authorities when the following conditions are met (USEPA 2004):

- Natural attenuation processes can achieve the groundwater CMO within a reasonable timeframe (e.g., within 30 years).
- Measures for source control of groundwater contamination will be implemented.
- The dominant natural attenuation process causes degradation or destruction of contaminants as opposed to their dilution or containment.
- The contaminant plume is stable in size or shrinking.
- MNA is used in conjunction with an active remedy or as a follow-up measure.

Because the source of groundwater contamination (i.e., rocket motor testing) has been stopped and data indicates that COC concentrations are decreasing, MNA will be retained for CMA development as a potentially cost-effective remedial technology.

3.3.1.3 Land Use Controls

LUCs include engineering and physical barriers, such as fences and security guards, as well as institutional controls. LUCs are used to control and minimize potential exposure to contamination and/or protect the integrity of a response action. LUCs are typically designed to work by limiting land and/or resource use or by providing information or notifications to modify or guide human behavior at a contaminated site (USEPA 2012). LUCs can include legal restrictions such as those involving real estate interests, governmental permitting, zoning, public advisories, deed notices, and physical restrictions including engineered barriers such as fences or concrete pads, or by human means, such as security guards. LUCs can be effective as long as they are maintained and enforced. LUCs are most effective when they are layered; multiple LUCs are implemented to provide overlapping levels of protection from contamination (USEPA 2004). Administrative controls currently in place include the installation-wide groundwater IROD and the Redstone Arsenal Environmental SAC Program (U.S. Army Garrison-Redstone 2012). Physical restrictions include fencing around the facility border, which is manned by the Army.

For sites where final corrective measures have not been selected for groundwater, including RSA-115 and RSA-116 under groundwater operable units RSA-156/157, Army, ADEM and the USEPA have selected interim measures in an IROD for installation-wide groundwater (Shaw 2007). The interim measure objectives of the IROD are to prevent the use of groundwater as drinking water, control its use for non-potable uses, and facilitate coordination with local government agencies regarding the use of groundwater in off-post locations adjacent to Redstone Arsenal (Shaw 2007). The IROD has been implemented using Redstone Arsenal's Environmental SAC Program (U.S. Army Garrison-Redstone 2012).

As part of the corrective measures at RSA-115/116, LUCs preventing potable use of groundwater and managing non-potable uses may be implemented. These provisions will be identical to those selected in the Redstone Arsenal's installation-wide groundwater IROD. The SAC program is an institutional management tool that will remain in place as long as Army operation of the facility continues. However, the cost to maintain the LUCs specified by the SAC program will transition to the site once it enters the cleanup phase of the project.

LUCs will be retained for CMA development because it is a potentially cost-effective technology when coupled with monitoring, containment, or treatment technologies.

3.3.1.4 In Situ Enhanced Biodegradation

ISEB is implemented by injecting a carbon substrate and other additives into groundwater to create geochemical conditions that promote the biological conversion of organic contaminants to less toxic compounds. Biostimulation is the injection of a carbon substrate without microorganisms. Bioaugmentation is the injection of microorganisms. Other additives, such as nutrients and pH buffers, are sometimes injected with the carbon substrate to enhance the rate of biodegradation. ISEB can occur under aerobic or anaerobic conditions.

ISEB is unlikely to be effective at RSA-115/116 because contaminated groundwater occurs within the fractured bedrock and it would be difficult to achieve adequate contact between contaminants and remediation chemicals. Active treatment of the relatively low concentrations of COCs at either site would not be cost or technically effective. Contaminants are likely trapped in the secondary porosity of the rock formation, and bioremediation substrate would either be difficult to inject into areas of low hydraulic conductivity or would be transported away in fractures with higher groundwater transport velocities. For all the above reasons, ISEB technology would have low effectiveness and will not be retained for CMA development for groundwater contamination at RSA-115/116.

3.3.1.5 In Situ Chemical Oxidation

ISCO is a widely used technology for the treatment of chlorinated solvents. Catalyzed hydrogen peroxide, ozone, sodium, and potassium permanganate, and activated sodium persulfate are all potential oxidants for the treatment of organic compounds including TCE (ITRC 2005). Permanganate is often the preferred oxidant due to its ease of use; it is a selective oxidant (less reactive with naturally occurring and nontarget constituents present in soil and aquifer materials), relatively persistent compared to some other oxidants, water soluble, and stable at neutral pH, and does not require activation like peroxide and persulfate (USEPA 2006).

ISCO is unlikely to be effective at RSA-115/116 for the same reasons provided above for ISEB. It would be difficult to get sufficient contact between contaminants and treatment chemicals due to the bedrock geology. Treatment of the relatively low concentrations of COCs at either site would not be particularly cost-effective. For all the above reasons, ISCO technology would have low effectiveness and will not be retained for CMA development for groundwater contamination at RSA-115/116.

3.3.1.6 Summary

Active corrective actions are not considered cost-effective due to the relatively low concentrations and isolated occurrence of COCs in the complex fractured bedrock at RSA-115/116. The technology screening retained no action, MNA, and LUCs as the viable technologies to develop CMAs for addressing the groundwater contamination at these sites.

3.3.2 Description of Corrective Measures Alternatives

The results of the technology screen in **Subsection 3.3.1** were used to develop two CMAs to address the groundwater COCs for RSA-115/116:

- **Alternative 1** – No Action
- **Alternative 2** – MNA with LUCs

3.3.2.1 Alternative 1- No Action

Under the no-action alternative, no active corrective measures would be taken to address the site-related COCs present in groundwater. Because this alternative would not be protective of human health and the environment, it is not considered eligible to be selected as the final corrective measure for RSA-115/116. Evaluation of the no action alternative will serve as a baseline for evaluating other CMAs.

3.3.2.2 Alternative 2- MNA with LUCs

Alternative 2 would protect human health by continuing the LUCs currently in place. The LUCs would continue to prevent exposure to groundwater until the concentrations of COCs were reduced to the groundwater CGs. Available data indicate that the present groundwater concentrations do not pose an unacceptable risk to current receptors. The monitoring program implemented under the MNA component of the alternative would track the progress of natural attenuation processes in reducing COC concentrations until CGs were attained.

Fifteen monitoring wells were selected for the monitoring program based on previous detections of PSV exceedances. After five years of monitoring, groundwater monitoring at RSA-115/116 would be combined with monitoring at associated underlying groundwater units (RSA-156 or RSA-157) if CGs have not been met within that timeframe.

3.3.3 Selection of Corrective Measures for RSA-115/ 116

Alternative 2 (MNA with LUCs) is recommended as the corrective measure for groundwater contamination at RSA-115/116 because site-related COCs in groundwater were detected at the sites at relatively low concentrations, and CGs for these COCs are expected to be met in a reasonable timeframe.

To meet the CMO identified for RSA-115/116, Alternative 2 would consist of groundwater LUCs and groundwater MNA. A proposed schedule of the implementation of Alternative 2 consists of the following:

- Establishment of LUCs.
- Year 0 – One baseline groundwater sampling event to establish current groundwater conditions.
- Years 1 and 2 – Semiannual groundwater monitoring and reporting. Groundwater monitoring would begin approximately six months after completion of the baseline groundwater sampling event. During years 1 and 2, the 15 wells identified for monitoring would be sampled on a semiannual basis. A data summary report would be submitted after each sampling event and a detailed analysis would be presented in an annual report. With approval from ADEM, a permit modification may be requested to modify the sampling frequency or analyte list based on sampling results and in accordance with Permit Condition I.J. (ADEM, 2022); subsequent years in the proposed schedule are contingent upon Department approval of sampling frequency reduction based on data received.

- Years 3 to 5 – Annual groundwater monitoring and reporting. Groundwater monitoring would be conducted annually for all COCs. A detailed data summary and analysis would be presented in an annual report.

- Post Year 5 – Groundwater monitoring at RSA-115/116 would be combined with monitoring at associated underlying groundwater units (RSA-156 or RSA-157) assuming that the Corrective Measures Implementation Plan for the groundwater units will have been approved by ADEM.

LUCs would be implemented under this CMA in accordance with Alabama Administrative Code (AAC) 335-5 (ADEM, 2013) to prevent potable use of groundwater and manage non-potable uses such that exposure to contaminated groundwater is minimized. The Army's SAC program would be used to implement the LUCs. Via the SAC program, the installation of wells for drinking water would be prevented, and all requests for the installation of wells for industrial processes or agricultural purposes for RSA-115/116 would be subject to Army review and approval. The following LUC measures would be implemented at these sites:

- Implementation of an Environmental Use Restriction (EUR) in accordance with ADEM to restrict groundwater use at RSA-115/116 (ADEM, 2013).

- Incorporation of the EUR into the facility Master Plan as required by ADEM (ADEM, 2013).

- Recording of the EUR in the land records for the property, as required by AAC 335-5-1-.02(3).

RSA-115/116 is located on RSA and access to the site by the general public is restricted by Army badging and access restrictions and the installation-wide perimeter fence. Under this alternative, after Year 5, the LUC program at RSA-115/116 would also be combined with those for the underlying groundwater units.

Groundwater monitoring wells to be included in the MNA program are presented on **Figure 3-1**. As shown on **Figure 3-1**, the MNA well network would include 15 existing wells at RSA-115/116 with historical PSV and/or CG exceedances. The groundwater constituents to be addressed by the corrective measures at RSA-115/116 are listed in **Exhibit 3-1**.

Analytical requirements for each well are provided in the Groundwater Monitoring Plan (**Appendix C**) and are focused on the COCs with historical detections above the CGs.

Exhibit 3-2. Site-Related Groundwater Constituents of Concern

RSA-115 Site-Related COCs in Groundwater	RSA-116 Site-Related COCs in Groundwater
Metals	
Aluminum [3] Arsenic Vanadium [2]	None
Perchlorate	
Perchlorate	Perchlorate
Explosives	
1,3-Dinitrobenzene [2] 2,6-Dinitrotoluene 2-Nitrotoluene Nitrobenzene [2] Nitroglycerin [2]	1,3-Dinitrobenzene[2] 2-Nitrotoluene 3-Nitrotoluene [3] Nitrobenzene [3] Nitroglycerin [3]

RSA-115 Site-Related COCs in Groundwater	RSA-116 Site-Related COCs in Groundwater
Semi-Volatile Organic Compounds (SVOCs)	
Benzo(a)anthracene [3] Bis(2-ethylhexyl)phthalate Naphthalene [2] Pentachlorophenol Unsymmetrical dimethyl hydramine (UDMH) [1]	Bis(2-ethylhexyl)phthalate Naphthalene [2] Unsymmetrical dimethyl hydramine (UDMH) [1]
Volatile Organic Compounds (VOCs)	
Benzene Bromomethane [2] Trichloroethene	1,1,2,2-Tetrachloroethane Trichloroethene

Notes:
1. UDMH is a COC because the constituent is in the Conceptual Site Model (CSM) of the site, the analytical detection limit exceeded the groundwater preliminary screening value (PSV), and risks from this constituent cannot be calculated until appropriate toxicity values are developed for this constituent.
2. The maximum detected concentration (MDC) for each of these constituents exceeded its PSV and/or background screening value (BSV). However, none of these constituents were determined to be a risk driver in the cumulative risk assessment.
3. The MDC for each of these constituents exceeded its PSV. However, none of these constituents were determined to be a risk driver in the cumulative risk assessment and the MDC did not exceed the cleanup goal (CG).

The goal of the MNA program would be attainment of CGs for the site groundwater COCs. The analytical suite would be optimized over time based on the analytical results and with ADEM approval. As the CG was achieved for a given COC and demonstrated as such for three successive events (per Redstone Arsenal's RCRA Permit requirements [ADEM, 2022]), the COC would be dropped off the analytical list. While UDMH has never been detected, the current lowest achievable detection limit is higher than the PSV; therefore, continued monitoring for UDMH under the current detection limits is not recommended. When the achievable laboratory detection limit drops to or below the PSV, UDMH will be included in the monitoring to determine whether it can be terminated.

3.4 REQUEST FOR PERMIT MODIFICATION

RFI Reports for RSA-115 and RSA-116 (APTIM, 2020a,b) received ADEM concurrence on October 19, 2020 and May 26, 2021, respectively. Copies of both concurrence letters for the RFI reports are included in **Appendix D.** The request for permit modification (**Appendix E**) presents the supporting information, including all procedures necessary to implement and monitor the final corrective measures for RSA-115/116 in accordance with AAC R. 335-14-8-04 (2). The inclusion of this request for permit modification meets requirements specified in Section VI.E.3 of the Permit.

4.0 CORRECTIVE MEASURES IMPLEMENTATION FOR RSA-115/ 116

This chapter provides an overview of the activities planned to completed groundwater corrective measures at RSA-115/116. Work discussed in this chapter will be completed in accordance with the procedures outlined in this CMI Work Plan and other approved documentation as appropriate.

4.1 GENERAL SCOPE

The general scope of work for RSA-115/ 116 activities is expected to include the following:

- Procurement and Subcontracting
- Mobilization/ Demobilization
- Groundwater sampling and gauging
- Record Keeping
- Implementation of LUCs
- CMI Reporting
- Well Closure

The general schedule for implementation of corrective measures at RSA-115/ 116 is provided in **Appendix F**. The actual start date is pending approval of this CMI Work Plan, incorporation of the site corrective measures into the revised Permit, and availability of funding.

Stakeholder communication and coordination during the CMI will follow the procedures outlined in the IW-QAPP (HydroGeoLogic, Inc. [HGL] 2019) and the Project Management Plan (PMP) (ECC, 2021a).

4.1.1 Procurement and Subcontracting

The following subcontracted service will be required for the completion of the project:

- Analytical laboratory services
- Remediation-derived waste transportation and disposal (e.g., sampling purge and decontamination water)

Support materials will be procured through equipment vendors and shipped directly to the site. Support materials and equipment include sampling supplies, and equipment, health and safety supplies, and equipment (personal protective equipment, air monitoring equipment [e.g., photoionization detector]), and other miscellaneous supplies (e.g., wooden stakes and pin flags). Copies and a fax machine at the contractor's office will also be used to support the work at RSA-115/ 116.

4.1.2 Field Personnel

The following field personnel may be utilized to complete field corrective measure activities:

- Site supervisor
- Site safety officer
- Field quality control site manager
- Groundwater sampling technicians

The same field personnel may satisfy multiple roles simultaneously. Groundwater sampling may be performed in house or subcontracted. The number and schedule of personnel will be adjusted during the project as required for completion.

4.1.3 Quality Control Inspections for Field Activities

Inspections will be performed to determine compliance with this CMI Work Plan. The inspection criteria are discussed further in the Quality Control Plan (QCP) presented in **Appendix G**. Inspections may be performed and verified through visual observation, measurement of materials or equipment, examination of documentation/certification, evaluation of performance, or testing.

Inspections will be performed using a three-phase inspection method. Participants in the inspections typically include, but are not limited to, the field personnel, the project quality control manager, the regulatory representative, and the project health and safety representative. The preparatory inspection(s) are performed prior to start-up and will examine training, procedures, equipment and materials, work plans and documents, and overall readiness to perform work. Initial inspection(s) are performed upon beginning a particular phase of work and include an examination of the quality of workmanship and a review of control testing for compliance with work plan requirements. Follow-up inspection(s) are then performed to verify compliance with procedures. Follow-up inspections will ensure a continuation of quality and safety standards established during preparatory and initial inspections until completion of the definable work feature. Final follow-up inspection(s) will be conducted at the completion of the activity. The final follow-up inspection will be performed to ensure that the completed feature of work meets the work plan requirements. Any deficiencies noted during this inspection will be documented and a determination will be made as to the corrective actions necessary to mitigate the deficiency. All significant deficiencies will be corrected prior to completion of the activity.

Records of inspections will be maintained in the project files. At a minimum, inspection files will include inspection reports/checklists, inspection responses, any supporting documents, and applicable comments.

4.1.4 Daily Reports

The requirements for preparation and submittal of daily project documentation are outlined in the QCP (**Appendix G**). As indicated, the daily reports (including daily construction logs, etc.) will be provided to the Project Manager or designee during CMI activities.

4.1.5 Safety and Health Requirements

All personnel involved in the corrective measures will follow this work plan and abide by the health and safety requirements presented in the Site Safety and Health Plan (SSHP) (ECC, 2021b) (**Appendix H**).

4.2 PRELIMINARY ACTIVITIES

Preliminary activities are summarized in further detail below. All field personnel will follow this work plan and abide by the health and safety requirements presented in the SSHP.

4.2.1 Mobilization

Upon notice to proceed, the contractor will begin mobilization, including the deployment of personnel, equipment, subcontractors, and materials necessary to commence CMI activities at RSA-115/ 116. After field mobilization, contractor personnel will attend a safety tailgate meeting and safety orientation to review the tasks and the sequencing of work to ensure safe work activities and a clear line of communication is established. All necessary site-specific safety training will be conducted at this time and in accordance with APP (Health and Safety Plan) (ECC, 2021b).

4.2.2 Access to Redstone Arsenal

RSA is a secure facility; visitors gain access through badging at the visitor control center at Gate 9. Badge requests for access to RSA should be submitted at least two weeks ahead of the date needed to allow for approval and processing by the RSA host organization. On the approved pickup date, new contractor personnel and subcontractor personnel will register at the RSA Visitor's Center at Gate 9 and receive a security badge. Personnel with prior approval from a host RSA organization will be issued a personnel badge upon presentation of proper identification. All personnel requesting access to RSA must be United States citizens in good standing (i.e., no convictions or outstanding warrants).

Military and government personnel will present current military (active, retired, or family) or Federal government identification cards and do not require a host RSA organization. Further information may be obtained by contacting the RSA Visitor's Center located at Gate 9 at (256) 876-1122.

Registered personnel may access RSA-115/ 116 using Gate 3 on Redstone Road. Directions from Gate 3 are to take Buxton Road west, to south on McAlpine Road, to east on Blackberry Road, then take the first left north. The RSA-116 leaching pool will be just east of the end of the road. Gate 3 is open Monday through Friday, from 0530 to 1300 to inbound and outbound traffic and 1300 to 1800 for outbound traffic only. Gate hours and conditions are subject to change; therefore, operational hours should be verified.

4.3 GROUNDWATER MONITORING TO EVALUATE MONITORED NATURAL ATTENUATION

A groundwater monitoring program will be implemented to evaluate the effectiveness of MNA to protect human health and the environment. Groundwater monitoring will be performed semi-annually for Years 1 and 2, and annually from Years 3 through 5 or until CGs are achieved and confirmed. After Year 5, the monitoring program will be combined with corrective measures for the underlying groundwater units (RSA-156 or RSA-157). The proposed monitoring well network is shown on **Figure 3-1. Appendix C** provides the plan for the implementation of the groundwater monitoring program. This plan includes the wells scheduled for monitoring, sampling worksheets, analysis methods, and data management.

4.4 RECORD KEEPING

Daily safety tailgate meetings will be recorded and field sample collection logs will be prepared during the corrective measures activities at RSA-115/116 and will be provided in the Corrective Measures Report and subsequent Monitoring Reports. Variance and inspection forms will be included in the project reporting in accordance with the IW-QAPP (HGL, 2019) and the PMP (ECC, 2021a).

4.5 DECONTAMINATION/INVESTIGATION-DERIVED WASTE

Non-disposable sampling equipment will be decontaminated prior to beginning work at the site and prior to the collection of individual samples to prevent cross-contamination and maintain the integrity of the environmental samples collected. All sampling equipment will be decontaminated in accordance with procedures specified in the IW-QAPP (HGL, 2019).

All solid and liquid investigation derived waste (IDW) generated during CMI activities will be handled in accordance with the most recent versions of AEIRG and AAC 335-14, as well as in accordance with the IW-QAPP (HGL, 2019).

4.6 DEMOBILIZATION

Personnel, equipment, and subcontractors will be demobilized from the project site after completion of remedial activities.

4.7 IMPLEMENTATION OF LUCS

LUCs at RSA-115/116 would prevent or minimize exposure to contaminated groundwater. The LUCs previously implemented for IWGW in the IROD (Shaw, 2007) would be made permanent until cleanup objectives were attained for the RSA-115/116 groundwater. The LUCs would be implemented to prevent potable use of groundwater and manage non-potable uses such that exposure to contaminated groundwater is minimized. The LUCs would remain in place until CGs were attained for COCs in groundwater at RSA-115/116. The Army-regulated SAC program would be used to implement LUCs. Via the SAC program, the installation of wells for drinking water would be prevented and all requests for the installation of wells for industrial processes or agricultural purposes for RSA-115/116 would be subject to Army review and approval. The LUCs would be separate from those for the underlying RSA-156/157 groundwater units.

4.7.1 Survey Plat

In accordance with the Permit (ADEM, 2022), where residual contaminant concentrations remain in place at levels greater than those appropriate for unrestricted land use, RSA will submit a survey plat indicating the locations and dimensions of the contaminated areas within RSA-115/116 and the concentrations of hazardous constituents. This survey plat shall be submitted to the Madison County Probate Judge's Office and to ADEM as part of the EUR in the CMI report. This plat must be prepared and certified by a professional land surveyor registered in the state of Alabama and contain a prominently displayed note stating RSA's obligations to limit property to the specified restricted uses. The survey plat shall be maintained as described in the Permit until RSA can demonstrate to ADEM that the levels of hazardous constituents in all contaminated media are within limits appropriate for unrestricted land uses.

4.7.2 Notice of Environmental Use Restriction

A Notice of Environmental Use Restriction (NEUR) is required when an approved CMIP allows corrective measures that will not result in remediation of the property or portions of the property to unrestricted use. The purpose of an NEUR is to ensure that risks to human health and/or the environment are properly managed by imposing activity and use restrictions on the applicable portions of the property and making these restrictions a legal obligation until the EUR is removed. The NEUR will be included in the CMI report for this site once all corrective measures are completed.

ADEM will be notified within 10 days after uses inconsistent with the NEUR are identified. Additionally, notice regarding any observed changes in use, identified proposed changes in use, applications for building permits, or proposals for site work inconsistent with the NEUR will be provided to ADEM as part of the annual monitoring report. Once the NEUR is approved, ADEM will execute and return the original document to RSA to be filed in the appropriate land records (Madison County Probate Judge's Office) within 30 days of receipt. Certification that the notice of NEUR was recorded with the Madison County Probate Judge's Office will be submitted to ADEM within 30 days of recording per AAC 335-1-05(3).

This certification will include a copy of the NEUR and the document in which the notation was placed. RSA will maintain the NEUR until demonstrating to the satisfaction of ADEM that hazardous constituents in all contaminated media at RSA-115/116 are within limits appropriate for unrestricted land use.

If the property is transferred to an owner that is not the Federal government, an environmental covenant will be executed and filed at that time in accordance with AAC 335-5-1-.02(3)(a)(1)(i) (ADEM, 2013). The NEUR is provided in **Appendix I**.

4.8 CORRECTIVE MEASURE IMPLEMENTATION REPORTING

CMI reporting will be conducted in accordance with Section VIII.D of the Permit and AEIRG (ADEM, 2017) as follows:

- CMI Report – Prepared following the baseline groundwater sampling event (Year 0).
- CMI Effectiveness Report – Prepared annually to present the results of groundwater monitoring data and progress toward the CGs for groundwater.
- Final Report of Corrective Measures – Prepared upon attainment of CGs for constituents in groundwater.

Field documentation (e.g., daily reports, daily field logs, calibration logs) will be provided to the Project Manager or designee during CMI activities. The requirements for preparation and submission of daily project documentation are outlined in the IW-QAPP (HGL, 2019) and the PMP (ECC, 2021a).

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5.0 CONTINGENCIES

The implementation of corrective measures is based on the best information currently available for RSA-115/116. The following sections include contingency plans to address possible different situations that could occur as part of the corrective measures implementation. Any contingencies implemented will be documented and included with the CMI report for the site.

5.1 MONITORED NATURAL ATTENUATION CONTINGENCIES

Recommendations for contingency measures will be presented in the CMI Effectiveness Reports. Following the baseline sampling event, groundwater sampling will be performed semi-annually in Years 1 and 2, and annually in Years 3 through 5 to determine the effectiveness of MNA. Recommendation may include changes to the monitoring frequency and/or parameters, adding additional monitoring wells, or the implementation of additional remedial technologies as appropriate.

5.2 VARIANCES

The implementation of corrective measures is based on the best information currently available for RSA-115/116. The Army recognizes that variations from this CMI Work Plan may be required during the execution phase of the work in order to fully address actual site conditions in a timely manner that is protective of human health and the environment. The Army may grant variances from this CMI Work Plan submitted by the contractor during the corrective measures process. As part of their approval process, the Army will discuss applicable field variances with ADEM to determine if the variance process is suitable for documenting the proposed changes, or whether revisions to the CMI Work Plan along with a permit modification may be needed. Any variance will be documented and included with the CMI report for the sites.

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TABLES

Table 3-1
Potential Federal and State Regulations Applicable to RSA-115 and RSA-116 Groundwater Corrective Measures
RSA-115 and RSA-116 Corrective Measures Implementation Work Plan
Redstone Arsenal, Madison County, Alabama

Standard, Requirement, or Criterion	Requirement	Applicability	Comments
Federal			
Safe Drinking Water Act – 40 CFR 149	Sole-source drinking water aquifer designation.	Not applicable	These sites are not located over a sole-source aquifer.
Safe Drinking Water Act (SDWA), 40 U.S.C. Section 300 – National Primary Drinking Water Standards - 40 CFR Part 141	Applicable to the use of public water systems. Establishes maximum contaminant level, monitoring requirements, and treatment techniques.	Applicable	Federal drinking water goals are used by ADEM to establish cleanup standards.
Safe Drinking Water Act (SDWA), 40 U.S.C. Section 300 – Maximum Contaminant Level Goals, 40 CFR 143	Establishes drinking water quality goals set at levels of no known or anticipated adverse health effects.	Applicable	Federal drinking water goals are used by ADEM to establish cleanup standards.
Floodplain Management – 40 CFR 6.302(b) Executive Order 11988	Federal agencies proposing actions to be located in a floodplain must first evaluate the potential adverse effects those actions might have on the natural and beneficial values served by the floodplain.	Not applicable	Sites are not located within the 100 year flood plain.
Floodplain Management – Resource Conservation and Recovery Act (RCRA); Resource Conservation and Recovery Act Location Standards, 42 USC Section 6901, 40 CFR 264.18(b)	Requires TSDF to be designated, constructed, operated, and maintained to avoid washout on a 100- year floodplain.	Not applicable	No new regulated units will be implemented as part of the expected corrective measures alternative.
Protection of Wetlands – 40 CFR 6.302(a) Executive Order 11990	Federal agencies are directed to avoid construction located in wetlands unless the agency head finds (1) no practical alternative to such construction, and (2) the proposed action includes all practical measures to minimize harm to wetlands which might results from such use.	Not applicable	Construction in wetlands is not a component of the expected corrective measures alternative.
Protection of Wetlands – 40 CFR 230	Sets forth guidelines for fill material in wetlands.	Not applicable	Filling wetlands is not a component of the expected corrective measures alternative.
Wetlands Permitting - 32 CFR 650.68	Identifies permitting requirements for excavation activities in wetlands.	Not applicable	Excavation activities are not a component of the expected corrective measures alternative.

Table 3-1
Potential Federal and State Regulations Applicable to RSA-115 and RSA-116 Groundwater Corrective Measures
RSA-115 and RSA-116 Corrective Measures Implementation Work Plan
Redstone Arsenal, Madison County, Alabama

Standard, Requirement, or Criterion	Requirement	Applicability	Comments
Endangered Species Act 16 USC 1531 50 CFR 200 & 402	Requires federal agencies to ensure that actions are not likely to threaten the continued existence of endangered/threatened species or adversely modify or destroy the critical habitats of such species.	Not applicable	No special status species or sensitive habitats are listed as occurring on these sites.
Fish and Wildlife Coordination Act - 16 USC 661-666 33 CFR 320-330	Sets forth procedures for consultation between regulatory agencies to consider wildlife conservation. Requires any federal agency proposing to modify a body of water to consult with the U.S. Fish and Wildlife Service.	Not applicable	Discharge to surface water is not a component of the expected corrective measures alternative.
Wild and Scenic Rivers Act, 16 U.S.C. 1274, 40 CFR 6.302(e)	Restricts activities within areas affecting national wild, scenic, or recreational rivers.	Not applicable	No such areas present.
Presence of archaeological resources, 43 CFR 7.4(a), 40 CFR 7.5(b)(1), 43CFR 10.4(c), 43 CFR 10.4(d)	Restricts excavating, removing, damaging, or otherwise altering or defacing such resources unless by permit or exception. Protects any such archaeological resources, if discovered. Restricts activities in the area of discovery and requires a reasonable effort be made to protect the objects discovered. Requires consultation with the Indian tribe likely to be affiliated with the objects to determine further disposition per 40 CFR 10.5(b).	Potentially applicable, but unlikely	This regulation would apply if archaeological or historic resources are discovered at the sites. This is unlikely since both sites are largely developed.
National Archaeological and Historical Preservation Act (16 USC Section 469-470); 35 CFR Part 65	Requires action be taken to recover and preserve artifacts.	Potentially applicable, but unlikely	This regulation would apply if archaeological or historic resources are discovered at the sites. This is unlikely since both sites are largely developed.
Department of the Army, Environmental Protection and Enhancement; Historic Preservation, 32 CFR 650.181 - 650.193	Requires preservation, restoration, or rehabilitation of all sites, structures, and objects of historical, architectural, archeological, or cultural significance located on Army-controlled property.	Potentially applicable, but unlikely	This regulation would apply if archaeological or historic resources are discovered at the sites. This is unlikely since both sites are largely developed.
Native American Graves Protection and Repatriation Act, 25 USC 3001-3013 and 43 CFR 10	Requires protection of Native American graves discovered during excavation activities	Potentially applicable, but unlikely	This regulation would apply if any Native American burial sites or cultural items are discovered at these sites. This is unlikely since the sites are largely developed.
American Indian Religious Freedom Act, 42 USC 1996	Requires activities in the area of discovery to be stopped and affected work to be suspended until a compliance strategy is approved.	Potentially applicable, but unlikely	This regulation would apply if archaeological or historic resources are discovered at these sites. This is unlikely since the sites are largely developed.

Table 3-1
Potential Federal and State Regulations Applicable to RSA-115 and RSA-116 Groundwater Corrective Measures
RSA-115 and RSA-116 Corrective Measures Implementation Work Plan
Redstone Arsenal, Madison County, Alabama

Standard, Requirement, or Criterion	Requirement	Applicability	Comments
Standards Applicable to Generators of Hazardous Waste, 40 CFR Part 262	Establishes standards for generators of hazardous waste under RCRA. Specifies requirements for hazardous waste packaging, labeling, manifesting, record keeping, and accumulation time.	Not applicable	Hazardous waste will not be generated as the result of the expected corrective measures alternative.
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, 40 CFR Part 264.13(a)(1)	Must obtain a detailed chemical and physical analysis on a representative sample of the waste(s).	Not applicable	Hazardous waste will not be generated as the result of the expected corrective measures alternative.
Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, 40 CFR Part 265.171-173(b)	Management of hazardous waste in containers.	Not applicable	Hazardous waste will not be generated as the result of the expected corrective measures alternative.
Land Disposal Restrictions, 40 CFR 268	Identifies hazardous wastes that are restricted from land disposal.	Not applicable	Hazardous waste will not be generated as the result of the expected corrective measures alternative.
Discharge to Offsite Surface Water, 40 CFR 122.26, 122.41, and 122.48	Requires that the selected remedial action must establish a standard of control to maintain surface water quality.	Not applicable	Surface disturbance is not a component of the expected corrective measures alternative.
Superfund Amendments and Reauthorization Act (SARA), 42 U.S.C. Section 9801 et. Seq.	Requires the discharge to comply with Federal water quality criteria.	Not applicable	Redstone Arsenal is under the authority of RCRA.
Clean Water Act, 33 U.S.C. Sections 1351-1376 – Best Available Treatment Technology, 40 CFR 122	Requires use of best available technology economically achievable to control discharge of toxic pollutants to a POTW.	Not applicable	There is no POTW at Redstone Arsenal.
Clean Water Act, 33 U.S.C. Sections 1351-1376 – National Pollutant Discharge Elimination System (NPDES) Permit Regulations, 40 CFR 122 Subpart C	Requires use of best available technology economically achievable for toxic pollutants discharged to surface waters. Mandates that the discharge must comply with the EPA-approved Water Quality Management Plan.	Not applicable	Discharge to surface water is not a component of the expected corrective measures alternative.
Discharge to a Publicly Owned Treatment Works (POTW), 33 USC Section 1317, 40 CFR 403	Establishes list of toxic pollutants and promulgates pretreatment standards for discharge to POTWs.	Not applicable	The treatment system is not publicly owned,

Table 3-1
Potential Federal and State Regulations Applicable to RSA-115 and RSA-116 Groundwater Corrective Measures
RSA-115 and RSA-116 Corrective Measures Implementation Work Plan
Redstone Arsenal, Madison County, Alabama

Standard, Requirement, or Criterion	Requirement	Applicability	Comments
Clean Air Act, codified under, 40 CFR Part 60, part 61 or part 63. Prerequisite for this action: 40 CFR 264,1030(e)	Process vents associated with air or stream stripping operations that manage hazardous wastes with organic concentrations of at least 10 ppmw.	Not applicable	This is not a component of the expected corrective measures alternative.
State			
Alabama Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, ADEM 335- 14-5-.01, Hazardous Waste Program	Establishes location standards for facilities located in 100-year floodplains. Forbids placement of any non-containerized or bulk liquid hazardous waste within any salt dome/salt bed, underground mine or cave.	Not applicable	The sites are not located within the 100 year flood plain.
Alabama Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, ADEM 33514-6, Hazardous Waste Program	Prohibits placement of any hazardous waste in a salt dome, salt bed formation, underground mine, or cave.	Not applicable	This is not a component of the expected corrective measures alternative.
Alabama Drinking Water Standards ADEM 335-7-2	Applicable to the use of public water systems. Establishes maximum contaminant level, monitoring requirements, and treatment techniques.	Applicable	Drinking water standards established by ADEM based on Federal drinking water goals.
Alabama Water Quality Criteria, ADEM 335-6-10, Water Quality Program	Requires any federal agency proposing to modify a body of water to consult with the U.S. Fish and Wildlife Service. Establishes antidegradation policy based on water use classifications and potentially impacted wildlife, fish, and aquatic life.	Not applicable	Discharge to surface water is not a component of the corrective measures alternative.
Wetlands Protection - ADEM 335-8-2.02/2.03	Defines requirements for dredging or filling and mitigation of impacts to wetlands.	Not applicable	Construction in wetlands is not a component of the expected corrective measures alternative.
Alabama Non-Game Species Regulation, AAC 220-2.92	Identifies state-protected species.	Potentially applicable	Applicable if the state-protected species are encountered at the sites.
Phase I Organic Air Emission Standards: AAC 335-14-5-.27 and 335-15-5-.28	For TSD facilities. Emission standards for process vents and emission standards for leaks from specific equipment containing hazardous waste with a total organic concentration of at least 10 percent by weight.	Not applicable	Active treatment is not a component of the expected corrective measures alternative.

Table 3-1
Potential Federal and State Regulations Applicable to RSA-115 and RSA-116 Groundwater Corrective Measures
RSA-115 and RSA-116 Corrective Measures Implementation Work Plan
Redstone Arsenal, Madison County, Alabama

Standard, Requirement, or Criterion	Requirement	Applicability	Comments
Phase II Organic Air Emission Standards: AAC 335-14-5-.29	For TSD facilities. Emission standards tanks, surface impoundments, containers and miscellaneous units that contact hazardous waste containing an average organic concentration greater than 500 ppmw.	Not applicable	Active treatment is not a component of the corrective measures alternative.
Alabama Solid Waste Act, Code of Alabama, Title 22, Chapter 27	Establishes site-wide program to provide for the safe management of non-hazardous wastes.	Applicable	Nonhazardous waste may be generated during groundwater monitoring or well installation/abandonment.
Alabama Solid Waste Management Regulations, ADEM 335-13-1 through 335-13- 8	Establishes minimum criteria for the processing, recycling, transportation, and disposal of solid wastes and the design, location, and operation of solid waste disposal facilities.	Applicable	Nonhazardous waste may be generated, transported, or disposed as part of monitoring or corrective measure activities.
Alabama Stormwater Discharge Regulations, ADEM 335-6-12	Establishes requirements for a stormwater discharge permit for construction activities that disturb greater than 1 acre of land.	Potentially applicable, but unlikely	The corrective measure activities are unlikely to affect areas greater than 1 acre.
Alabama Water Quality Criteria and Use Classifications Regulations, ADEM 335-6-10	Establishes water quality criteria and uses for lakes and rivers based on toxicity to aquatic organisms and human health and water use classifications and antidegradation policy.	Not applicable	Discharge to surface water is not included as a component of the expected corrective measures alternative.
Indirect Discharge Permits and Pretreatment Rules, ADEM 335- 6-5	Establishes list of toxic pollutants and promulgates pretreatment standards for discharge to POTWs and defines the requirements for State Indirect Discharge permits for discharge to POTWs.	Not applicable	No POTW is present at Redstone Arsenal.
Alabama Wellhead Protection Program, ADEM 335-7-12	Establishes requirements for the closure or abandonment of groundwater monitoring or extraction wells.	Applicable	Applicable to the abandonment and construction of groundwater monitoring wells.

CFR – Code of Federal Regulations
POTW – Publicly owned treatment works
RCRA – Resource Conservation and Recovery Act
TSDF – Treatment, storage, and disposal facility

Table 3-2
Summary of Cleanup Goals
RSA-115/RSA-116 Corrective Measures Implementation Work Plan
Redstone Arsenal, Madison County, Alabama

COC Requiring Action	RSA-115			RSA-116		
	Maximum Concentration (µg/L)	Groundwater CG (µg/L)	Basis	Maximum Concentration (µg/L)	Groundwater CG (µg/L)	Basis
Aluminum	2,980	4,000	NC (THQ=0.2)	--	--	--
Arsenic	31.4	10	MCL	--	--	--
Vanadium	32.2	17	NC (THQ=0.2)	--	--	--
Perchlorate	18	15	MCL	52.5	15	MCL
1,3-Dinitrobenzene	0.889	0.39	NC (THQ=0.2)	0.547	0.65	NC (THQ=0.33)
2,6-Dinitrotoluene	1.4	0.097	C (TR=2E-06)	--	--	--
2-Nitrotoluene	1.92	0.63	C (TR=2E-06)	2.25	0.79	C (TR=2.5E-06)
3-Nitrotoluene	--	--	--	0.23	0.58	NC (THQ=0.33)
Nitrobenzene	4.29	0.28	C (TR=2E-06)	0.261	0.35	C (TR=2.5E-06)
Nitroglycerin	0.902	0.39	NC (THQ=0.2)	0.325	0.65	NC (THQ=0.33)
Benzo(a)anthracene	0.0456	0.06	C (TR=2E-06)	--	--	--
bis(2-Ethylhexyl)phthalate	9.98	6	MCL	30.9	6	MCL
Naphthalene	1.5	0.23	C (TR=2E-06)	0.62	0.29	C (TR=2.5E-06)
Pentachlorophenol	4.2	1	MCL	--	--	--
1,1,2,2-Tetrachloroethane	--	--	--	0.608	0.19	C (TR=2.5E-06)
Benzene	56.4	5	MCL	--	--	--
Bromomethane	1.8	1.5	NC (THQ=0.2)	--	--	--
Trichloroethene	102	5	MCL	29.6	5	MCL

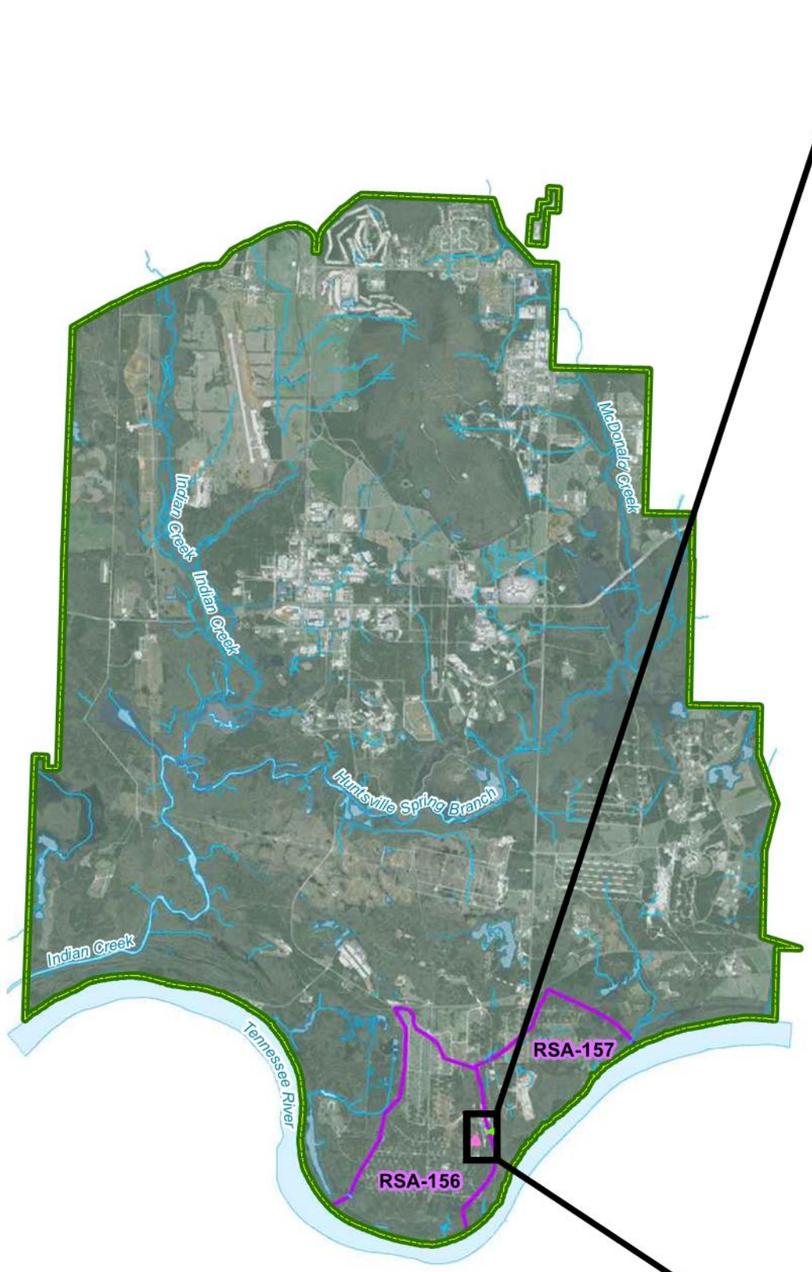
Note:

-- Not applicable; chemical not identified as a COC requiring action at this site.
µg/L - micrograms per liter.
BSV - Background screening value.
C – CG derived based on the cancer endpoint.
CG - Cleanup goal.
COC - Chemical of concern.
MCL - Maximum contaminant limit.
NC – CG derived based on the noncancer HI.
THQ - Target hazard quotient.
TR – target risk.
UDMH - Unsymmetrical dimethyl hydrazine
USEPA RSLs (May 2022)

For RSA 115:
Carcinogenic CG = 1E-05/N where N = 5 carcinogenic compounds
Noncarcinogenic CG = 1/N where N = 5 noncarcinogenic compounds

For RSA 116:
Carcinogenic CG = 1E-05/N where N = 4 carcinogenic compounds
Noncarcinogenic CG = 1/N where N = 3 noncarcinogenic compounds

FIGURES





Legend

- RSA Installation Boundary
- RSA-156 & RSA-157 Groundwater Site Boundary
- RSA-115 Environmental Site Boundary
- RSA-116 Environmental Site Boundary
- River/Stream (Perennial)
- Stream (Intermittent)
- Water Body



REDSTONE ARSENAL
MADISON COUNTY, ALABAMA
RSA-115/116 CORRECTIVE MEASURES IMPLEMENTATION PLAN

RSA-115/116
Site Location Map

ARCADIS ECC

FIGURE
1-1

RSA-146

RSA-154

RSA-152

RSA-157

RSA-151

RSA-115

RSA-116

RSA-156

Tennessee River

Legend

- RSA Installation Boundary
- RSA Groundwater Group Boundary
- RSA-115
- RSA-116
- Surface Media Site Boundary
- Surface Drainage Feature
- Water Body

Figure 1-2
RSA-115-116
Regional Site Location Map

REDSTONE ARSENAL
MADISON COUNTY, ALABAMA
RSA-115/116 CORRECTIVE MEASURES
IMPLEMENTATION PLAN

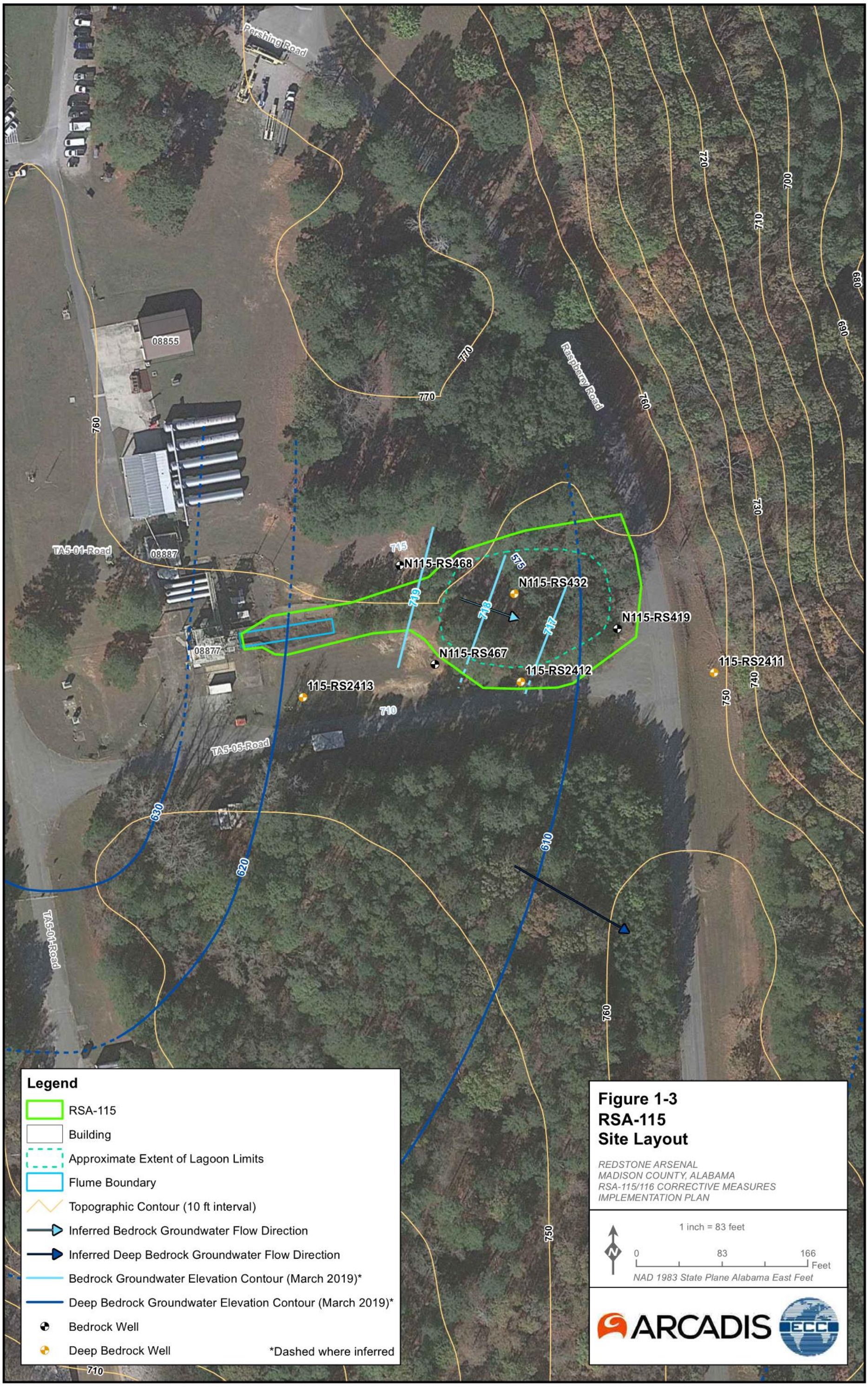
1 inch = 1,250 feet

N

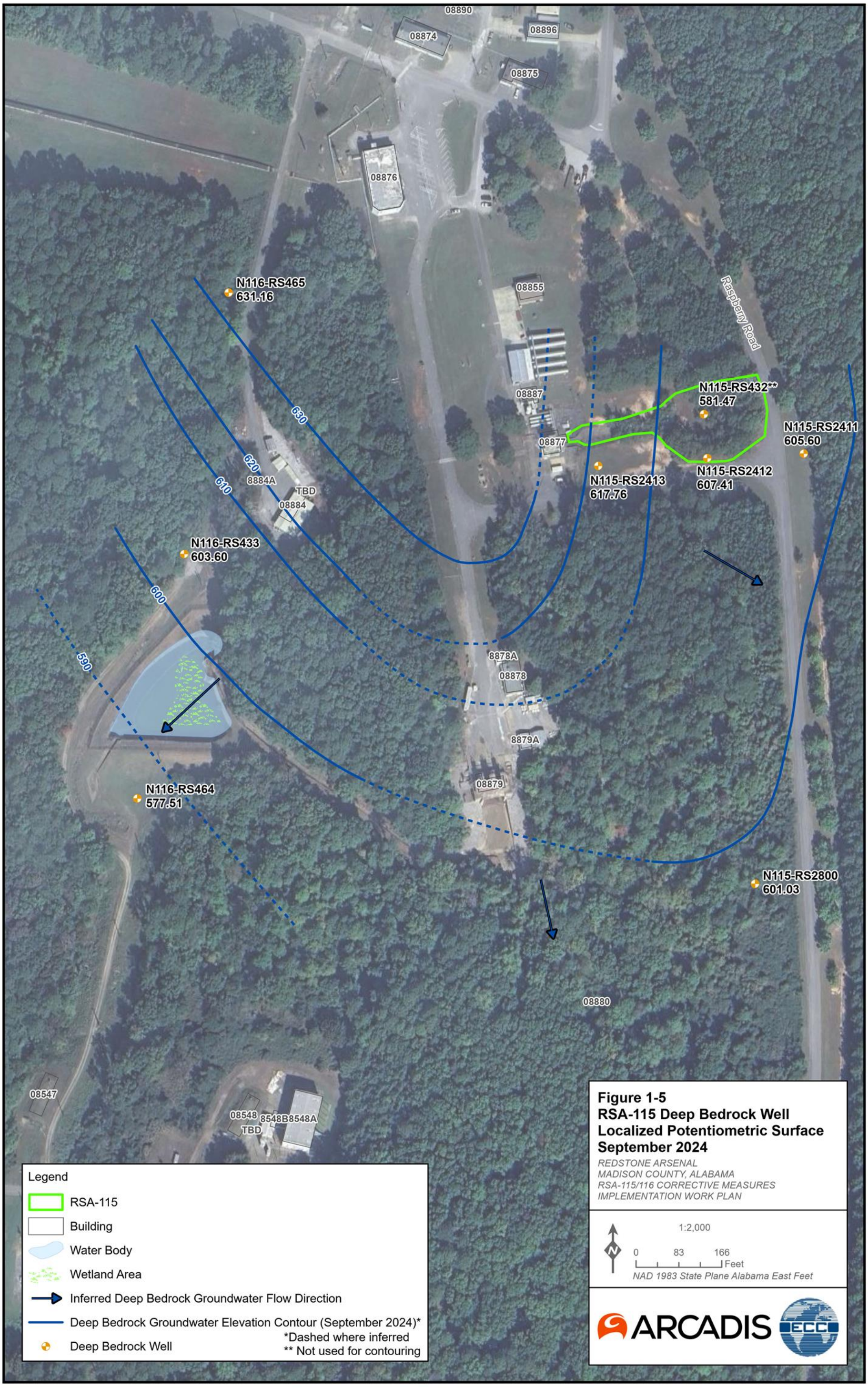
0 1,000 2,000 Feet

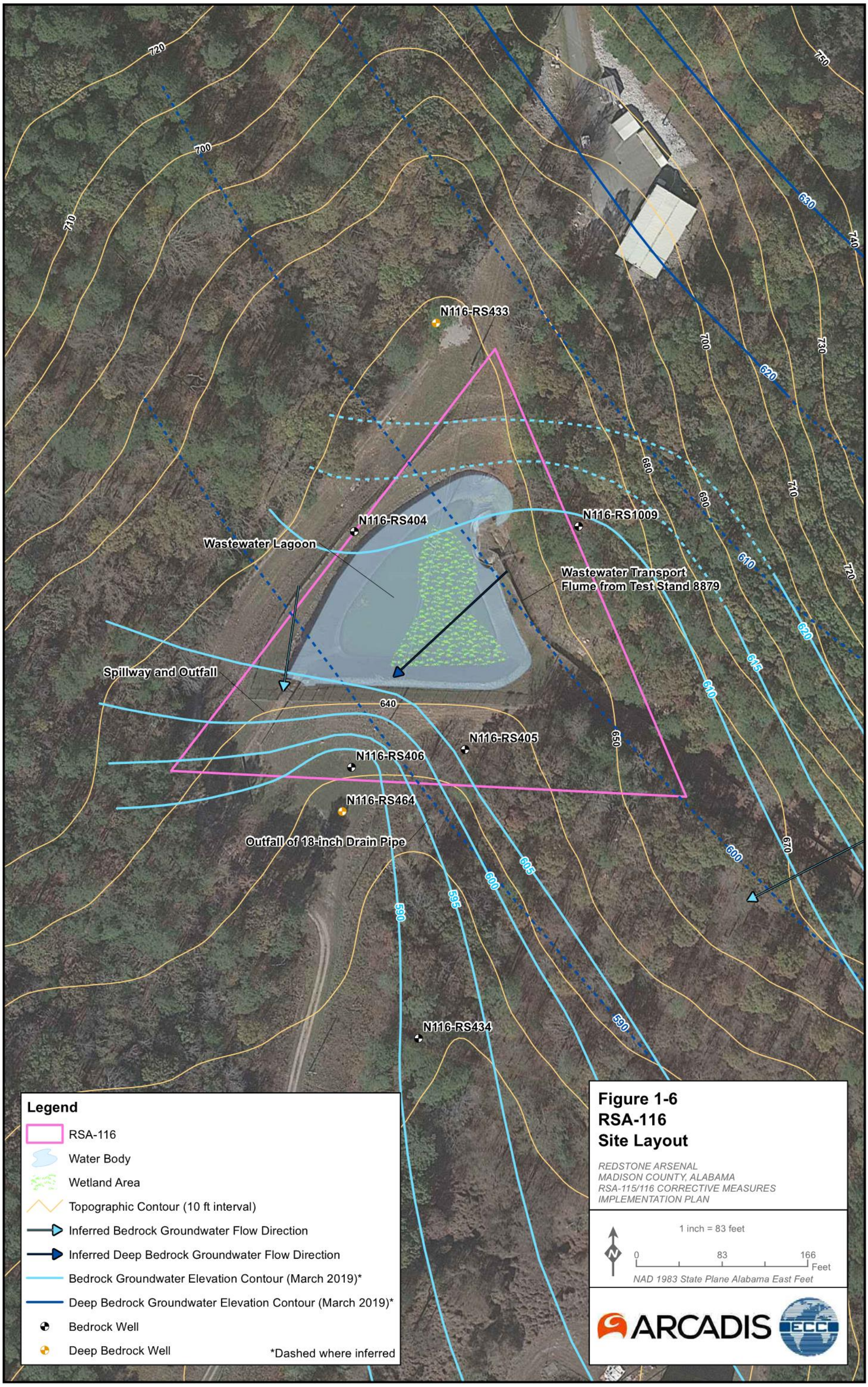
NAD 1983 State Plane Alabama East Feet

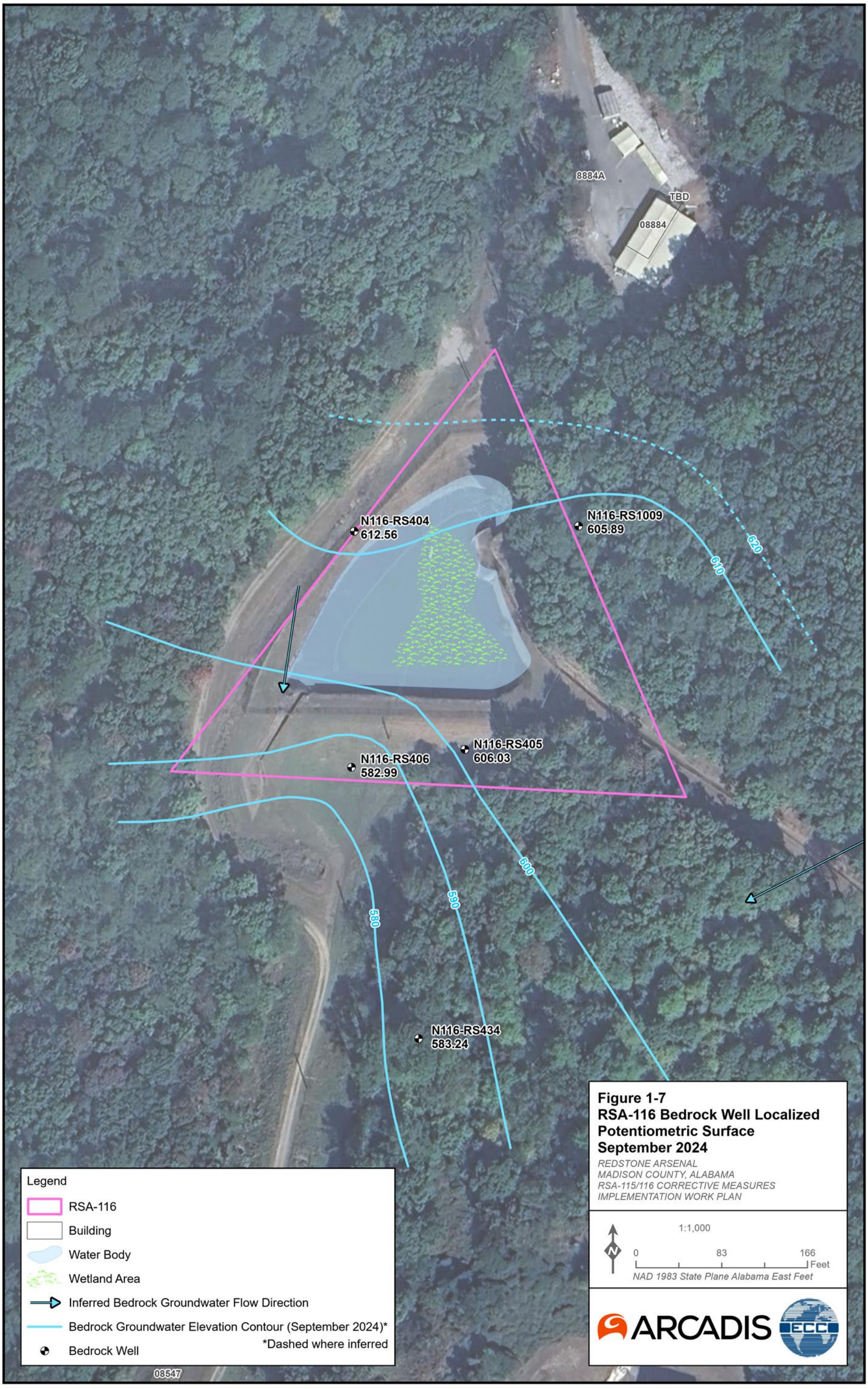
ARCADIS ECC

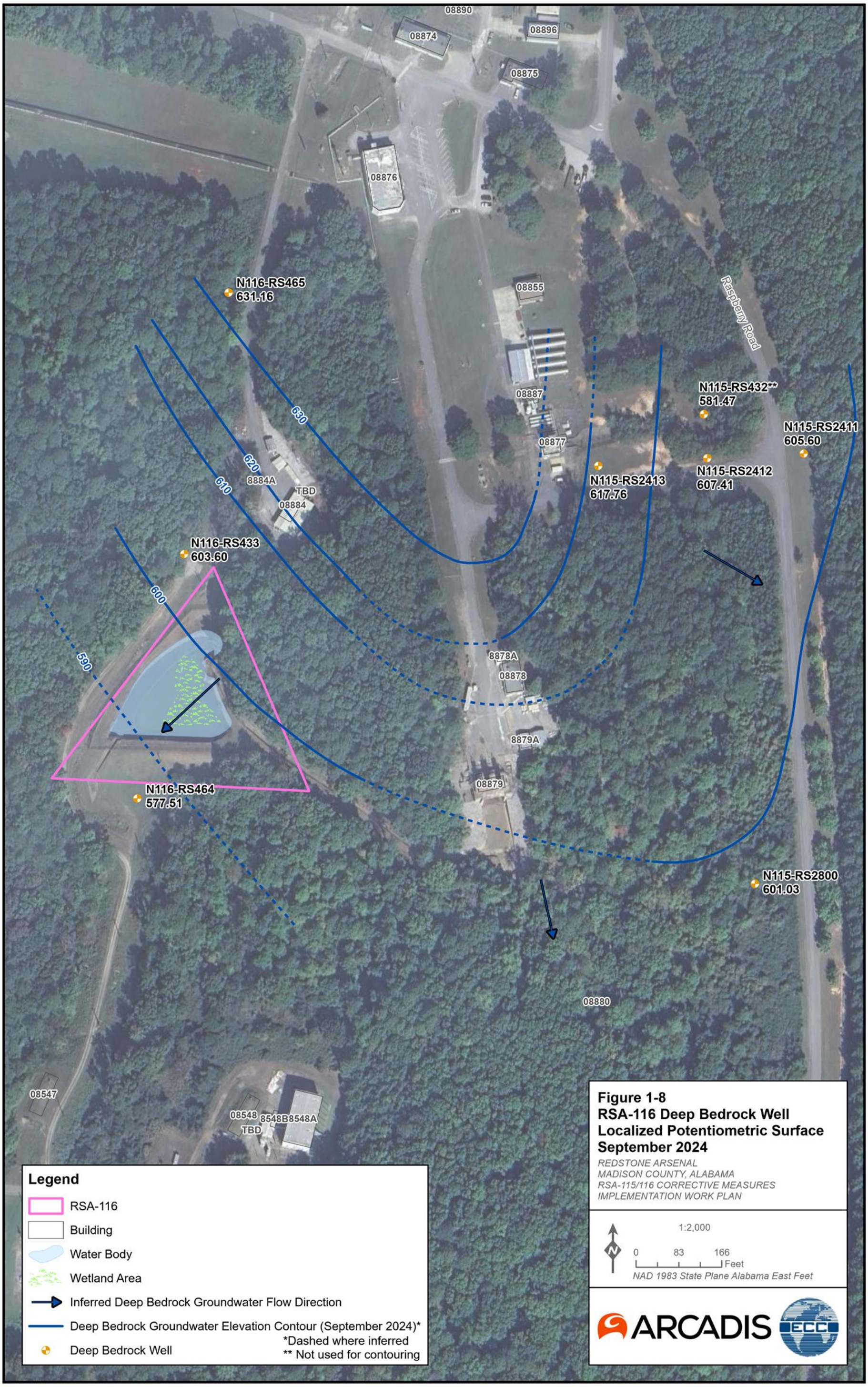

Pershing Road
Raspberry Road
08855
08887
08877
TA5-01-Road
TA5-05-Road
TA5-01-Road
N115-RS468
N115-RS432
N115-RS419
N115-RS467
115-RS2412
115-RS2413
115-RS2411
770
760
720
700
710
690
680
730
715
719
718
717
575
740
750
630
620
610
760
750
710
Legend
RSA-115
Building
Approximate Extent of Lagoon Limits
Flume Boundary
Topographic Contour (10 ft interval)
Inferred Bedrock Groundwater Flow Direction
Inferred Deep Bedrock Groundwater Flow Direction
Bedrock Groundwater Elevation Contour (March 2019)*
Deep Bedrock Groundwater Elevation Contour (March 2019)*
Bedrock Well
Deep Bedrock Well
*Dashed where inferred
Figure 1-3
RSA-115
Site Layout
REDSTONE ARSENAL
MADISON COUNTY, ALABAMA
RSA-115/116 CORRECTIVE MEASURES
IMPLEMENTATION PLAN
1 inch = 83 feet
N
0
83
166
Feet
NAD 1983 State Plane Alabama East Feet
ARCADIS
ECC


08855
Raspberry Road
08887
N115-RS468
719.31
08877
N115-RS467
719.65
715
719
717
N115-RS419
714.64
8878A
08878
Legend
RSA-115
Building
Inferred Bedrock Groundwater Flow Direction
Bedrock Groundwater Elevation Contour (September 2024)*
*Dashed where inferred
Bedrock Well
Figure 1-4
RSA-115 Bedrock Well Localized Potentiometric Surface September 2024
REDSTONE ARSENAL
MADISON COUNTY, ALABAMA
RSA-115/116 CORRECTIVE MEASURES IMPLEMENTATION WORK PLAN
1:1,000
0
83
166
Feet
NAD 1983 State Plane Alabama East Feet
ARCADIS
ECC


08890
08874
08896
08875
08876
08855
Raspberry Road
N116-RS465
631.16
08887
N115-RS432**
581.47
N115-RS2411
605.60
08877
N115-RS2413
617.76
N115-RS2412
607.41
630
620
610
8884A
TBD
08884
N116-RS433
603.60
600
590
8878A
08878
8879A
08879
N116-RS464
577.51
N115-RS2800
601.03
08880
08547
08548
8548B
8548A
TBD
Legend
RSA-115
Building
Water Body
Wetland Area
Inferred Deep Bedrock Groundwater Flow Direction
Deep Bedrock Groundwater Elevation Contour (September 2024)*
Deep Bedrock Well
*Dashed where inferred
** Not used for contouring
Figure 1-5
RSA-115 Deep Bedrock Well
Localized Potentiometric Surface
September 2024
REDSTONE ARSENAL
MADISON COUNTY, ALABAMA
RSA-115/116 CORRECTIVE MEASURES
IMPLEMENTATION WORK PLAN
1:2,000
0
83
166
Feet
NAD 1983 State Plane Alabama East Feet
ARCADIS
ECC


N116-RS433
N116-RS404
N116-RS1009
Wastewater Lagoon
Wastewater Transport
Flume from Test Stand 8879
Spillway and Outfall
N116-RS405
N116-RS406
N116-RS464
Outfall of 18-inch Drain Pipe
N116-RS434
720
700
710
750
630
740
730
620
680
690
610
615
640
650
600
605
595
590
670
Legend
RSA-116
Water Body
Wetland Area
Topographic Contour (10 ft interval)
Inferred Bedrock Groundwater Flow Direction
Inferred Deep Bedrock Groundwater Flow Direction
Bedrock Groundwater Elevation Contour (March 2019)*
Deep Bedrock Groundwater Elevation Contour (March 2019)*
Bedrock Well
Deep Bedrock Well
*Dashed where inferred
Figure 1-6
RSA-116
Site Layout
REDSTONE ARSENAL
MADISON COUNTY, ALABAMA
RSA-115/116 CORRECTIVE MEASURES
IMPLEMENTATION PLAN
1 inch = 83 feet
N
0
83
166
Feet
NAD 1983 State Plane Alabama East Feet
ARCADIS
ECC


8884A
TBD
08884
N116-RS404
612.56
N116-RS1009
605.89
620
610
N116-RS405
606.03
N116-RS406
582.99
600
590
580
N116-RS434
583.24
08547
Legend
RSA-116
Building
Water Body
Wetland Area
Inferred Bedrock Groundwater Flow Direction
Bedrock Groundwater Elevation Contour (September 2024)*
*Dashed where inferred
Bedrock Well
Figure 1-7
RSA-116 Bedrock Well Localized Potentiometric Surface September 2024
REDSTONE ARSENAL
MADISON COUNTY, ALABAMA
RSA-115/116 CORRECTIVE MEASURES IMPLEMENTATION WORK PLAN
1:1,000
0
83
166
Feet
NAD 1983 State Plane Alabama East Feet
ARCADIS
ECC


08890
08874
08896
08875
08876
08855
Raspberry Road
N116-RS465
631.16
08887
N115-RS432**
581.47
N115-RS2411
605.60
08877
N115-RS2412
607.41
N115-RS2413
617.76
630
620
610
8884A
TBD
08884
N116-RS433
603.60
600
590
8878A
08878
8879A
08879
N116-RS464
577.51
N115-RS2800
601.03
08880
08547
08548
8548B
8548A
TBD
Legend
RSA-116
Building
Water Body
Wetland Area
Inferred Deep Bedrock Groundwater Flow Direction
Deep Bedrock Groundwater Elevation Contour (September 2024)*
*Dashed where inferred
** Not used for contouring
Deep Bedrock Well
Figure 1-8
RSA-116 Deep Bedrock Well
Localized Potentiometric Surface
September 2024
REDSTONE ARSENAL
MADISON COUNTY, ALABAMA
RSA-115/116 CORRECTIVE MEASURES
IMPLEMENTATION WORK PLAN
1:2,000
N
0
83
166
Feet
NAD 1983 State Plane Alabama East Feet
ARCADIS
ECC

Location	N115-RS468															
Sample Date	8-Aug-00		21-Jan-09		25-Oct-11		13-Dec-12		28-May-14		2-Dec-14		22-Jan-19		6-Apr-20	
Sample Depth (feet)	47.32 - 47.32		50.5 - 50.5		55 - 55		53.67 - 53.67		51 - 51		54 - 54		49 - 49		49 - 49	
Parameter	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Aluminum	NA		NA		91.1	J	NA		76.2	J	105	J	NA		NA	
Perchlorate	18	nv	NA		NA		17		10.5		13.6		6.91		NA	
2-Nitrotoluene	NA		NA		NA		-	U	0.123	J	0.505		-	UJ	NA	
Benzo(a)anthracene	NA		NA		0.0263	J	-	U	-	U	-	U	-	U	NA	
bis(2-Ethylhexyl)phthalate	NA		NA		-	U	-	U	4.75	J	9.98		0.73	J	NA	
Naphthalene	NA		NA		-	U	-	U	-	U	-	U	0.45		0.19	UB
Trichloroethene	NA		0.78	J	6.7	J	1.3		0.57	J	1.4		0.82	J	NA	

Location	N115-RS419																			
Sample Date	25-Sep-91		10-Jun-92		7-Oct-93		21-Jan-09		25-Oct-11		12-Dec-12		28-May-14		3-Dec-14		22-Jan-19		7-Apr-20	
Sample Depth (feet)	0 - 0		0 - 0		0 - 0		69.3 - 69.3		70 - 70		70 - 70		0 - 0		65 - 65		66 - 66		67 - 67	
Parameter	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Aluminum	NA		NA		NA		NA		918		NA		351		136	J	NA		NA	
Arsenic	NA		NA		NA		NA		3.77	J	NA		-	U	-	U	NA		NA	
Perchlorate	NA		NA		NA		NA		10.5		9.17		8.04	J	10.5		8.94		NA	
2-Nitrotoluene	NA		NA		NA		NA		0.525		-	U	-	U	-	U	-	UJ	NA	
Nitrobenzene	NA		NA		NA		NA		-	U	-	U	0.0852	J	-	U	-	UJ	NA	
bis(2-Ethylhexyl)phthalate	NA		NA		1.8		NA		-	U	-	U	4.87	J	-	U	-	U	NA	
Naphthalene	NA		NA		1.5	J	NA		-	U	-	U	-	U	-	U	0.31		0.57	UB
Trichloroethene	-	U	-	U	3	J	0.18	J	7.75	J	0.68	J	-	U	-	U	-	U	NA	

Location	115-RS2411					
Sample Date	17-Jun-14		5-Dec-14		28-Jan-19	
Sample Depth (feet)	151 - 151		158 - 158		160 - 160	
Parameter	Result	Q	Result	Q	Result	Q
Aluminum	2360		2980		1160	J
Arsenic	12.5		13.9		31.4	J
Vanadium	32.2		28.6		24.6	
1,3-Dinitrobenzene	0.508	J	-	U	0.52	J
2,6-Dinitrotoluene	0.246	J	-	U	1.4	J
2-Nitrotoluene	0.538	J	0.562		-	U
Nitrobenzene	4.29	J	2.35	J	1.6	J
Benzo(a)anthracene	-	U	0.0331	J	-	U
Naphthalene	-	U	-	U	0.013	J
Benzene	1.08		-	U	0.22	J
Bromomethane	-	UJ	-	U	1.8	J

Location	115-RS2413					
Sample Date	16-Jun-14		4-Dec-14		24-Jan-19	
Sample Depth (feet)	138 - 138		145 - 145		150 - 150	
Parameter	Result	Q	Result	Q	Result	Q
Aluminum	357		200		NA	
Vanadium	-	U	5.54	J	NA	
Trichloroethene	-	U	102		2.9	

Location	N115-RS467							
Sample Date	29-May-14		2-Dec-14		22-Jan-19		6-Apr-20	
Sample Depth (feet)	48 - 48		48 - 48		44 - 44		45 - 45	
Parameter	Result	Q	Result	Q	Result	Q	Result	Q
Aluminum	79.9	J	301		NA		NA	
Perchlorate	-	U	-	U	0.281	J	NA	
2-Nitrotoluene	-	U	0.167	J	-	U	NA	
bis(2-Ethylhexyl)phthalate	4.9	J	1.97	J	-	U	NA	
Naphthalene	-	U	-	U	0.35		0.18	UB
Trichloroethene	-	U	1.49		-	U	NA	

Location	N115-RS432															
Sample Date	10-Jun-92		8-Aug-00		9-Feb-09		31-Oct-11		20-Dec-12		29-May-14		4-Dec-14		30-Jan-19	
Sample Depth (feet)	0 - 0		175.9 - 175.9		205 - 205		205 - 205		203 - 203		204 - 204		200 - 200		205 - 205	
Parameter	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Aluminum	NA		NA		NA		83.7	J	NA		-	U	67.3	J	NA	
2-Nitrotoluene	NA		NA		NA		-	U	-	U	-	U	0.196	J	-	U
Nitrobenzene	NA		NA		NA		0.15	J	-	U	-	U	-	U	-	U
Nitroglycerin	NA		NA		NA		0.902	J	-	UJ	-	U	-	U	-	U
Benzo(a)anthracene	NA		NA		NA		-	U	-	U	-	U	0.0265	J	-	U
bis(2-Ethylhexyl)phthalate	NA		NA		NA		-	U	-	U	4.87	J	3.64	J	-	U
Pentachlorophenol	NA		NA		NA		-	U	-	U	-	U	-	UJ	4.2	J
Trichloroethene	-	UJ	NA		7.6	J	1.29	J	0.47	J	-	U	-	U	-	U

Location	115-RS2412							
Sample Date	16-Jun-14		3-Dec-14		30-Jul-15		7-Dec-17	
Sample Depth (feet)	190 - 190		184 - 184		192 - 192		192 - 192	
Parameter	Result	Q	Result	Q	Result	Q	Result	Q
Aluminum	593		137	J	NA		-	U
1,3-Dinitrobenzene	0.889	J	-	U	NA		-	U
2-Nitrotoluene	0.835		1.92		NA		-	U
Nitrobenzene	-	U	-	U	NA		0.776	J
Nitroglycerin	0.232	J	-	U	NA		-	U
Benzo(a)anthracene	0.0456	J	-	U	NA		-	U
bis(2-Ethylhexyl)phthalate	-	U	6.27		NA		-	U
Naphthalene	0.224		-	U	NA		0.0675	J
Benzene	56.4		-	U	NA		2.42	

Location	115-RS2800			
Sample Date	4-Apr-16		6-Dec-17	
Sample Depth (feet)	181.5 - 181.5		177 - 177	
Parameter	Result	Q	Result	Q
Aluminum	173	J	191	J
1,3-Dinitrobenzene	-	U	0.106	J
2-Nitrotoluene	-	UJ	0.734	J
Nitrobenzene	0.0787	J	0.323	J
Benzo(a)anthracene	0.0279	J	-	U

Screening Criteria			
Parameter	Units	BSV	PSV
Aluminum	µg/L	1259	2000
Arsenic	µg/L	5.14	10
Vanadium	µg/L	9.17	8.6
Perchlorate	µg/L	NA	**15**
1,3-Dinitrobenzene	µg/L	NA	0.2
2,6-Dinitrotoluene	µg/L	NA	0.049
2-Nitrotoluene	µg/L	NA	0.31
Nitrobenzene	µg/L	NA	0.14
Nitroglycerin	µg/L	NA	0.2
Benzo(a)anthracene	µg/L	NA	0.03
Bis(2-ethylhexyl)phthalate	µg/L	NA	6
Naphthalene	µg/L	NA	0.17
Pentachlorophenol	µg/L	NA	1
Benzene	µg/L	NA	5
Bromomethane	µg/L	NA	0.75
Trichloroethene	µg/L	NA	5

Legend

- RSA-115
- Inferred Bedrock Groundwater Flow Direction
- Inferred Deep Bedrock Groundwater Flow Direction
- Building
- Approximate Extent of Lagoon Limits
- Flume Boundary
- Bedrock Well
- Deep Bedrock Well

Notes:
1. Bolded data indicates detection.
2. Yellow highlighted data indicates exceedance of PSV.
3. µg/L = micrograms per liter
4. NA = not analyzed
5. - = not detected above laboratory detection limit.
6. J = The analyte was positively identified, but the associated numerical value is estimated and represents the approximate concentration of the analyte in the sample.
7. U = The analyte was not detected above the reported sample limit of detection (LOD) or limit of quantitation (LOQ).
8. UJ = The analyte was not detected above the reported sample LOD or LOQ. However, the reported quantitation limit is approximate.
9. UB = Concentrations determined to be present as a result of contamination
10. PSV = preliminary screening value
11. BSV = background screening value
12. Q = validated data qualifier
13. nv = not validated

Figure 2-1
RSA-115
Detections of Constituents of Concern in Groundwater

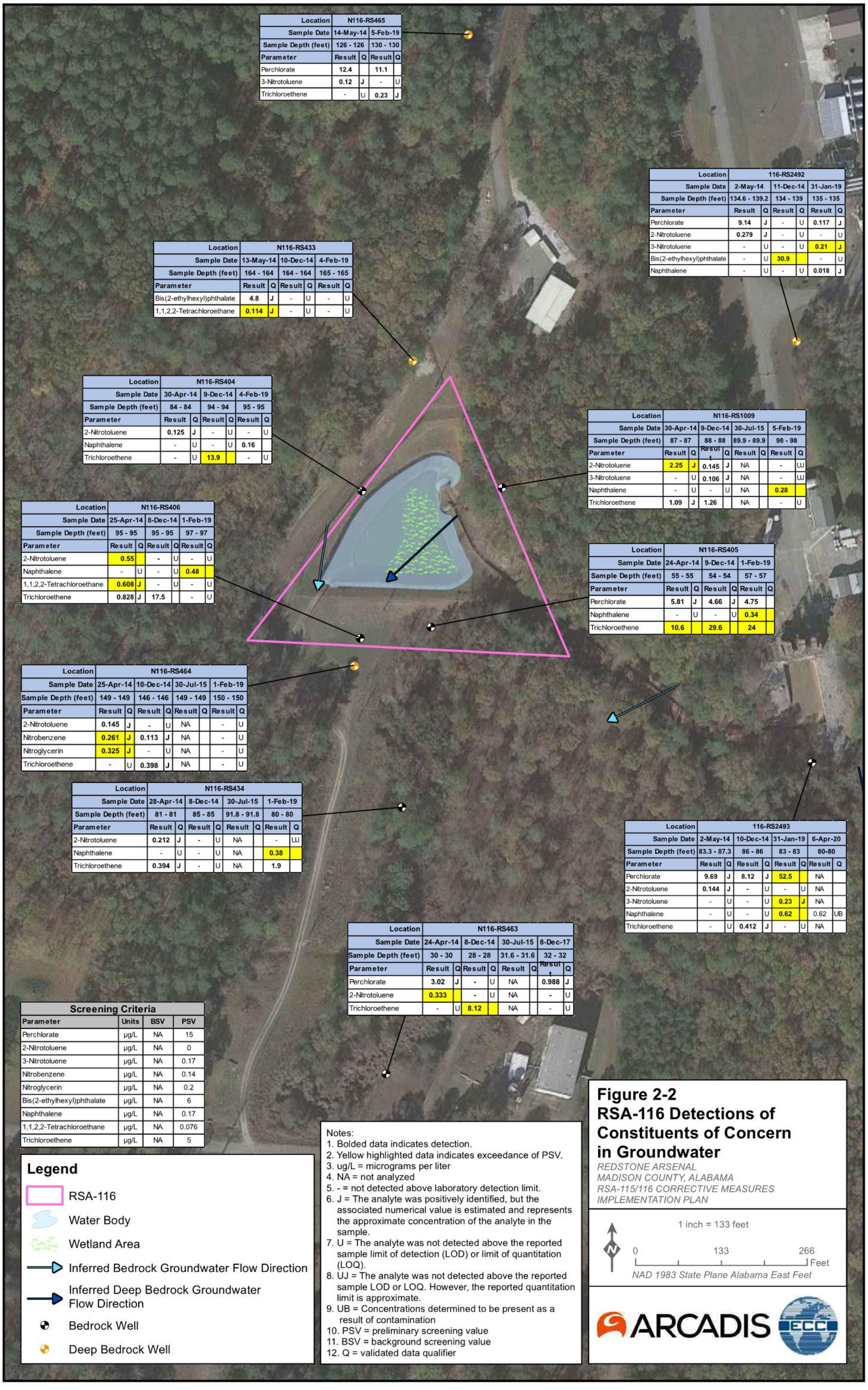
REDSTONE ARSENAL
MADISON COUNTY, ALABAMA
RSA-115/116 CORRECTIVE MEASURES IMPLEMENTATION PLAN

1 inch = 125 feet

0 125 250 Feet

NAD 1983 State Plane Alabama East Feet

ARCADIS ECC



Location	N116-RS465			
Sample Date	14-May-14		5-Feb-19	
Sample Depth (feet)	126 - 126		130 - 130	
Parameter	Result	Q	Result	Q
Perchlorate	12.4		11.1	
3-Nitrotoluene	0.12	J	-	U
Trichloroethene	-	U	0.23	J

Location	116-RS2492					
Sample Date	2-May-14		11-Dec-14		31-Jan-19	
Sample Depth (feet)	134.6 - 139.2		134 - 139		135 - 135	
Parameter	Result	Q	Result	Q	Result	Q
Perchlorate	9.14	J	-	U	0.117	J
2-Nitrotoluene	0.279	J	-	U	-	U
3-Nitrotoluene	-	U	-	U	0.21	J
Bis(2-ethylhexyl)phthalate	-	U	30.9		-	U
Naphthalene	-	U	-	U	0.018	J

Location	N116-RS433					
Sample Date	13-May-14		10-Dec-14		4-Feb-19	
Sample Depth (feet)	164 - 164		164 - 164		165 - 165	
Parameter	Result	Q	Result	Q	Result	Q
Bis(2-ethylhexyl)phthalate	4.8	J	-	U	-	U
1,1,2,2-Tetrachloroethane	0.114	J	-	U	-	U

Location	N116-RS404					
Sample Date	30-Apr-14		9-Dec-14		4-Feb-19	
Sample Depth (feet)	84 - 84		94 - 94		95 - 95	
Parameter	Result	Q	Result	Q	Result	Q
2-Nitrotoluene	0.125	J	-	U	-	U
Naphthalene	-	U	-	U	0.16	
Trichloroethene	-	U	13.9		-	U

Location	N116-RS1009							
Sample Date	30-Apr-14		9-Dec-14		30-Jul-15		5-Feb-19	
Sample Depth (feet)	87 - 87		88 - 88		89.9 - 89.9		98 - 98	
Parameter	Result	Q	Result	Q	Result	Q	Result	Q
2-Nitrotoluene	2.25	J	0.145	J	NA		-	UJ
3-Nitrotoluene	-	U	0.106	J	NA		-	UJ
Naphthalene	-	U	-	U	NA		0.28	
Trichloroethene	1.09	J	1.26		NA		-	U

Location	N116-RS406					
Sample Date	25-Apr-14		8-Dec-14		1-Feb-19	
Sample Depth (feet)	95 - 95		95 - 95		97 - 97	
Parameter	Result	Q	Result	Q	Result	Q
2-Nitrotoluene	0.55		-	U	-	U
Naphthalene	-	U	-	U	0.48	
1,1,2,2-Tetrachloroethane	0.608	J	-	U	-	U
Trichloroethene	0.828	J	17.5		-	U

Location	N116-RS405					
Sample Date	24-Apr-14		9-Dec-14		1-Feb-19	
Sample Depth (feet)	55 - 55		54 - 54		57 - 57	
Parameter	Result	Q	Result	Q	Result	Q
Perchlorate	5.81	J	4.66	J	4.75	
Naphthalene	-	U	-	U	0.34	
Trichloroethene	10.6		29.6		24	

Location	N116-RS464							
Sample Date	25-Apr-14		10-Dec-14		30-Jul-15		1-Feb-19	
Sample Depth (feet)	149 - 149		146 - 146		149 - 149		150 - 150	
Parameter	Result	Q	Result	Q	Result	Q	Result	Q
2-Nitrotoluene	0.145	J	-	U	NA		-	U
Nitrobenzene	0.261	J	0.113	J	NA		-	U
Nitroglycerin	0.325	J	-	U	NA		-	U
Trichloroethene	-	U	0.398	J	NA		-	U

Location	N116-RS434							
Sample Date	28-Apr-14		8-Dec-14		30-Jul-15		1-Feb-19	
Sample Depth (feet)	81 - 81		85 - 85		91.8 - 91.8		80 - 80	
Parameter	Result	Q	Result	Q	Result	Q	Result	Q
2-Nitrotoluene	0.212	J	-	U	NA		-	UJ
Naphthalene	-	U	-	U	NA		0.38	
Trichloroethene	0.394	J	-	U	NA		1.9	

Location	116-RS2493							
Sample Date	2-May-14		10-Dec-14		31-Jan-19		6-Apr-20	
Sample Depth (feet)	83.3 - 87.3		86 - 86		83 - 83		80-80	
Parameter	Result	Q	Result	Q	Result	Q	Result	Q
Perchlorate	9.69	J	8.12	J	52.5		NA	
2-Nitrotoluene	0.144	J	-	U	-	U	NA	
3-Nitrotoluene	-	U	-	U	0.23	J	NA	
Naphthalene	-	U	-	U	0.62		0.62	UB
Trichloroethene	-	U	0.412	J	-	U	NA	

Location	N116-RS463							
Sample Date	24-Apr-14		8-Dec-14		30-Jul-15		8-Dec-17	
Sample Depth (feet)	30 - 30		28 - 28		31.6 - 31.6		32 - 32	
Parameter	Result	Q	Result	Q	Result	Q	Result	Q
Perchlorate	3.02	J	-	U	NA		0.988	J
2-Nitrotoluene	0.333		-	U	NA		-	U
Trichloroethene	-	U	8.12		NA		-	U

Screening Criteria			
Parameter	Units	BSV	PSV
Perchlorate	µg/L	NA	15
2-Nitrotoluene	µg/L	NA	0
3-Nitrotoluene	µg/L	NA	0.17
Nitrobenzene	µg/L	NA	0.14
Nitroglycerin	µg/L	NA	0.2
Bis(2-ethylhexyl)phthalate	µg/L	NA	6
Naphthalene	µg/L	NA	0.17
1,1,2,2-Tetrachloroethane	µg/L	NA	0.076
Trichloroethene	µg/L	NA	5

Legend

- RSA-116
- Water Body
- Wetland Area
- Inferred Bedrock Groundwater Flow Direction
- Inferred Deep Bedrock Groundwater Flow Direction
- Bedrock Well
- Deep Bedrock Well

Notes:
1. Bolded data indicates detection.
2. Yellow highlighted data indicates exceedance of PSV.
3. ug/L = micrograms per liter
4. NA = not analyzed
5. - = not detected above laboratory detection limit.
6. J = The analyte was positively identified, but the associated numerical value is estimated and represents the approximate concentration of the analyte in the sample.
7. U = The analyte was not detected above the reported sample limit of detection (LOD) or limit of quantitation (LOQ).
8. UJ = The analyte was not detected above the reported sample LOD or LOQ. However, the reported quantitation limit is approximate.
9. UB = Concentrations determined to be present as a result of contamination
10. PSV = preliminary screening value
11. BSV = background screening value
12. Q = validated data qualifier

Figure 2-2
RSA-116 Detections of Constituents of Concern in Groundwater

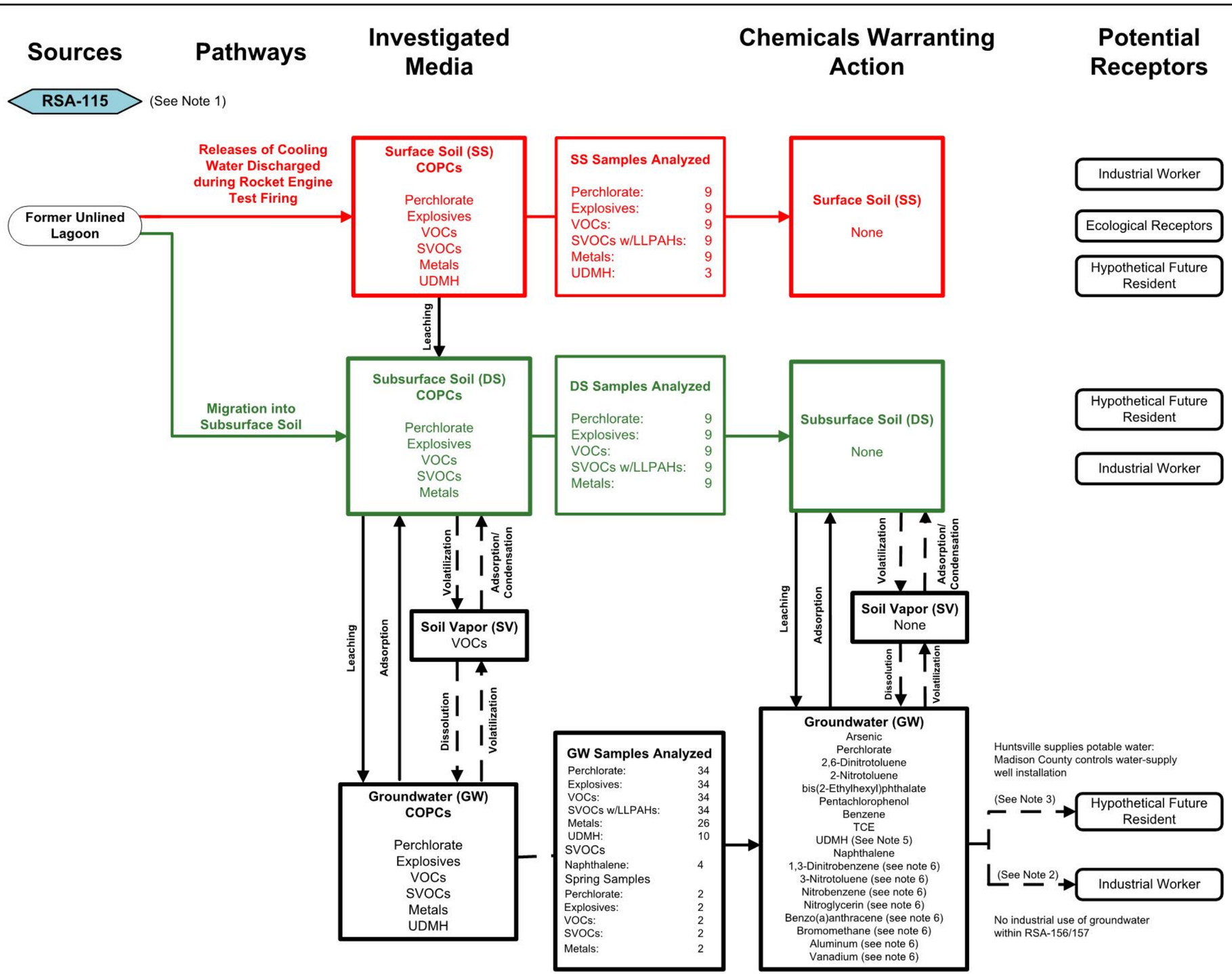
REDSTONE ARSENAL
MADISON COUNTY, ALABAMA
RSA-115/116 CORRECTIVE MEASURES IMPLEMENTATION PLAN

1 inch = 133 feet

0 133 266 Feet

NAD 1983 State Plane Alabama East Feet

ARCADIS ECC



LEGEND:

Known/Assumed Transport

Potential Transport

NOTES:

1. The current and anticipated future land use of this area is designated as industrial.
2. At Redstone Arsenal, unmanaged exposure to Installation Restoration Program sites is prevented by the Arsenal's Site Access Control Program. Current and potential future receptors include groundskeeper and industrial worker. The residential receptor evaluation will determine if the site is safe for trespassers.
3. The hypothetical residential receptor provides the basis for establishing some remedial responses including justification for the selection of land-use controls. Sites that do not exceed acceptable risk limits for a residential receptor can be released for any use without restriction.
4. Samples were analyzed for TCL VOCs, SVOCs, Explosives, Perchlorate, UDMH, and TAL metals. Not all chemicals on these standard lists are within the CSM of this site. See the text in Section 1.8 for discussion.
5. UDMH is a COC because the analytical detection limit exceeded the PSV and UDMH is in the conceptual site model.
6. The following chemicals will be included in the corrective measures for groundwater at this site because they occurred at concentrations greater than associated groundwater screening values:1,3-Dinitrobenzene, 3-Nitrotoluene, Nitrobenzene, Nitroglycerin, Benzo(a)anthracene, Bromomethane, Aluminum, and Vanadium.

ACRONYMS:

COPCs	Chemicals of Potential Concern
LL	Low Level
PAHs	Polynuclear Aromatic Hydrocarbons
SVOCs	Semivolatile Organic Compounds
TAL	Target Analyte List
TCE	Trichloroethene
TCL	Target Compound List
UDMH	Unsymmetrical Dimethyl Hydrazine
VOCs	Volatile Organic Compounds

Common acronyms are listed in the report acronyms list.

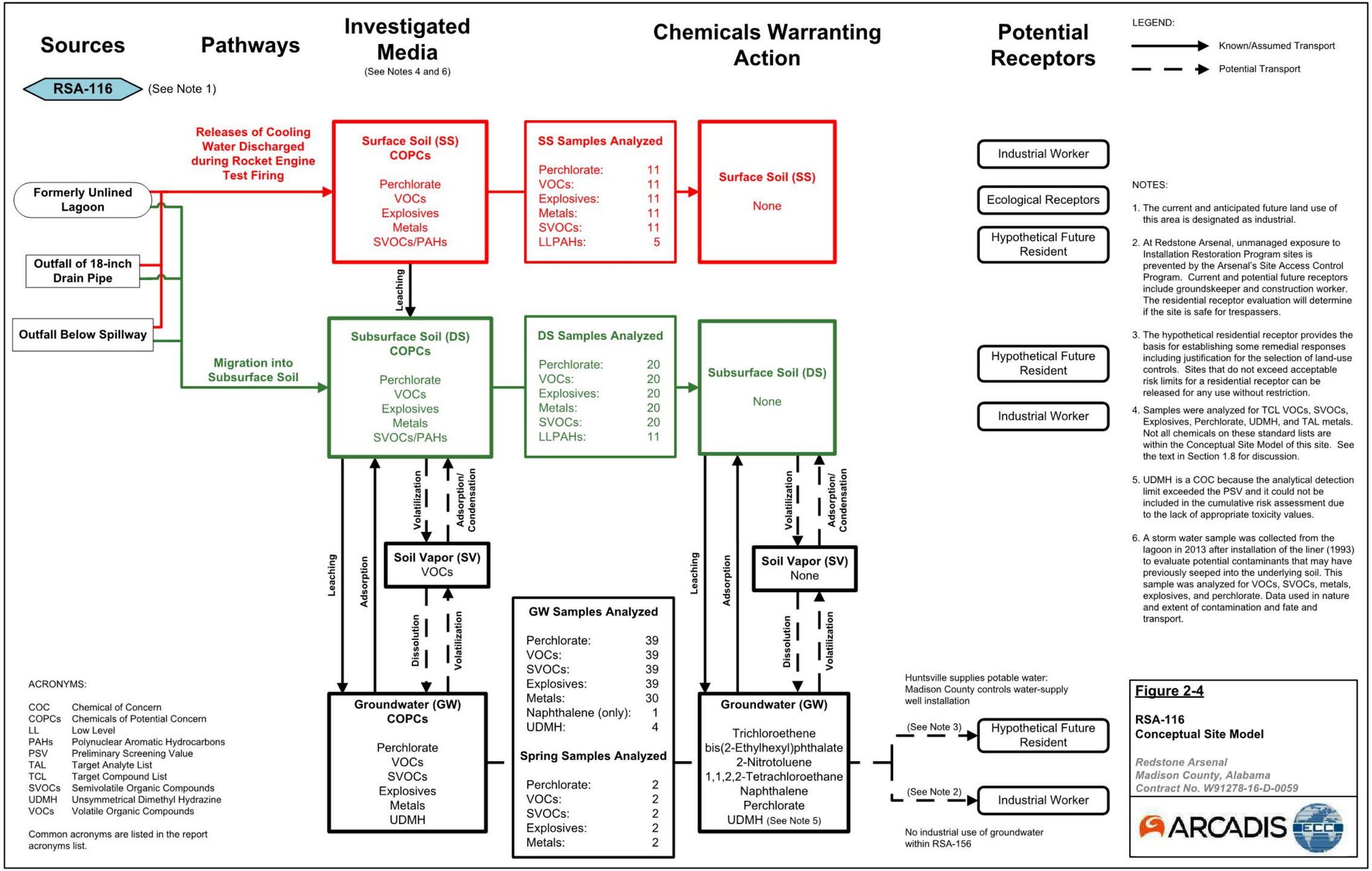
Figure 2-3

RSA-115
Conceptual Site Model

Redstone Arsenal
Madison County, Alabama
Contract No. W91278-16-D-0059

ARCADIS ECC

Figure from RCRA Facility Investigation Report, RSA-115 Revision 3, Figure 1-7



ACRONYMS:

COC	Chemical of Concern
COPCs	Chemicals of Potential Concern
LL	Low Level
PAHs	Polynuclear Aromatic Hydrocarbons
PSV	Preliminary Screening Value
TAL	Target Analyte List
TCL	Target Compound List
SVOCs	Semivolatile Organic Compounds
UDMH	Unsymmetrical Dimethyl Hydrazine
VOCs	Volatile Organic Compounds

Common acronyms are listed in the report acronyms list.

NOTES:

1. The current and anticipated future land use of this area is designated as industrial.
2. At Redstone Arsenal, unmanaged exposure to Installation Restoration Program sites is prevented by the Arsenal's Site Access Control Program. Current and potential future receptors include groundskeeper and construction worker. The residential receptor evaluation will determine if the site is safe for trespassers.
3. The hypothetical residential receptor provides the basis for establishing some remedial responses including justification for the selection of land-use controls. Sites that do not exceed acceptable risk limits for a residential receptor can be released for any use without restriction.
4. Samples were analyzed for TCL VOCs, SVOCs, Explosives, Perchlorate, UDMH, and TAL metals. Not all chemicals on these standard lists are within the Conceptual Site Model of this site. See the text in Section 1.8 for discussion.
5. UDMH is a COC because the analytical detection limit exceeded the PSV and it could not be included in the cumulative risk assessment due to the lack of appropriate toxicity values.
6. A storm water sample was collected from the lagoon in 2013 after installation of the liner (1993) to evaluate potential contaminants that may have previously seeped into the underlying soil. This sample was analyzed for VOCs, SVOCs, metals, explosives, and perchlorate. Data used in nature and extent of contamination and fate and transport.

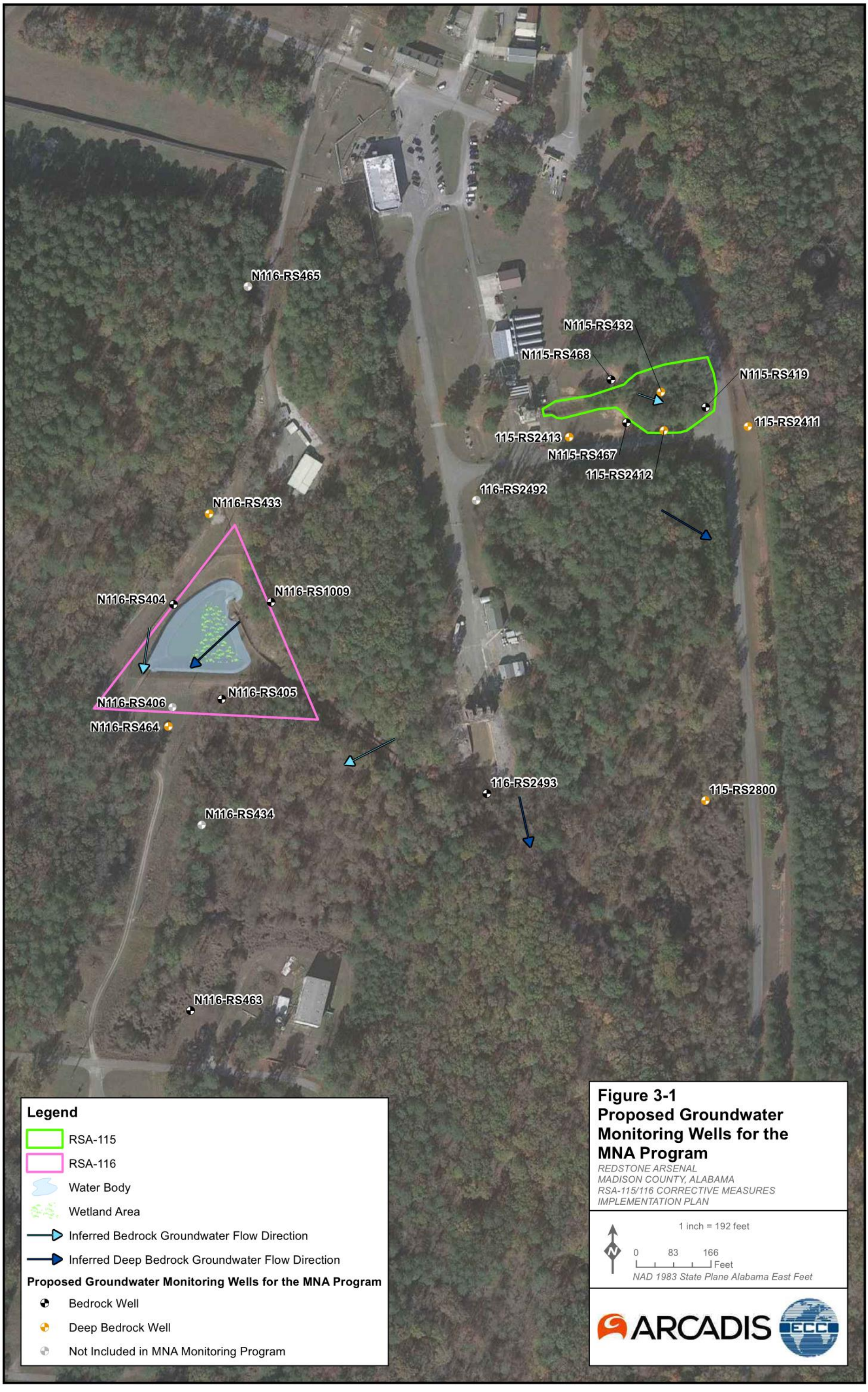
Figure 2-4

RSA-116
Conceptual Site Model

Redstone Arsenal
Madison County, Alabama
Contract No. W91278-16-D-0059

ARCADIS ECC

Figure from RCRA Facility Investigation Report, RSA-116 Revision 4, Figure 1-9


N116-RS465
N115-RS432
N115-RS468
N115-RS419
115-RS2411
115-RS2413
N115-RS467
115-RS2412
116-RS2492
N116-RS433
N116-RS404
N116-RS1009
N116-RS405
N116-RS406
N116-RS464
116-RS2493
115-RS2800
N116-RS434
N116-RS463
Legend
RSA-115
RSA-116
Water Body
Wetland Area
Inferred Bedrock Groundwater Flow Direction
Inferred Deep Bedrock Groundwater Flow Direction
Proposed Groundwater Monitoring Wells for the MNA Program
Bedrock Well
Deep Bedrock Well
Not Included in MNA Monitoring Program
Figure 3-1
Proposed Groundwater Monitoring Wells for the MNA Program
REDSTONE ARSENAL
MADISON COUNTY, ALABAMA
RSA-115/116 CORRECTIVE MEASURES IMPLEMENTATION PLAN
1 inch = 192 feet
N
0 83 166
Feet
NAD 1983 State Plane Alabama East Feet
ARCADIS
ECC

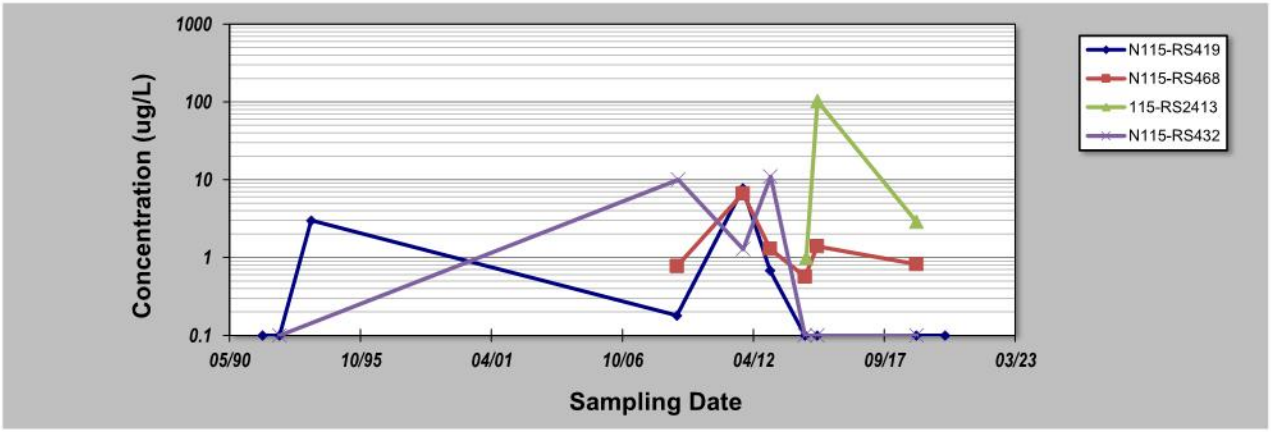
APPENDIX A

MANN KENDALL ANALYSIS

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	29-Jul-22	Job ID:	-
Facility Name:	Redstone Arsenal	Constituent:	TCE
Conducted By:	Whitney Plasket	Concentration Units:	ug/L

Sampling Point ID:	N115-RS419	N115-RS468	115-RS2413	N115-RS432			
Sampling Event	Sampling Date	TCE CONCENTRATION (ug/L)						
1	25-Sep-91	0.1						
2	10-Jun-92	0.1			0.1			
3	7-Oct-93	3						
4	21-Jan-09	0.18	0.78					
5	9-Feb-09				10			
6	25-Oct-11	7.75	6.7					
7	31-Oct-11				1.29			
8	12-Dec-12	0.68						
9	13-Dec-12		1.3					
10	20-Dec-12				11			
11	28-May-14	0.1	0.57					
12	29-May-14				0.1			
13	16-Jun-14			1				
14	2-Dec-14		1.4					
15	3-Dec-14	0.1						
16	4-Dec-14			103	0.1			
17	22-Jan-19	0.1	0.82					
18	24-Jan-19			2.9				
19	30-Jan-19				0.1			
20	7-Apr-20	0.1						
21								
22								
23								
24								
25								
Coefficient of Variation:		2.02	1.22	1.64	1.54			
Mann-Kendall Statistic (S):		-8	-1	1	-5			
Confidence Factor:		72.9%	50.0%		71.9%			
Concentration Trend:		No Trend	No Trend		No Trend			



Notes:

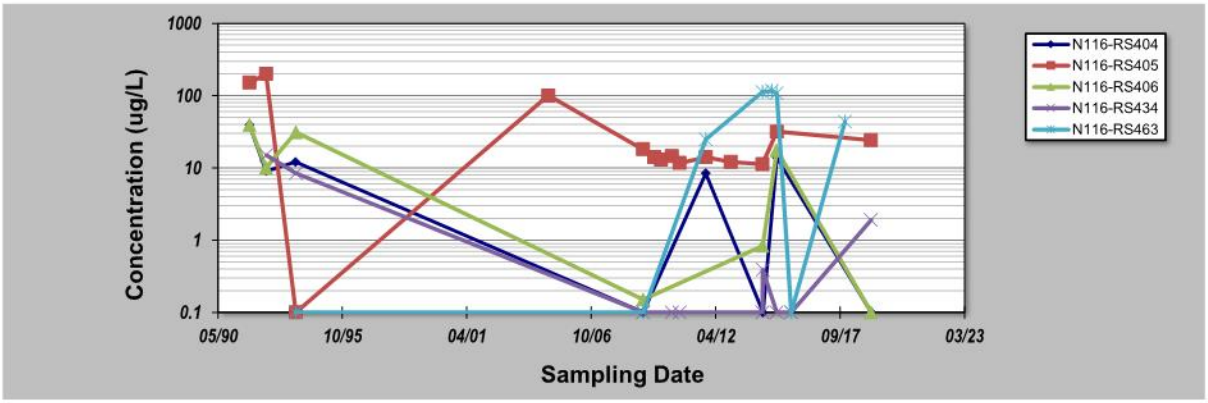
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

DISCLAIMER: *The GSI Mann-Kendall Toolkit is available "as is". Considerable care has been exercised in preparing this software product; however, no party, including without limitation GSI Environmental Inc., makes any representation or warranty regarding the accuracy, correctness, or completeness of the information contained herein, and no such party shall be liable for any direct, indirect, consequential, incidental or other damages resulting from the use of this product or the information contained herein. Information in this publication is subject to change without notice. GSI Environmental Inc., disclaims any responsibility or obligation to update the information contained herein.*

GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	29-Jul-22	Job ID:	-
Facility Name:	Redstone Arsenal	Constituent:	TCE
Conducted By:	Whitney Plasket	Concentration Units:	ug/L

Sampling Point ID:	N116-RS404	N116-RS405	N116-RS406	N116-RS434	N116-RS463		
Sampling Event	Sampling Date	TCE CONCENTRATION (ug/L)						
1	24-Sep-91	39	150	39				
2	19-Jun-92	9	200	10	15			
3	7-Oct-93	12				0.1		
4	8-Oct-93		0.1	31	8.4			
5	18-Nov-04		100					
6	21-Jan-09		18	0.15	0.1	0.1		
7	22-Jan-09	0.1						
8	22-Jul-09		14					
9	2-Nov-09		13					
10	26-Apr-10		14.6					
11	27-Apr-10				0.1			
12	30-Aug-10		11.6		0.1			
13	24-Oct-11					24.8		
14	25-Oct-11	8.38	14					
15	29-Nov-12		12.1					
16	24-Apr-14		11.2		0.1	112		
17	25-Apr-14			0.83				
18	28-Apr-14				0.39			
19	30-Apr-14	0.1						
20	17-Sep-14					116		
21	8-Dec-14			17.5	0.1	107		
22	9-Dec-14	13.9	31.6					
23	30-Jul-15				0.1	0.1		
24	8-Dec-17					43.5		
25	1-Feb-19		24	0.1	1.9			
26	4-Feb-19	0.1						
27								
28								
29								
30								
Coefficient of Variation:		1.25	1.39	1.12	1.92	1.05		
Mann-Kendall Statistic (S):		-11	-24	-11	-8	7		
Confidence Factor:		88.7%	89.4%	93.2%	72.9%	76.4%		
Concentration Trend:		No Trend	No Trend	Prob. Decreasing	No Trend	No Trend		



Notes:

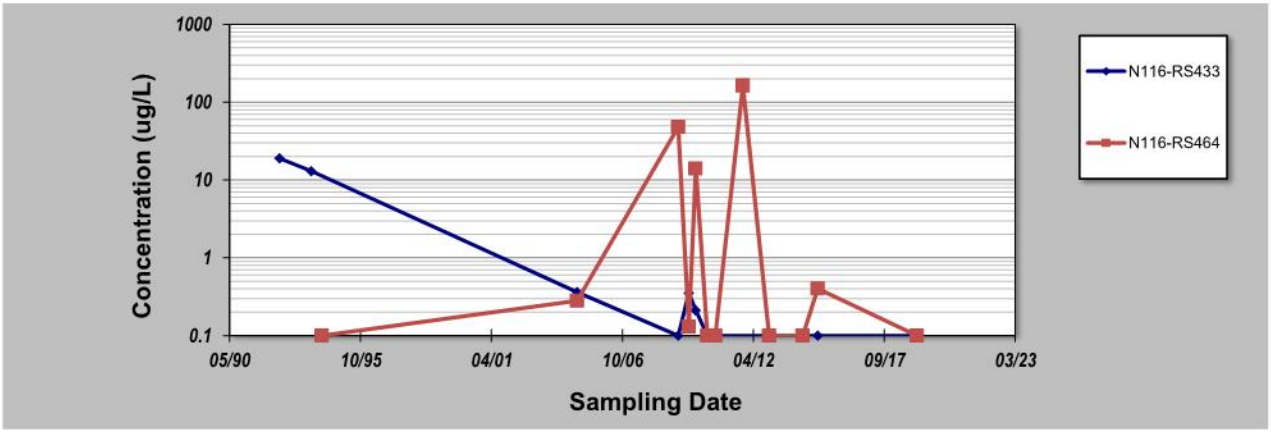
1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water* , 41(3):355-367, 2003.

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GSI MANN-KENDALL TOOLKIT
for Constituent Trend Analysis

Evaluation Date:	29-Jul-22	Job ID:	-
Facility Name:	Redstone Arsenal	Constituent:	TCE
Conducted By:	Whitney Plasket	Concentration Units:	ug/L

Sampling Point ID:	N116-RS433	N116-RS464					
Sampling Event	Sampling Date	TCE CONCENTRATION (ug/L)						
1	10-Jun-92	19						
2	8-Oct-93	13						
3	16-Mar-94		0.1					
4	18-Nov-04	0.36	0.28					
5	9-Feb-09	0.1	48					
6	22-Jul-09	0.35	0.13					
7	2-Nov-09	0.21	14					
8	28-Apr-10	0.1	0.1					
9	30-Aug-10		0.1					
10	31-Aug-10	0.1						
11	26-Oct-11		163					
12	28-Nov-12	0.1						
13	29-Nov-12		0.1					
14	25-Apr-14		0.1					
15	13-May-14	0.1						
16	10-Dec-14	0.1	0.4					
17	1-Feb-19		0.1					
18	4-Feb-19	0.1						
19								
20								
Coefficient of Variation:		2.25	2.52					
Mann-Kendall Statistic (S):		-41	-9					
Confidence Factor:		99.8%	70.4%					
Concentration Trend:		Decreasing	No Trend					



Notes:

1. At least four independent sampling events per well are required for calculating the trend. *Methodology is valid for 4 to 40 samples.*
2. Confidence in Trend = Confidence (in percent) that constituent concentration is increasing (S>0) or decreasing (S<0): >95% = Increasing or Decreasing; ≥ 90% = Probably Increasing or Probably Decreasing; < 90% and S>0 = No Trend; < 90%, S≤0, and COV ≥ 1 = No Trend; < 90% and COV < 1 = Stable.
3. Methodology based on "MAROS: A Decision Support System for Optimizing Monitoring Plans", J.J. Aziz, M. Ling, H.S. Rifai, C.J. Newell, and J.R. Gonzales, *Ground Water*, 41(3):355-367, 2003.

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APPENDIX B

RISK-BASED TARGET LEVEL CALCULATIONS

Appendix B
Risk Calculations
RSA-115/ 116 Corrective Measures Implementation Plan

Variable	Resident Tap Water Default Value	Site-Specific Value
BW_{0-2} (mutagenic body weight) kg	15	15
BW_{2-6} (mutagenic body weight) kg	15	15
BW_{6-16} (mutagenic body weight) kg	80	80
BW_{16-26} (mutagenic body weight) kg	80	80
BW_{res-a} (body weight - adult) kg	80	80
BW_{res-c} (body weight - child) kg	15	15
$DFW_{res-adj}$ (age-adjusted dermal factor) cm^2-event/kg	2610650	2610650
$DFWM_{res-adj}$ (mutagenic age-adjusted dermal factor) cm^2-event/kg	8191633	8191633
ED_{res} (exposure duration - resident) years	26	26
ED_{0-2} (mutagenic exposure duration first phase) years	2	2
ED_{2-6} (mutagenic exposure duration second phase) years	4	4
ED_{6-16} (mutagenic exposure duration third phase) years	10	10
ED_{16-26} (mutagenic exposure duration fourth phase) years	10	10
ED_{res-a} (exposure duration - adult) years	20	20
ED_{res-c} (exposure duration - child) years	6	6
EF_{res} (exposure frequency) days/year	350	350
EF_{0-2} (mutagenic exposure frequency first phase) days/year	350	350
EF_{2-6} (mutagenic exposure frequency second phase) days/year	350	350
EF_{6-16} (mutagenic exposure frequency third phase) days/year	350	350
EF_{16-26} (mutagenic exposure frequency fourth phase) days/year	350	350
EF_{res-a} (exposure frequency - adult) days/year	350	350
EF_{res-c} (exposure frequency - child) days/year	350	350
ET_{res} (exposure time) hours/day	24	24
$ET_{event-res-adj}$ (age-adjusted exposure time) hours/event	0.67077	0.67077
$ET_{event-res-madj}$ (mutagenic age-adjusted exposure time) hours/event	0.67077	0.67077
ET_{0-2} (mutagenic dermal exposure time first phase) hours/event	0.54	0.54
ET_{2-6} (mutagenic dermal exposure time second phase) hours/event	0.54	0.54
ET_{6-16} (mutagenic dermal exposure time third phase) hours/event	0.71	0.71
ET_{16-26} (mutagenic dermal exposure time fourth phase) hours/event	0.71	0.71
ET_{res-a} (dermal exposure time - adult) hours/event	0.71	0.71
ET_{res-c} (dermal exposure time - child) hours/event	0.54	0.54
ET_{0-2} (mutagenic inhalation exposure time first phase) hours/day	24	24
ET_{2-6} (mutagenic inhalation exposure time second phase) hours/day	24	24
ET_{6-16} (mutagenic inhalation exposure time third phase) hours/day	24	24
ET_{16-26} (mutagenic inhalation exposure time fourth phase) hours/day	24	24
ET_{res-a} (inhalation exposure time - adult) hours/day	24	24
ET_{res-c} (inhalation exposure time - child) hours/day	24	24
EV_{0-2} (mutagenic events) per day	1	1
EV_{2-6} (mutagenic events) per day	1	1
EV_{6-16} (mutagenic events) per day	1	1
EV_{16-26} (mutagenic events) per day	1	1
EV_{res-a} (events - adult) per day	1	1
EV_{res-c} (events - child) per day	1	1
THQ (target hazard quotient) unitless	0.1	0.1
$IFW_{res-adj}$ (adjusted intake factor) L/kg	327.95	327.95
$IFWM_{res-adj}$ (mutagenic adjusted intake factor) L/kg	1019.9	1019.9
IRW_{0-2} (mutagenic water intake rate) L/day	0.78	0.78
IRW_{2-6} (mutagenic water intake rate) L/day	0.78	0.78
IRW_{6-16} (mutagenic water intake rate) L/day	2.5	2.5
IRW_{16-26} (mutagenic water intake rate) L/day	2.5	2.5
IRW_{res-a} (water intake rate - adult) L/day	2.5	2.5
IRW_{res-c} (water intake rate - child) L/day	0.78	0.78
K (volatilization factor of Andelman) L/m^3	0.5	0.5
LT (lifetime) years	70	70
SA_{0-2} (mutagenic skin surface area) cm^2	6365	6365
SA_{2-6} (mutagenic skin surface area) cm^2	6365	6365
SA_{6-16} (mutagenic skin surface area) cm^2	19652	19652
SA_{16-26} (mutagenic skin surface area) cm^2	19652	19652
SA_{res-a} (skin surface area - adult) cm^2	19652	19652
SA_{res-c} (skin surface area - child) cm^2	6365	6365
l_{sc} (apparent thickness of stratum corneum) cm	0.001	0.001
TR (target risk) unitless	0.000001	0.000001

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Site-specific

Resident Risk-Based Regional Screening Levels (RSL) for Tap Water

Chemical	CAS Number	Mutagen?	Volatile?	Chemical Type	SF_o(mg/kg-day)$^{-1}$	SF_oRef	IUR (ug/m^3)$^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	K_p (cm/hr)	MW	B (unitless)	t^*(hr)	τ_{event}(hr/event)	FA (unitless)	In EPD?	$DA_{event\ (ca)}$	$DA_{event\ (nc\ child)}$	$DA_{event\ (nc\ adult)}$
Aluminum	7429-90-5	No	No	Inorganics	-		-		1.00E+00	P	5.00E-03	P	1.00E+00	1.00E-03	2.70E+01	2.00E-03	3.57E-01	1.49E-01	1.00E+00	Yes	-	2.46E-01	4.25E-01
Arsenic, Inorganic	7440-38-2	No	No	Inorganics	1.50E+00	I	4.30E-03	I	3.00E-04	I	1.50E-05	C	1.00E+00	1.00E-03	7.49E+01	3.33E-03	6.63E-01	2.76E-01	1.00E+00	Yes	6.52E-06	7.37E-05	1.27E-04
Benz[a]anthracene	56-55-3	Yes	Yes	Organics	1.00E-01	E	6.00E-05	E	-		-		1.00E+00	5.52E-01	2.28E+02	3.21E+00	8.48E+00	2.00E+00	1.00E+00	No	-	-	-
Benzene	71-43-2	No	Yes	Organics	5.50E-02	I	7.80E-06	I	4.00E-03	I	3.00E-02	I	1.00E+00	1.49E-02	7.81E+01	5.07E-02	6.91E-01	2.88E-01	1.00E+00	Yes	1.78E-04	9.83E-04	1.70E-03
Bis(2-ethylhexyl)phthalate	117-81-7	No	No	Organics	1.40E-02	I	2.40E-06	C	2.00E-02	I	-		1.00E+00	1.13E+00	3.91E+02	8.59E+00	7.29E+01	1.62E+01	8.00E-01	No	-	-	-
Bromomethane	74-83-9	No	Yes	Organics	-		-		1.40E-03	I	5.00E-03	I	1.00E+00	2.84E-03	9.49E+01	1.06E-02	8.58E-01	3.58E-01	1.00E+00	Yes	-	3.44E-04	5.94E-04
Dinitrobenzene, 1,3-	99-65-0	No	No	Organics	-		-		1.00E-04	I	-		1.00E+00	1.74E-03	1.68E+02	8.68E-03	2.21E+00	9.19E-01	1.00E+00	Yes	-	2.46E-05	4.25E-05
Dinitrotoluene, 2,6-	606-20-2	No	No	Organics	1.50E+00	P	-		3.00E-04	X	-		1.00E+00	3.70E-03	1.82E+02	1.92E-02	2.64E+00	1.10E+00	1.00E+00	Yes	6.52E-06	7.37E-05	1.27E-04
Naphthalene	91-20-3	No	Yes	Organics	1.20E-01	C	3.40E-05	C	2.00E-02	I	3.00E-03	I	1.00E+00	4.66E-02	1.28E+02	2.03E-01	1.32E+00	5.49E-01	1.00E+00	Yes	8.16E-05	4.92E-03	8.49E-03
Nitrobenzene	98-95-3	No	Yes	Organics	-		4.00E-05	I	2.00E-03	I	9.00E-03	I	1.00E+00	5.41E-03	1.23E+02	2.31E-02	1.23E+00	5.14E-01	1.00E+00	Yes	-	4.92E-04	8.49E-04
Nitroglycerin	55-63-0	No	No	Organics	1.70E-02	P	-		1.00E-04	P	-		1.00E+00	9.94E-04	2.27E+02	5.76E-03	4.72E+00	1.97E+00	1.00E+00	Yes	5.76E-04	2.46E-05	4.25E-05
Nitrotoluene, m-	99-08-1	No	No	Organics	-		-		1.00E-04	X	-		1.00E+00	1.13E-02	1.37E+02	5.09E-02	1.48E+00	6.16E-01	1.00E+00	Yes	-	2.46E-05	4.25E-05
Nitrotoluene, o-	88-72-2	No	Yes	Organics	2.20E-01	P	-		9.00E-04	P	-		1.00E+00	8.99E-03	1.37E+02	4.05E-02	1.48E+00	6.16E-01	1.00E+00	Yes	4.45E-05	2.21E-04	3.82E-04
Pentachlorophenol	87-86-5	No	No	Organics	4.00E-01	I	5.10E-06	C	5.00E-03	I	-		1.00E+00	1.27E-01	2.66E+02	7.97E-01	1.25E+01	3.26E+00	9.00E-01	Yes	2.45E-05	1.23E-03	2.12E-03
Perchlorate and Perchlorate Salts	14797-73-0	No	No	Inorganics	-		-		7.00E-04	I	-		1.00E+00	1.00E-03	1.17E+02	4.17E-03	1.15E+00	4.78E-01	1.00E+00	Yes	-	1.72E-04	2.97E-04
Tetrachloroethane, 1,1,2,2-	79-34-5	No	Yes	Organics	2.00E-01	I	5.80E-05	C	2.00E-02	I	-		1.00E+00	6.94E-03	1.68E+02	3.46E-02	2.20E+00	9.16E-01	1.00E+00	Yes	4.89E-05	4.92E-03	8.49E-03
Trichloroethylene	79-01-6	Yes	Yes	Organics	4.60E-02	I	4.10E-06	I	5.00E-04	I	2.00E-03	I	1.00E+00	1.16E-02	1.31E+02	5.11E-02	1.37E+00	5.72E-01	1.00E+00	Yes	1.48E-04	1.23E-04	2.12E-04
Vanadium and Compounds	7440-62-2	No	No	Inorganics	-		-		5.04E-03	G	1.00E-04	A	2.60E-02	1.00E-03	5.09E+01	2.75E-03	4.87E-01	2.03E-01	1.00E+00	Yes	-	3.22E-05	5.56E-05

Output generated 01AUG2024:20:33:41

Key:
SSL values are based on DAF=1
* = where: nc SL < 100X ca SL
** = where nc SL < 10X ca SL
A = ATSDR
C = Cal EPA
ca = cancer
D = OW
E = RPF applied
G = see user guide
H = HEAST
I = IRIS
max = ceiling limit exceeded
N = WI
nc = noncancer
O = OPP
P = PPRTV
R = ORD
sat = Csat exceeded
T = ATSDR DRAFT
U = user provided
W = TEF applied
X = PPRTV Screening Level

Site-specific

Resident Risk-Based Regional Screening Levels (RSL) for Tap Water

Chemical	MCL (ug/L)	Ingestion SL TR=1E-06 (ug/L)	Dermal SL TR=1E-06 (ug/L)	Inhalation SL TR=1E-06 (ug/L)	Carcinogenic SL TR=1E-06 (ug/L)	Ingestion SL Child THQ=0.1 (ug/L)	Dermal SL Child THQ=0.1 (ug/L)	Inhalation SL Child THQ=0.1 (ug/L)	Noncarcinogenic SL Child THI=0.1 (ug/L)	Ingestion SL Adult THQ=0.1 (ug/L)	Dermal SL Adult THQ=0.1 (ug/L)	Inhalation SL Adult THQ=0.1 (ug/L)	Noncarcinogenic SL Adult THI=0.1 (ug/L)	Screening Level (ug/L)
Aluminum	-	-	-	-	-	2.01E+03	4.55E+05	-	2.00E+03	3.34E+03	5.98E+05	-	3.32E+03	2.00E+03 nc
Arsenic, Inorganic	1.00E+01	5.19E-02	9.73E+00	-	5.17E-02	6.02E-01	1.37E+02	-	5.99E-01	1.00E+00	1.79E+02	-	9.96E-01	5.17E-02 ca
Benz[a]anthracene	-	2.51E-01	-	3.38E-02	2.98E-02	-	-	-	-	-	-	-	-	2.98E-02 ca
Benzene	5.00E+00	1.42E+00	9.83E+00	7.20E-01	4.55E-01	8.02E+00	6.05E+01	6.26E+00	3.32E+00	1.33E+01	8.90E+01	6.26E+00	4.07E+00	4.55E-01 ca
Bis(2-ethylhexyl)phthalate	6.00E+00	5.56E+00	-	-	5.56E+00	4.01E+01	-	-	4.01E+01	6.67E+01	-	-	6.67E+01	5.56E+00 ca
Bromomethane	-	-	-	-	-	2.81E+00	9.97E+01	1.04E+00	7.55E-01	4.67E+00	1.50E+02	1.04E+00	8.48E-01	7.55E-01 nc
Dinitrobenzene, 1,3-	-	-	-	-	-	2.01E-01	7.25E+00	-	1.95E-01	3.34E-01	1.09E+01	-	3.24E-01	1.95E-01 nc
Dinitrotoluene, 2,6-	-	5.19E-02	7.42E-01	-	4.85E-02	6.02E-01	9.35E+00	-	5.65E-01	1.00E+00	1.41E+01	-	9.35E-01	4.85E-02 ca
Naphthalene	-	6.49E-01	1.04E+00	1.65E-01	1.17E-01	4.01E+01	7.01E+01	6.26E-01	6.11E-01	6.67E+01	1.06E+02	6.26E-01	6.16E-01	1.17E-01 ca
Nitrobenzene	-	-	-	1.40E-01	1.40E-01	4.01E+00	6.24E+01	1.88E+00	1.25E+00	6.67E+00	9.40E+01	1.88E+00	1.44E+00	1.40E-01 ca
Nitroglycerin	-	4.58E+00	1.82E+02	-	4.47E+00	2.01E-01	8.68E+00	-	1.96E-01	3.34E-01	1.31E+01	-	3.25E-01	1.96E-01 nc
Nitrotoluene, m-	-	-	-	-	-	2.01E-01	1.36E+00	-	1.75E-01	3.34E-01	2.05E+00	-	2.87E-01	1.75E-01 nc
Nitrotoluene, o-	-	3.54E-01	2.78E+00	-	3.14E-01	1.80E+00	1.54E+01	-	1.62E+00	3.00E+00	2.32E+01	-	2.66E+00	3.14E-01 ca
Pentachlorophenol	1.00E+00	1.95E-01	5.24E-02	-	4.13E-02	1.00E+01	2.93E+00	-	2.27E+00	1.67E+01	4.42E+00	-	3.49E+00	4.13E-02 ca
Perchlorate and Perchlorate Salts	1.50E+01	-	-	-	-	1.40E+00	3.19E+02	-	1.40E+00	2.34E+00	4.19E+02	-	2.32E+00	1.40E+00 nc
Tetrachloroethane, 1,1,2,2-	-	3.90E-01	3.25E+00	9.68E-02	7.57E-02	4.01E+01	3.64E+02	-	3.61E+01	6.67E+01	5.49E+02	-	5.95E+01	7.57E-02 ca
Trichloroethylene	5.00E+00	1.18E+00	7.45E+00	9.57E-01	4.94E-01	1.00E+00	6.89E+00	4.17E-01	2.83E-01	1.67E+00	1.04E+01	4.17E-01	3.23E-01	2.83E-01 nc
Vanadium and Compounds	-	-	-	-	-	1.01E+01	5.96E+01	-	8.64E+00	1.68E+01	7.84E+01	-	1.38E+01	8.64E+00 nc

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Site-specific - RSA 115

Resident Risk-Based Regional Screening Levels (RSL) for Tap Water

Chemical	CAS Number	Mutagen?	Volatile?	Chemical Type	SF_o(mg/kg-day)$^{-1}$	SF_oRef	IUR (µg/m3)-1	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	K_p (cm/hr)	MW	B (unitless)	t*(hr)	τ_{event}(hr/event)	FA (unitless)	In EPD?	$DA_{event\ (ca)}$	$DA_{event\ (nc\ child)}$	$DA_{event\ (nc\ adult)}$
Aluminum	7429-90-5	No	No	Inorganics	-		-		1.00E+00	P	5.00E-03	P	1.00E+00	1.00E-03	2.70E+01	2.00E-03	3.57E-01	1.49E-01	1.00E+00	Yes	-	2.46E-01	4.25E-01
Arsenic, Inorganic	7440-38-2	No	No	Inorganics	1.50E+00	I	4.30E-03	I	3.00E-04	I	1.50E-05	C	1.00E+00	1.00E-03	7.49E+01	3.33E-03	6.63E-01	2.76E-01	1.00E+00	Yes	6.52E-06	7.37E-05	1.27E-04
Benz[a]anthracene	56-55-3	Yes	Yes	Organics	1.00E-01	E	6.00E-05	E	-		-		1.00E+00	5.52E-01	2.28E+02	3.21E+00	8.48E+00	2.00E+00	1.00E+00	No	-	-	-
Benzene	71-43-2	No	Yes	Organics	5.50E-02	I	7.80E-06	I	4.00E-03	I	3.00E-02	I	1.00E+00	1.49E-02	7.81E+01	5.07E-02	6.91E-01	2.88E-01	1.00E+00	Yes	1.78E-04	9.83E-04	1.70E-03
Bis(2-ethylhexyl)phthalate	117-81-7	No	No	Organics	1.40E-02	I	2.40E-06	C	2.00E-02	I	-		1.00E+00	1.13E+00	3.91E+02	8.59E+00	7.29E+01	1.62E+01	8.00E-01	No	-	-	-
Bromomethane	74-83-9	No	Yes	Organics	-		-		1.40E-03	I	5.00E-03	I	1.00E+00	2.84E-03	9.49E+01	1.06E-02	8.58E-01	3.58E-01	1.00E+00	Yes	-	3.44E-04	5.94E-04
Dinitrobenzene, 1,3-	99-65-0	No	No	Organics	-		-		1.00E-04	I	-		1.00E+00	1.74E-03	1.68E+02	8.68E-03	2.21E+00	9.19E-01	1.00E+00	Yes	-	2.46E-05	4.25E-05
Dinitrotoluene, 2,6-	606-20-2	No	No	Organics	1.50E+00	P	-		3.00E-04	X	-		1.00E+00	3.70E-03	1.82E+02	1.92E-02	2.64E+00	1.10E+00	1.00E+00	Yes	6.52E-06	7.37E-05	1.27E-04
Naphthalene	91-20-3	No	Yes	Organics	1.20E-01	C	3.40E-05	C	2.00E-02	I	3.00E-03	I	1.00E+00	4.66E-02	1.28E+02	2.03E-01	1.32E+00	5.49E-01	1.00E+00	Yes	8.16E-05	4.92E-03	8.49E-03
Nitrobenzene	98-95-3	No	Yes	Organics	-		4.00E-05	I	2.00E-03	I	9.00E-03	I	1.00E+00	5.41E-03	1.23E+02	2.31E-02	1.23E+00	5.14E-01	1.00E+00	Yes	-	4.92E-04	8.49E-04
Nitroglycerin	55-63-0	No	No	Organics	1.70E-02	P	-		1.00E-04	P	-		1.00E+00	9.94E-04	2.27E+02	5.76E-03	4.72E+00	1.97E+00	1.00E+00	Yes	5.76E-04	2.46E-05	4.25E-05
Nitrotoluene, o-	88-72-2	No	Yes	Organics	2.20E-01	P	-		9.00E-04	P	-		1.00E+00	8.99E-03	1.37E+02	4.05E-02	1.48E+00	6.16E-01	1.00E+00	Yes	4.45E-05	2.21E-04	3.82E-04
Pentachlorophenol	87-86-5	No	No	Organics	4.00E-01	I	5.10E-06	C	5.00E-03	I	-		1.00E+00	1.27E-01	2.66E+02	7.97E-01	1.25E+01	3.26E+00	9.00E-01	Yes	2.45E-05	1.23E-03	2.12E-03
Perchlorate and Perchlorate Salts	14797-73-0	No	No	Inorganics	-		-		7.00E-04	I	-		1.00E+00	1.00E-03	1.17E+02	4.17E-03	1.15E+00	4.78E-01	1.00E+00	Yes	-	1.72E-04	2.97E-04
Trichloroethylene	79-01-6	Yes	Yes	Organics	4.60E-02	I	4.10E-06	I	5.00E-04	I	2.00E-03	I	1.00E+00	1.16E-02	1.31E+02	5.11E-02	1.37E+00	5.72E-01	1.00E+00	Yes	1.48E-04	1.23E-04	2.12E-04
Vanadium and Compounds	7440-62-2	No	No	Inorganics	-		-		5.04E-03	G	1.00E-04	A	2.60E-02	1.00E-03	5.09E+01	2.75E-03	4.87E-01	2.03E-01	1.00E+00	Yes	-	3.22E-05	5.56E-05

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O = OPP
P = PPRTV
R = ORD
sat = Csat exceeded
T = ATSDR DRAFT
U = user provided
W = TEF applied
X = PPRTV Screening Level

RBTLnc = (Tapwater RSL × 10)/(#HIs)

Where:
RBTLc = risk based target level based on cancer endpoint
RBTLnc = risk based target level based on noncancer endpoint
#HIs = 7 constituents with noncarcinogenic endpoints - 2 constituents with MCLs and noncarcinogenic endpoints = 5 constituents with no MCLs
#Risks = 9 constituents with carcinogenic endpoints -4 constituents with MCLs and carcinogenic endpoints = 5 constituents with no MCLs
TR = target risk
THQ = target hazard quotient

Site-specific - RSA 115

Resident Risk-Based Regional Screening Levels (RSL) for Tap Water

Chemical	MCL (µg/L)	Ingestion SL TR=1E-06 (µg/L)	Dermal SL TR=1E-06 (µg/L)	Inhalation SL TR=1E-06 (µg/L)	Carcinogenic SL TR=1E-06 (µg/L)	Ingestion SL Child THQ=0.1 (µg/L)	Dermal SL Child THQ=0.1 (µg/L)	Inhalation SL Child THQ=0.1 (µg/L)	Noncarcinogenic SL Child THI=0.1 (µg/L)	Ingestion SL Adult THQ=0.1 (µg/L)	Dermal SL Adult THQ=0.1 (µg/L)	Inhalation SL Adult THQ=0.1 (µg/L)	Noncarcinogenic SL Adult THI=0.1 (µg/L)	Tapwater RSL (µg/L)	Basis	RBTL (µg/L)	Basis
Aluminum	-	-	-	-	-	2.01E+03	4.55E+05	-	2.00E+03	3.34E+03	5.98E+05	-	3.32E+03	2,000	nc	4,000	THQ=0.2
Arsenic, Inorganic	1.00E+01	5.19E-02	9.73E+00	-	5.17E-02	6.02E-01	1.37E+02	-	5.99E-01	1.00E+00	1.79E+02	-	9.96E-01	0.052	ca	10	MCL
Benz[a]anthracene	-	2.51E-01	-	3.38E-02	2.98E-02	-	-	-	-	-	-	-	-	0.030	ca	0.06	TCR=2×10^{-6}
Benzene	5.00E+00	1.42E+00	9.83E+00	7.20E-01	4.55E-01	8.02E+00	6.05E+01	6.26E+00	3.32E+00	1.33E+01	8.90E+01	6.26E+00	4.07E+00	0.46	ca	5.0	MCL
Bis(2-ethylhexyl)phthalate	6.00E+00	5.56E+00	-	-	5.56E+00	4.01E+01	-	-	4.01E+01	6.67E+01	-	-	6.67E+01	5.56	ca	6.0	MCL
Bromomethane	-	-	-	-	-	2.81E+00	9.97E+01	1.04E+00	7.55E-01	4.67E+00	1.50E+02	1.04E+00	8.48E-01	0.76	nc	1.5	THQ=0.2
Dinitrobenzene, 1,3-	-	-	-	-	-	2.01E-01	7.25E+00	-	1.95E-01	3.34E-01	1.09E+01	-	3.24E-01	0.20	nc	0.39	THQ=0.2
Dinitrotoluene, 2,6-	-	5.19E-02	7.42E-01	-	4.85E-02	6.02E-01	9.35E+00	-	5.65E-01	1.00E+00	1.41E+01	-	9.35E-01	0.049	ca	0.097	TCR=2×10^{-6}
Naphthalene	-	6.49E-01	1.04E+00	1.65E-01	1.17E-01	4.01E+01	7.01E+01	6.26E-01	6.11E-01	6.67E+01	1.06E+02	6.26E-01	6.16E-01	0.12	ca	0.23	TCR=2×10^{-6}
Nitrobenzene	-	-	-	1.40E-01	1.40E-01	4.01E+00	6.24E+01	1.88E+00	1.25E+00	6.67E+00	9.40E+01	1.88E+00	1.44E+00	0.14	ca	0.28	TCR=2×10^{-6}
Nitroglycerin	-	4.58E+00	1.82E+02	-	4.47E+00	2.01E-01	8.68E+00	-	1.96E-01	3.34E-01	1.31E+01	-	3.25E-01	0.20	nc	0.39	THQ=0.2
Nitrotoluene, o-	-	3.54E-01	2.78E+00	-	3.14E-01	1.80E+00	1.54E+01	-	1.62E+00	3.00E+00	2.32E+01	-	2.66E+00	0.31	ca	0.63	TCR=2×10^{-6}
Pentachlorophenol	1.00E+00	1.95E-01	5.24E-02	-	4.13E-02	1.00E+01	2.93E+00	-	2.27E+00	1.67E+01	4.42E+00	-	3.49E+00	0.041	ca	1.0	MCL
Perchlorate and Perchlorate Salts	1.50E+01	-	-	-	-	1.40E+00	3.19E+02	-	1.40E+00	2.34E+00	4.19E+02	-	2.32E+00	1.4	nc	15	MCL
Trichloroethylene	5.00E+00	1.18E+00	7.45E+00	9.57E-01	4.94E-01	1.00E+00	6.89E+00	4.17E-01	2.83E-01	1.67E+00	1.04E+01	4.17E-01	3.23E-01	0.28	nc	5.0	MCL
Vanadium and Compounds	-	-	-	-	-	1.01E+01	5.96E+01	-	8.64E+00	1.68E+01	7.84E+01	-	1.38E+01	8.64	nc	17	THQ=0.2

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O = OPP
P = PPRTV
R = ORD
sat = Csat exceeded
T = ATSDR DRAFT
U = user provided
W = TEF applied
X = PPRTV Screening Level

RBTLnc = (Tapwater RSL × 10)/(#HIs)

Where:
RBTLc = risk based target level based on cancer endpoint
RBTLnc = risk based target level based on noncancer endpoint
#HIs = 7 constituents with noncarcinogenic endpoints - 2 constituents with MCLs and noncarcinogenic endpoints = 5 constituents with no MCLs
#Risks = 9 constituents with carcinogenic endpoints -4 constituents with MCLs and carcinogenic endpoints = 5 constituents with no MCLs
TR = target risk
THQ = target hazard quotient

Site-specific - RSA 116

Resident Risk-Based Regional Screening Levels (RSL) for Tap Water

Chemical	CAS Number	Mutagen?	Volatile?	Chemical Type	Sfo $(mg/kg\text{-}day)^{-1}$	SFo Ref	IUR $(ug/m^3)^{-1}$	IUR Ref	RfD (mg/kg-day)	RfD Ref	RfC (mg/m^3)	RfC Ref	GIABS	K_p (cm/hr)	MW	B (unitless)	t^*(hr)	T_{event} (hr/event)	FA (unitless)	In EPD?	$DA_{event\ (ca)}$	$DA_{event\ (nc\ child)}$	$DA_{event\ (nc\ adult)}$	MCL (µg/L)
Bis(2-ethylhexyl)phthalate	117-81-7	No	No	Organics	1.40E-02	I	2.40E-06	C	2.00E-02	I	-		1.00E+00	1.13E+00	3.91E+02	8.59E+00	7.29E+01	1.62E+01	8.00E-01	No	-	-	-	6.00E+00
Dinitrobenzene, 1,3-	99-65-0	No	No	Organics	-		-		1.00E-04	I	-		1.00E+00	1.74E-03	1.68E+02	8.68E-03	2.21E+00	9.19E-01	1.00E+00	Yes	-	2.46E-05	4.25E-05	-
Naphthalene	91-20-3	No	Yes	Organics	1.20E-01	C	3.40E-05	C	2.00E-02	I	3.00E-03	I	1.00E+00	4.66E-02	1.28E+02	2.03E-01	1.32E+00	5.49E-01	1.00E+00	Yes	8.16E-05	4.92E-03	8.49E-03	-
Nitrobenzene	98-95-3	No	Yes	Organics	-		4.00E-05	I	2.00E-03	I	9.00E-03	I	1.00E+00	5.41E-03	1.23E+02	2.31E-02	1.23E+00	5.14E-01	1.00E+00	Yes	-	4.92E-04	8.49E-04	-
Nitroglycerin	55-63-0	No	No	Organics	1.70E-02	P	-		1.00E-04	P	-		1.00E+00	9.94E-04	2.27E+02	5.76E-03	4.72E+00	1.97E+00	1.00E+00	Yes	5.76E-04	2.46E-05	4.25E-05	-
Nitrotoluene, m-	99-08-1	No	No	Organics	-		-		1.00E-04	X	-		1.00E+00	1.13E-02	1.37E+02	5.09E-02	1.48E+00	6.16E-01	1.00E+00	Yes	-	2.46E-05	4.25E-05	-
Nitrotoluene, o-	88-72-2	No	Yes	Organics	2.20E-01	P	-		9.00E-04	P	-		1.00E+00	8.99E-03	1.37E+02	4.05E-02	1.48E+00	6.16E-01	1.00E+00	Yes	4.45E-05	2.21E-04	3.82E-04	-
Perchlorate and Perchlorate Salts	14797-73-0	No	No	Inorganics	-		-		7.00E-04	I	-		1.00E+00	1.00E-03	1.17E+02	4.17E-03	1.15E+00	4.78E-01	1.00E+00	Yes	-	1.72E-04	2.97E-04	1.50E+01
Tetrachloroethane, 1,1,2,2-	79-34-5	No	Yes	Organics	2.00E-01	I	5.80E-05	C	2.00E-02	I	-		1.00E+00	6.94E-03	1.68E+02	3.46E-02	2.20E+00	9.16E-01	1.00E+00	Yes	4.89E-05	4.92E-03	8.49E-03	-
Trichloroethylene	79-01-6	Yes	Yes	Organics	4.60E-02	I	4.10E-06	I	5.00E-04	I	2.00E-03	I	1.00E+00	1.16E-02	1.31E+02	5.11E-02	1.37E+00	5.72E-01	1.00E+00	Yes	1.48E-04	1.23E-04	2.12E-04	5.00E+00

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O = OPP
P = PPRTV
R = ORD
sat = Csat exceeded
T = ATSDR DRAFT
U = user provided
W = TEF applied
X = PPRTV Screening Level

RBTLc = (Tapwater RSL × 10^{-5})/(#Risks)
RBTLnc = (Tapwater RSL × 10)/(#HIs)

Where:
RBTLc = risk based target level based on cancer endpoint
RBTLnc = risk based target level based on noncancer endpoint
#HIs = 5 constituents with noncarcinogenic endpoints - 2 constituents with MCLs and noncarcinogenic endpoints = 3constituents with no MCLs
#Risks = 5 constituents with carcinogenic endpoints -1 constituents with MCLs and carcinogenic endpoints = 4 constituents with no MCLs
TR = target risk
THQ = target hazard quotient

Site-specific - RSA 116

Resident Risk-Based Regional Screening Levels (RSL) for Tap Water

Chemical	Ingestion SL TR=1E-06 (µg/L)	Dermal SL TR=1E-06 (µg/L)	Inhalation SL TR=1E-06 (µg/L)	Carcinogenic SL TR=1E-06 (µg/L)	Ingestion SL Child THQ=0.1 (µg/L)	Dermal SL Child THQ=0.1 (µg/L)	Inhalation SL Child THQ=0.1 (µg/L)	Noncarcinogenic SL Child THI=0.1 (µg/L)	Ingestion SL Adult THQ=0.1 (µg/L)	Dermal SL Adult THQ=0.1 (µg/L)	Inhalation SL Adult THQ=0.1 (µg/L)	Noncarcinogenic SL Adult THI=0.1 (µg/L)	Tapwater RSL (µg/L)	Basis	RBTL (µg/L)	Basis
Bis(2-ethylhexyl)phthalate	5.56E+00	-	-	5.56E+00	4.01E+01	-	-	4.01E+01	6.67E+01	-	-	6.67E+01	5.6	ca	6.0	MCL
Dinitrobenzene, 1,3-	-	-	-	-	2.01E-01	7.25E+00	-	1.95E-01	3.34E-01	1.09E+01	-	3.24E-01	0.2	nc	0.65	THQ=0.33
Naphthalene	6.49E-01	1.04E+00	1.65E-01	1.17E-01	4.01E+01	7.01E+01	6.26E-01	6.11E-01	6.67E+01	1.06E+02	6.26E-01	6.16E-01	0.12	ca	0.29	TCR=2.5×10^{-6}
Nitrobenzene	-	-	1.40E-01	1.40E-01	4.01E+00	6.24E+01	1.88E+00	1.25E+00	6.67E+00	9.40E+01	1.88E+00	1.44E+00	0.14	ca	0.35	TCR=2.5×10^{-6}
Nitroglycerin	4.58E+00	1.82E+02	-	4.47E+00	2.01E-01	8.68E+00	-	1.96E-01	3.34E-01	1.31E+01	-	3.25E-01	0.20	nc	0.65	THQ=0.33
Nitrotoluene, m-	-	-	-	-	2.01E-01	1.36E+00	-	1.75E-01	3.34E-01	2.05E+00	-	2.87E-01	0.18	nc	0.58	THQ=0.33
Nitrotoluene, o-	3.54E-01	2.78E+00	-	3.14E-01	1.80E+00	1.54E+01	-	1.62E+00	3.00E+00	2.32E+01	-	2.66E+00	0.31	ca	0.79	TCR=2.5×10^{-6}
Perchlorate and Perchlorate Salts	-	-	-	-	1.40E+00	3.19E+02	-	1.40E+00	2.34E+00	4.19E+02	-	2.32E+00	1.4	nc	15	MCL
Tetrachloroethane, 1,1,2,2-	3.90E-01	3.25E+00	9.68E-02	7.57E-02	4.01E+01	3.64E+02	-	3.61E+01	6.67E+01	5.49E+02	-	5.95E+01	0.076	ca	0.19	TCR=2.5×10^{-6}
Trichloroethylene	1.18E+00	7.45E+00	9.57E-01	4.94E-01	1.00E+00	6.89E+00	4.17E-01	2.83E-01	1.67E+00	1.04E+01	4.17E-01	3.23E-01	0.28	nc	5.0	MCL

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#Risks = 5 constituents with carcinogenic endpoints -1 constituents with MCLs and carcinogenic endpoints = 4 constituents with no MCLs
TR = target risk
THQ = target hazard quotient

APPENDIX C

GROUNDWATER MONITORING PLAN

Advance Review
Groundwater Monitoring Plan
RSA-115, Inactive East Side Blowdown Lagoon at Test Area 5 and RSA-116, South Side Blowdown Lagoon at Test Area 5
Operable Unit 13

ENVIRONMENTAL REMEDIATION SERVICES
U.S. ARMY GARRISON-REDSTONE ARSENAL

October 2024

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ACRONYMS AND ABBREVIATIONS

1,3-DNB	1,3-dinitrobenzene
2-NT	2-nitrotoluene
2,6-DNT	2,6-dinitrotoluene
µg/L	microgram per liter
ADEM	Alabama Department of Environmental Management
AHWMMA	Alabama Hazardous Wastes Management and Minimization Act
APP	accident prevention plan
APTIM	Aptim Federal Services, LLC
ARBCA	Alabama Risk-Based Corrective Action
Army	United States Army
CG	cleanup goal
CMI	corrective measures implementation
CMO	Corrective Measure Objective
COC	constituent of concern
ECC	Environmental Chemical Corporation
HDPE	high-density polyethylene
HHRA	human health risk assessment
IDW	investigation derived waste
LUC	land use control
MNA	Monitored Natural Attenuation
PSV	preliminary screening value
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RCRA Permit	Alabama Hazardous Wastes Management and Minimization Act Hazardous Storage Facility/Thermal Treatment/Solid Waste Management Unit Corrective Action Permit
RFI	Resource Conservation and Recovery Act Facility Investigation
RSA	Redstone Arsenal
SLERA	screening level ecological risk assessment
SOPPs	standard operating project procedures
TCE	trichloroethene
TeCA	1,1,2,2-tetrachloroethane
UDMH	Unsymmetrical dimethyl hydrazine
UPL	upper prediction limit
UTL	upper tolerance limit
USEPA	United States Environmental Protection Agency

1.0 INTRODUCTION

This groundwater monitoring plan has been developed in support of the Redstone Arsenal (RSA)-115/116 Corrective Measures Implementation (CMI) Work Plan. This document provides details for implementation of groundwater monitoring as a component of the corrective measures for RSA 115/116 contaminated groundwater in order to achieve the cleanup goals (CGs). The plan will include identification of wells scheduled for monitoring, monitoring parameters, the monitoring period, analytical methods, reporting, and records maintenance. The corrective measures to be implemented at RSA 115/116 include monitored natural attenuation (MNA) and land use controls (LUCs) to achieve the Corrective Measure Objective (CMO) for groundwater at RSA-115/116.

1.1 OBJECTIVE AND SCOPE

The primary objective of the groundwater monitoring program for RSA-115/116 is to verify that the corrective measure (MNA) reduces concentrations of constituents of concern (COCs) in groundwater beneath the site to levels determined to be acceptable to human health (i.e., CGs). This plan is designed to be modified, if necessary, in response to new hydrologic or COC data or changes in remedial, hydrologic, technical, or land-use conditions. Recommendations for changes to the groundwater monitoring program will be documented in annual CMI effectiveness reports. Closure for groundwater will be achieved when the concentrations in groundwater have been verified for three consecutive sampling events below the CGs.

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2.0 DESCRIPTION OF RSA-115/116

2.1 OVERVIEW

RSA is located in the southwestern portion of Madison County, which is in the northern portion of Alabama (Figure 1 of the CMI Work Plan). RSA is a United States Army facility that encompasses approximately 38,300 acres and is approximately 10 miles long from north to south and six miles wide from east to west. The Army controls 36,459 acres of the total acreage, of which approximately 15,500 acres are woodlands, 5,360 acres are leased for agricultural use, and approximately 12,000 acres are managed as military test areas/ranges. Development within RSA has largely centered on the historical production (and later disposal) of conventional and chemical munitions and, more recently, development and testing of missiles and rockets. These processes have produced chemical wastes since operations began in the early-1940s.

RSA-115, the inactive East Side Blowdown Lagoon at Test Area 5, is a 0.78-acre site at Test Area 5 and lies within groundwater units RSA-156/157. The lagoon occupies an area of 7,500 square feet (approximately 0.17 acre) within the 0.78-acre site approximately 300 feet east-northeast of the Attitude Test Stand (Building 8877) (CMI Work Plan Figure 1-2). RSA-116, the South Side Blowdown Lagoon at Test Area 5, is a triangular, lined lagoon, approximately 0.7 acres in size, within the 2.4-acre site at Test Area 5 and also lies within groundwater units RSA-156/157 approximately 1000 feet west of RSA-115 (CMI Work Plan Figure 1-3).

The following investigations have taken place at RSA-115 and RSA-116 since 1991:

- Visual Site Inspection (Geraghty and Miller, Inc. 1991)
- Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) for RSA-115 and RSA-116 (Parsons, 1995)
- Supplemental RFI for RSA-115 (Parsons, 1997)
- Baseline Risk Assessment for OU-13, OU-12 (RSA-140), and OU-7 (RSA-129 and RSA-58) (Parsons, 1998)
- Focused Feasibility Study for RSA-115 and RSA-116 (Parsons, 1999)
- Basewide spring/seep sampling (Shaw, 2004)
- Redstone Arsenal RCRA Facility Assessment (Alabama Department of Environmental Management [ADEM], 2008)
- RSA-156/157 Groundwater Unit RFI (APTIM, 2019)
- RSA-115 RFI Report (Revision 3) (APTIM, 2020a)
- RSA-116 RFI Report (Revision 4) (APTIM, 2020b).

The RFI Reports for RSA-115 and RSA-116 (APTIM, 2020a,b) contain complete discussions of previous site investigations as well as results of the Alabama Risk Based Corrective Action (ARBCA) evaluation for human health and Screening Level Ecological Risk Assessment (SLERA) for each site. The current use of RSA-115/116 is not residential, nor is it expected to be in the future. A residential scenario was included in the ARBCA evaluations to determine whether these sites are eligible for unrestricted reuse in accordance with ADEM requirements. In RSA's Alabama Hazardous Wastes Management and Minimization Act Hazardous Storage Facility/Thermal Treatment/Solid Waste Management Unit Corrective Action Permit (RCRA Permit), issued under the Alabama Hazardous Wastes Management and

Minimization Act (AHWMMA), ADEM has specified that investigations must comply with Alabama Environmental Investigation and Remediation Guidance (ADEM, 2017b) and ARBCA guidance (ADEM, 2017a). To determine whether these sites are eligible for unrestricted reuse as defined in Alabama Administrative Code 335-5, risks to a residential site user were assessed.

The results of the RFI Reports for RSA-115 and 116/ (APTIM, 2020a,b) indicated that corrective measures are warranted for these sites based on the following:

- Nine COCs in groundwater were detected at concentrations that require action based on the results of the risk assessment:
  - At RSA-115, arsenic, perchlorate, 2,6-dinitrotoluene (DNT), 2-nitrotoluene (NT), bis(2-ethylhexyl)phthalate, pentachlorophenol, benzene, and trichloroethene (TCE) in groundwater pose an unacceptable health threat and require action.
  - At RSA-116, perchlorate, 2-NT, bis(2-ethylhexyl)phthalate, 1,1,2,2-tetrachloroethane (TeCA), and TCE in groundwater pose an unacceptable health threat and require action.
- Nine other constituents were detected at RSA-115 and/or RSA-116 at concentrations exceeding preliminary screening values (PSVs) but were not determined to be risk drivers in the cumulative risk assessment. As such, none of these nine constituents require corrective actions; however, at ADEM's request, the following constituents will be included as groundwater COCs:
  - RSA-115: Aluminum, vanadium, 1,3-dinitrobenzene (DNB), nitrobenzene, nitroglycerin, bromomethane, benzo(a)anthracene, and naphthalene.
  - RSA-116: 3-NT, nitrobenzene, nitroglycerin, and naphthalene.
- Unsymmetrical dimethyl hydrazine (UDMH) is identified as a groundwater COC at both sites because the achievable laboratory detection limit exceeds the PSV. Because no appropriate toxicity values were available, UDMH was not evaluated in the risk assessment.

The cleanup goals (CGs) for these COCs in RSA-115/116 groundwater are summarized in **Exhibit G-1** below:

Exhibit C- 1: Summary of Cleanup Goals - RSA-115/116

Site-Related Groundwater Constituent of Concern	RSA-115 Cleanup Goal (µg/L)	RSA-116 Cleanup Goal (µg/L)
Metals		
Aluminum	4,000	--
Arsenic	10	--
Vanadium	17	--
Perchlorate		
Perchlorate	15	15
Explosives		
1,3-Dinitrobenzene	0.39	--
2,6-Dinitrotoluene	0.097	--
2-Nitrotoluene	0.63	0.79
3-Nitrotoluene	--	0.88
Nitrobenzene	0.28	0.35
Nitroglycerin	0.39	0.98

Site-Related Groundwater Constituent of Concern	RSA-115 Cleanup Goal (µg/L)	RSA-116 Cleanup Goal (µg/L)
SVOCs		
Benzo(a)anthracene	0.06	--
Bis(2-ethylhexyl)phthalate	6	6
Naphthalene	0.23	0.29
Pentachlorophenol	1	--
UDMH	0.00042	0.00042
VOCs		
1,1,2,2-Tetrachloroethane	--	0.19
Benzene	5	--
Bromomethane	1.5	--
Trichloroethene	5	5

Note:
-- Not applicable; chemical not identified as a COC requiring action at this site.

The CMO for RSA-115/116 is to prevent human exposure to site groundwater contaminated with COCs that exceed their groundwater CGs via any exposure route (ingestion, inhalation, or dermal contact).

2.2 RSA-115/116 SITE DESCRIPTION, HISTORY, GEOLOGY AND HYDROGEOLOGY

RSA-115 and RSA-116 are located in the southern portion of RSA, approximately 2 miles south of Buxton Road and approximately 0.8 mile north of the Tennessee River (Figure 1-1 of the CMI Work Plan). RSA-115 is approximately 800 feet to the east-northeast of RSA-116 (Figure 1-2 of the CMI Work Plan). **Sections 2.2.1** and **2.2.2** provide brief descriptions, site histories, geology, and hydrogeology for each of the two sites.

2.2.1 RSA-115

2.2.1.1 Site Description

RSA-115, the inactive East Side Blowdown Lagoon at Test Area 5, is a 0.78-acre site at Test Area 5 and lies within groundwater units RSA-156/157. The lagoon occupies an area of 7,500 square feet (approximately 0.17 acre) within the 0.78-acre site approximately 300 feet east-northeast of the Attitude Test Stand (Building 8877) (Figure 1-3 of the CMI Work Plan).

The site is located on a level area within Test Area 5 and bordered to the south by Arsenal Road and to the east by Raspberry Road, both paved roads. A concrete flume, which transported the cooling water used during the tests to the lagoon, leads from the test stand at Building 8877 to the earthen lagoon. The lagoon is unlined and bounded on three sides by an earthen berm and surrounded by young pine trees. The inactive lagoon at RSA-115 is usually dry and is covered with sparse vegetation, likely due to exposed fractured sandstone and lack of soil.

2.2.1.2 History

The lagoon was used as a holding basin for cooling water discharged during test firing of Redstone rocket engines from Attitude Test Stand 8877. Tests were conducted up to five times a week during the 1960s, using a kerosene-based fuel. Subsequent testing during the development of the Lance rocket between 1964 and 1970 utilized UDMH as the primary active fuel ingredient and nitric acid as the primary

oxidant. Between 1975 and 1990, a variety of rocket motors were tested at the site. The concrete flume transported cooling water used during tests to the earthen lagoon to ultimately evaporate or seep into the ground. Cooling water may have contained dissolved solid rocket propellant and rocket engine exhaust.

The blowdown lagoon has been generally inactive since the mid-1980s. The test stand associated with this lagoon is now used exclusively for static tests, which do not require a blowdown lagoon. The concrete flume that carried water from the test stand is not functional and is inactive. Reportedly, the lagoon never held cooling water because of poor integrity, and it is reported that no plans exist to line and refit the lagoon for use in the future (Parsons Engineering Science, Inc. [Parsons] 1995).

2.2.1.3 Geology and Hydrogeology

The overburden in the lagoon is very shallow, generally less than 1 foot thick, and consists of sandy clay with some silt and gravel. The overburden outside of the lagoon is approximately 7 feet thick and consists of predominantly reddish-brown clays with some silt, sand, and/or limestone fragments (APTIM, 2020a).

Groundwater beneath the site generally occurs in two groundwater vertical zones entirely within bedrock, and flow is governed by the orientation and interconnectivity of bedrock fractures. Depth to water in the shallow bedrock ranged from 39.81 feet bgs (N115-RS467) to 44.68 feet bgs (N115-RS468) during the April 2020 sampling event (APTIM, 2020a). Depth to water in the deep bedrock ranged from 120.19 feet bgs (115-RS2492) to 148.03 feet bgs (115-RS2411) during the January 2019 sampling event (APTIM, 2020a). The shallow bedrock and deep bedrock groundwater vertical zones are poorly connected hydraulically (Parsons, 1997). Given the difficulty in predicting joint and fracture patterns from the existing well control, potentiometric surface maps in this type of flow regime do not necessarily predict flow directions. Groundwater flow in this area is fully discussed in the RSA-156/157 groundwater unit RFI report (APTIM, 2019) and summarized in the RFI Report for RSA-115 (APTIM, 2020a). Potentiometric surface maps for both groundwater zones are shown on Figures 1-4 and 1-5 of the CMI Work Plan, respectively.

RSA-115 is situated on a northerly trending ridge that is likely underlain by a groundwater divide (APTIM, 2019). Groundwater on the eastern side of the ridge appears to be controlled by topography and to move east-southeast; groundwater on the western side of the ridge appears to move west-southwest. However, the general direction of groundwater flow of the water table is south towards the Tennessee River, the regional drain for this aquifer.

2.2.2 RSA-116

2.2.2.1 Site Description

RSA-116, the South Side Blowdown Lagoon at Test Area 5, is a triangular, lined lagoon, approximately 0.7 acres in size, within the 2.4-acre site at Test Area 5 and lies within groundwater units RSA-156/157. The lagoon is approximately 500 feet west of Test Stand 8879 (Figure 1-6 of the CMI Work Plan).

The site is located south of Buxton and Pershing Roads, on the south side of Test Area 5, in a ravine within a heavily wooded area. The ravine is a topographically low feature trending roughly north to south, which received rainfall runoff from the surrounding slopes. Initially, the lagoon was created by constructing an earthen dam 35 feet in height and 40 feet in width across the unlined ravine. A concrete flume transported cooling water from the test stand and entered the lagoon on the east side. Although the concrete flume is present within the site boundary, the concrete flume is not included as part of the permitted site.

2.2.2.2 History

The lagoon began operation in the mid-1960s as a holding basin for cooling water discharged during test firing of rocket engines at Test Stand 8879. Tests were conducted as frequently as once every 10 days. Cooling water from the test stand was discharged to a concrete apron that channeled the water to the concrete flume and ultimately to the lagoon. Cooling water may have contained dissolved rocket propellant and rocket engine exhaust from UDMH as the active fuel ingredient and nitric acid as the primary oxidant. It is also reported that JP-1 and JP-4 fuels were used. Site personnel reported that TCE was used regularly as a solvent on the test stand until the mid- to late 1970s (ADEM, 2008).

Natural drainage also continued to enter the lagoon, as the ravine entered the lagoon from the north. Water contained in the lagoon was allowed to evaporate or seep into the soil. If water levels in the lagoon were too high, water was allowed to flow over the spillway on the west side of the dam or released through an 18-inch-diameter drainpipe at the base of the dam. The discharged water followed the ravine south to the Tennessee River, approximately 1 mile downstream.

In 1993, the lagoon was regraded, expanding its size from approximately 0.5 acre to approximately 0.6 acre. The purpose of the lagoon expansion was to facilitate the addition of a high-density polyethylene (HDPE) liner. The HDPE material, 0.080 millimeter thick, was designed and manufactured specifically for containment of liquids in hydraulic structures (Parsons, 1999). A containment berm was constructed surrounding the lagoon to prevent surface runoff from entering the lagoon. In addition, an 8-foot-high chain-link fence was installed around the lagoon to prevent unauthorized access.

The site is currently inactive. Test firings are not currently being conducted, although the facility is operational and may resume at any time. The concrete flume is not currently in use. Leaf litter and broken pieces of tree branches are present in the flume, and cracks exist in the concrete base and sidewalls in some places along the flume. Vegetation from outside the flume is growing down into it along various sections. Water levels in the lagoon fluctuate based on precipitation events and evaporation; however, accumulated water is periodically pumped out to maintain the water levels.

2.2.2.3 Geology and Hydrogeology

The lithologic logs of soil from well borings installed at RSA-116 indicate native soils consist of predominantly red-to yellow-brown clays with some silt, sand, and/or limestone fragments. Based on depth of auger refusal, thickness of the overburden ranges from approximately 1 to 24 feet (APTIM, 2020b).

Groundwater beneath the site is entirely within bedrock, and its flow is governed by the orientation and interconnectivity of bedrock fractures. Potentiometric surface maps in this type of flow regime do not necessarily predict flow directions.

Depth to groundwater at RSA-116 in March 2019 ranged from 17.04 feet bgs at N116-RS463 to 118.96 feet bgs at 116-RS2492; the overall average groundwater depth across all wells at the site and multiple synoptic water level events was 54.41 feet bgs (APTIM, 2020b). December 2014 and March 2019 groundwater data collected at the site show a southwesterly gradient across the site and beneath the lagoon. Regionally, groundwater flow direction at RSA-116 is controlled by topography in the form of steep slopes and ridges, which divert flow to the south-southwest towards the Tennessee River, the regional drain for this aquifer. Groundwater flow in this area is fully discussed in the RSA-156/157 groundwater RFI report (APTIM, 2019) and summarized in the RFI Report for RSA-116 (APTIM, 2020b). Potentiometric surface maps for both groundwater zones are shown on Figures 1-7 and 1-8 of the CMI Work Plan, respectively

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3.0 GROUNDWATER MONITORING PROGRAM

The groundwater monitoring program for RSA-115/116 includes wells proposed for monitoring, sampling frequency and sampling parameters, sampling and analytical protocol, and quality assurance (QA)/quality control (QC) requirements. The measurement performance criteria are presented in **Table C-1**. The laboratory-specific reference limits and evaluation tables are presented in **Table C-2**, PSVs and Laboratory Specific Limits. The sampling design and rationale is presented in **Table C-3**. Well identifiers, sampling frequency and analytical parameters, sampling and analytical protocols, and QA/QC requirements are presented in **Tables C-4** through **C-6**. **Tables C-7** through **C-12** are itemized in **Section 3.3**. The selected 15 existing wells are shown on **Figure 3-1** of the CMI Work Plan. The duration of monitoring is estimated at five years for the RSA-115/116 sites before combining monitoring efforts with the underlying groundwater unites (RSA-156 or RSA-157). Subject to Alabama Department of Environmental Management (ADEM) approval, in the event that COC concentrations for action in all 15 monitoring wells have reached CGs before that time, groundwater monitoring will be proposed for early termination. Changes in the groundwater monitoring program can be adjusted in the recommendations section of each annual groundwater monitoring report.

3.1 SCOPE AND IMPLEMENTATION STRATEGY FOR THE GROUNDWATER MONITORING PROGRAM

Groundwater monitoring will be performed to evaluate the effectiveness and permanence of the RSA-115/116 corrective measure- MNA with LUCs.

The groundwater monitoring program is designed to maximize cost-effectiveness without compromising program and data quality using the following general strategies:

- Select and maintain an optimal number of sampling points and an appropriate analytical suite to evaluate the progress of MNA in groundwater;
- Select wells that act as indicators of contaminant concentration changes or expansion;
- Maintain surveillance for contaminant migration away from RSA-115/116;
- Maintain an adequate frequency of conventional and/or mainstream sampling;
- Where appropriate, utilize cost-effective analytical programs; and
- Initiate a streamlined data management and reporting information system.

3.2 APPLICABLE STANDARD OPERATING PROJECT PROCEDURES

Copies of the following applicable Standard Operating Project Procedures (SOPPs) to be applied at RSA-115/116 are presented in Volume II of the Installation-Wide Quality Assurance Program Plan IW-QAPP (HydroGeoLogic, Inc. [HGL], 2019):

- SOPP 1.0, Field Documentation
- SOPP 3.0, Field Equipment Decontamination
- SOPP 4.0, Investigation-Derived Waste (IDW)
- SOPP 7.0, Groundwater Sampling
- SOPP 11.0, Field Generated Records Management
- SOPP 12.0, Field Measurable Physical Characteristics

- SOPP 15.0, Non-Hazardous Sample Handling, Packaging and Shipping
- SOPP 16.0, Groundwater Level Measurements
- SOPP 24.0, Field Equipment Calibration

3.3 RSA-115/116 PROJECT-SPECIFIC QAPP WORKSHEETS

The IW-QAPP (HGL, 2019) requires project-specific worksheets that are not included in the generic IW-QAPP. **Tables C-1** though **C-12** provide the following RSA-115/116 project-specific IW-QAPP worksheets:

- **Table C-1: Worksheet #12** Measurement of Performance Criteria
- **Table C-2: Worksheet #15** Preliminary Screening Values and Laboratory Specific Limits - Groundwater
- **Table C-3: Worksheet #17** Sampling Design and Rationale
- **Table C-4: Worksheet #18** Sample Locations, Analytical, and SOPP Requirements
- **Table C-5: Worksheet #19 & 30** Sample Containers, Preservation, and Hold Times
- **Table C-6: Worksheet #20** Field Quality Control Sample Summary
- **Table C-7: Worksheet #23** Analytical Laboratory Standard Operating Procedures
- **Table C-8: Worksheet #24** Analytical Instrument Calibration
- **Table C-9: Worksheet #25** Analytical Instrument and Equipment Maintenance, Testing, and Inspection
- **Table C-10: Worksheet #26** Sample Handling, Custody, and Disposal
- **Table C-11: Worksheet #28** Analytical Quality Control and Corrective Action
- **Table C-12: Worksheet #36** Data Validation Procedures

Additional site-specific information can be found in the Project Management Plan (Environmental Chemical Corporation [ECC], 2021a) and the Quality Control Plan provided in Appendix E of the CMI Work Plan.

3.4 MONITORING WELLS PROPOSED FOR GROUNDWATER MONITORING

The MNA well network will include 15 existing wells at RSA-115/116 with preliminary screening value (PSV) and/or CG exceedances. **Exhibit C-2** below summarizes the monitoring well information for the wells to be included in the MNA program. The constituents to be analyzed at each well are shown **in Exhibit C-3**.

Exhibit C-2: Monitoring Well Information

Monitoring Well	Monitored Zone	Screened Interval (ft bgs)	Total Well Depth (ft bgs)
RSA-115			
N115-RS419	BR	58.6- 74.8	74.8
N115-RS432	BR-D	197.5- 207.5	207.5
N115-RS467	BR	37.5- 47.5	47.5
N115-RS468	BR	42.5- 52.5	52.5
115-RS2411	BR-D	146.0- 161.0	161.0
115-RS2412	BR-D	182.0- 202.0	202.0
115-RS2413	BR-D	121.0- 151.0	151.0
115-RS2800	BR-D	156.6- 176.6	181.0
RSA-116			
N116-RS404	BR	89.0- 99.0	100.0
N116-RS405	BR	49.7- 59.8	59.8
N116-RS433	BR-D	159.9- 169.6	170.2
N116-RS463	BR	26.0- 31.0	32.0
N116-RS464	BR-D	144.7- 154.7	155.0
N116-RS1009	BR	82.4- 97.4	97.5
116-RS2493	BR	63.0- 83.0	83.0

Note:
ft bgs = feet below ground surface
BR = bedrock
BR-D = deep bedrock

Exhibit C-3: MNA Program Constituent of Concern Analytical Requirements

Metals
Aluminum [3]
Arsenic
Vanadium [2]
Perchlorate
Perchlorate
Explosives
1,3-Dinitrobenzene [2]
2,6-Dinitrotoluene
2-Nitrotoluene
Nitrobenzene [2]
Nitroglycerin [2]
Semi-Volatile Organic Compounds (SVOCs)
Benzo(a)anthracene [3]
Bis(2-ethylhexyl)phthalate
Naphthalene [2]
Pentachlorophenol
Unsymmetrical dimethyl hydramine (UDMH) [1]
Volatile Organic Compounds (VOCs)
1,1,2,2-Tetrachloroethane
Benzene
Bromomethane [2]
Trichloroethene

Note:

1. Green shaded cells with "X" indicate samples from the well will be analyzed for the COC. Note that if a well historically had a CG exceedance for one or more COCs in an analyte grouping (e.g., metals, explosives, SVOCs, VOCs), then all of the COCs in that analyte grouping will be included in the analysis for that well.
2. Grey shaded cells indicate analyte is not a site COC; therefore, this constituent will not be analyzed in samples collected from any wells at the site.
3. Orange shaded cells with "DL" indicate current lowest achievable detection limit (0.5 µg/L) is higher than the CG of 0.00042 µg/L; therefore, continued monitoring for UDMH under the current detection limits is not recommended. When/if the achievable laboratory detection limit drops to or below the CH, UDMH will be included in the monitoring program.

3.5 CONSTITUENT LIST AND SAMPLING FREQUENCY

Based on the conclusions presented in the RFI reports for RSA-115 and RSA-116 (APTIM, 2020a,b), the constituent list for this groundwater monitoring contains both constituents that were detected at concentrations that require action based on the results of the Human Health Risk Assessment (HHRA) and those that were detected above their PSV but not determined to be risk drivers in the cumulative risk assessment (see **Exhibit C-3**). These constituents include aluminum, arsenic, vanadium, perchlorate, 1,3-DNB, 2,6-DNT, 2-NT, 3-NT, nitrobenzene, nitroglycerin, benzo(a)anthracene, bis(2-ethylhexyl) phthalate, naphthalene, pentachlorophenol, UDMH, 1,1,2,2-TeCA, benzene, bromomethane, and TCE. While UDMH has never been detected, the current lowest achievable detection limit is higher than the PSV; therefore, continued monitoring for UDMH under the current detection limits is not recommended. When the achievable laboratory detection limit drops to or below the PSV, UDMH will be included in the monitoring to determine whether it can be terminated. Water quality parameters monitoring during groundwater sample collection will include pH, dissolved oxygen, temperature, specific conductance, oxidation-reduction potential, and turbidity. Water levels will also be measured during each sampling event.

To meet the objectives of this groundwater monitoring program, groundwater sampling will begin with a baseline sampling event to establish groundwater conditions. Years 1 and 2 of the monitoring program will consist of semi-annual groundwater monitoring of the 15 wells, starting approximately six months after the baseline sampling event. A data summary report will be submitted after each sampling event and a detailed analysis will be presented in an annual report. Years 3 to 5 will consist of annual groundwater monitoring followed by a detailed analysis in an annual report. After Year 5, the groundwater monitoring program will be combined with monitoring at the associated underlying groundwater units (RSA-156 or RSA-157) assuming that the Corrective Measures Implementation Plan for the groundwater units will have been approved by ADEM.

The goal of the MNA program is attainment of CGs for the site groundwater COCs. The analytical suite will be optimized over time based on the analytical results. As the CG is achieved for a given COC and demonstrated as such for three successive events (per Redstone Arsenal's RCRA Permit requirements [ADEM, 2022]), the COC will be dropped off the analytical list.

3.6 SAMPLING AND ANALYTICAL PROTOCOL

All data will be collected, stored, and managed in accordance with the requirements defined by the IW-QAPP (HGL, 2019 or as updated based on submissions to ADEM) and the Installation-Wide Accident Prevention Plan (APP) (ECC, 2021b). Prior to sampling the wells, static water levels will be measured in all wells. Water level measurements will be performed in accordance with SOPP No. 16.0, Groundwater Level Measurements. Groundwater sampling will be performed using a submersible pump for purging and low-flow sampling techniques in accordance with SOPP No. 7.0, Groundwater Sampling Rev. 4.

The sampling technician will measure and record physical parameters of the groundwater during well purging to help determine when the well is ready to be sampled. Complete and accurate records in the groundwater well development/ purge log are necessary to ensure representative groundwater samples are being collected. Samples will be analyzed using the United States Environmental Protection Agency (USEPA) Solid Waste (SW)-846 methods as presented in the IW (Investigation Workplan) Quality Assurance Project Plan (QAPP, HGL, 2019 or most recent submission to ADEM) including updates resulting from changes to USEPA and ADEM guidance documents.

The analytical laboratory will provide sample containers. Sample containers are purchased precleaned and treated according to USEPA specifications for the methods. Sample containers are not reused. Containers are stored in clean areas to prevent exposure to fuels, solvents, and other contaminants. The required

sample containers for the analysis of constituents in groundwater at RSA-115/116 are provided in **Table G-5**, along with sample volumes, preservation requirements, and holding times for the analytical methods performed on the groundwater samples.

Sample preservation, packaging, and shipping will follow the procedures as specified in SOPP No. 15, Non-Hazardous Sampling Handling, Packaging, and Shipping, in the IW QAPP (HGL, 2019 or as updated based on submissions to ADEM).

Completed analysis request/chain-of-custody records will be secured and included with each shipment of coolers to the contracted laboratory.

Recommendations to modify the groundwater monitoring program will be made in the annual CMI effectiveness reports.

3.7 QUALITY ASSURANCE/QUALITY CONTROL

Groundwater media will be sampled and analyzed to meet the objectives of the groundwater monitoring program. QA/QC samples will be collected for all sampling events in accordance with requirements established in the IW QAPP (HGL, 2019 or as updated based on submissions to ADEM) to assure long-term comparability of data. Samples will be analyzed by USEPA-approved SW-846 methods of analysis where applicable, comply with USEPA definitive data requirements, and be reported using both hard copy and electronic data packages.

The chemical data will be reported via hard-copy packages by the laboratory using Contract Laboratory Program-like forms, in addition to electronic deliverables, and will include all raw analytical and QC data for each analysis.

All sample preparation and analysis shall be completed within the method-required holding times specified in **Table C-5**. The holding time of a sample begins at the time of sample collection. If holding times are exceeded and the analyses are performed, the results shall be flagged accordingly.

4.0 DATA EVALUATION AND REPORTING

4.1 DATA EVALUATION AND INTERPRETATION

During the baseline sampling event, groundwater samples will be collected from the 15 existing groundwater monitoring wells as shown on Figure 3-1 of the CMI Work Plan. These samples will be collected using low-flow purging and sampling techniques. The samples will be analyzed for the analytes and field parameters described in Section 3.5 above.

The primary objective of the groundwater monitoring program for RSA-115/116 is to determine whether the corrective measure (MNA) reduces concentrations of COCs in groundwater beneath the site to the CGs. This will be determined based on the results of a statistical test or other methods. Statistical analysis will follow Alabama Administrative Code (AAC) 335-14-5-.06(8)(h) (ADEM, 2021) and USEPA guidance for groundwater monitoring at RCRA facilities (USEPA, 1989; 1992; and 2009). Groundwater data collected during sampling events will be compared to the CGs. COCs that exceed these values may be subjected to additional analysis as allowed in ACC 335-14-5-.06(8)(h). The additional analyses may include, for example, control charts, Wilcoxon rank sum tests, box plots, and/or temporal trend analysis, as appropriate. Specific evaluation techniques will depend upon detection frequencies and statistical distributions of each COC. For example, one COC concentration at a given well may exceed the site-specific upper tolerance limit (UTL) or upper prediction limit (UPL), and that could be either a random occurrence or indicative of an increasing trend. Trend analysis will indicate if a trend is present and whether it has statistical significance.

Well data sets that pass statistical comparison tests (i.e., wells that do not demonstrate statistically significant increases over baseline concentrations) for all COCs will be sampled in accordance with planned activities. Wells that fail statistical comparison tests for one or both COCs will be resampled. Following the collection of these additional data, statistical evaluation will again be performed and reported, along with recommendations for adjustment to sampling frequency, if appropriate.

The following non-statistical methods may also be used to characterize RSA-115/116 groundwater conditions:

- **Hydrographs:** Graph water levels versus time may be constructed to determine increases, decreases, seasonal, or man-made fluctuations in groundwater levels;
- **Potentiometric Surface Maps:** Depths to groundwater from multiple wells may be used to construct potentiometric surface contour maps to estimate flow directions;
- **Concentration-versus-Time Plots:** Graphs of COC concentration versus time at each well will be constructed for each data set subjected to trend analysis. This supports the identification of trends and helps determine if concentration changes are related to changes in water level, changes in groundwater flow directions, or natural attenuation;
- **Plume Maps:** Map depicting the physical distribution of chemical constituents will aid in determining movement of plumes.

COCs will be evaluated for compliance with the CMO by comparison of groundwater monitoring results with the established CGs. After an actionable COC is present in a concentration below the CG for three consecutive sampling events, the Army will petition ADEM to eliminate that constituent from the groundwater monitoring program.

4.2 REPORTING

An annual CMI effectiveness/ groundwater monitoring report will be prepared each year of the corrective measure. Letter reports summarizing the activities and the analytical results for each semiannual sampling event will be issued upon receipt of the analytical data for years one and two. The annual report will present and summarize the analytical data from all sampling events completed in that calendar year and will include well redevelopment records, completed well inspection checklist forms, well repair or closure records, and other pertinent information. The annual report will discuss the most recent sampling events and relate the findings as they pertain to the CGs for the groundwater contaminants. Recommendations for changes to the sampling frequency, wells sampled, and parameters for analysis, if appropriate, will be included in the reports. At a minimum, the annual report will include a discussion of sampling activities, tables and maps to document contaminant concentrations in groundwater, an evaluation of the groundwater contaminant data, and all activities completed as part of the Monitoring Well Maintenance Plan (see Section 5.0). Other recommendations may include installation of additional monitoring wells and resampling for verification of sampling results. Record keeping for data and reports is described in the IW QAPP (HGL, 2019 or the most recent submission to ADEM).

5.0 MONITORING WELL MAINTENANCE PLAN

In order to maintain consistent data quality and track contaminant concentrations and migration, the groundwater monitoring wells at RSA-115/116 will be maintained, repaired, and/or replaced, as necessary. Further details are presented in the IW QAPP (HGL, 2019 or as updated based on submissions to ADEM).

5.1 WELL REDEVELOPMENT

A well may be redeveloped prior to sampling if any of the following conditions are exhibited:

- Sediment accumulation in the well covers more than 5 percent (%) of the total length of the well screen.
- Turbidity of groundwater is greater than 20 nephelometric turbidity units after the well has been purged prior to sampling.
- Recharge rate to the well has declined through time (e.g., recharge rates have declined to less than 60% of the recharge rate recorded in the initial development).

5.2 WELL REPLACEMENT OR CLOSURE

If the well does not meet the above requirements after two episodes of redevelopment, the well may be deemed nonfunctional and scheduled for replacement or closure. Consultation with RSA personnel and ADEM staff will be made to determine whether closure or replacement is necessary. The procedures for well replacement or closure are outlined in the IW QAPP (HGL, 2019 or most recent submission to ADEM).

5.3 WELL INSPECTIONS

Site inspections will be performed to help ascertain the condition of monitoring wells and confirm the integrity of the monitoring wells has not been compromised. Wells will be inspected during each sampling event. At a minimum, all monitoring wells in the groundwater monitoring program will be inspected annually. The groundwater monitoring wells at the site will be inspected for the integrity of the following:

- Locks
- Locking cap
- Protective casing
- Bollards (stick-up wells only)
- Concrete pad.

Well redevelopment, replacement, or closure will be documented in the annual report. In addition, well inspection checklist forms for all pertinent site wells will be included in the annual reports. Deficiencies will be documented and corrected as soon as practical, but not less than annually. If a well cannot be properly repaired, it should be replaced or closed.

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TABLES

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Table C-1: Measurement Performance Criteria
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #12 Measurement Performance Criteria

Analytical Group: Metals, VOCs, SVOCs/PAHs, Explosives, Perchlorate, and Dissolved Gases
Concentration Level: Low

Analytical Method & SOP	DQIs	MPC	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for S, A or both (S&A)
EPA 3010A/6010C & MET-002/ MET-009	Precision	RPD from **Worksheet #28**	Lab duplicates and LCS/LCSD	A
	Precision	Sampling per QAP/SOP	Field duplicates and MS/MSD	S&A
	Accuracy/Bias	% Rec. from **Worksheet #28**	LCS	A
	Accuracy/Bias (contamination)	Acceptable Blanks Levels	MB	A
	Accuracy/Bias (contamination)	Sampling per QAP/SOP	Field Blanks and/or Equipment Blanks	S&A
	Completeness	Laboratory Analysis	> 90%	S&A
	Representativeness	Sampling per QAP/SOP	Field Notes	S
	Comparability	Use of promulgated Methodology	QAPP compliance, data review	A
	Sensitivity	PQL/EDL to meet project objectives	ICAL level acceptable, MB acceptable	A
EPA 3010A/6020A & MET-002/ MET-016	Precision	RPD from **Worksheet #28**	Lab duplicates and LCS/LCSD	A
	Precision	Sampling per QAP/SOP	Field duplicates and MS/MSD	S&A
	Accuracy/Bias	% Rec. from **Worksheet #28**	LCS	A
	Accuracy/Bias (contamination)	Acceptable Blanks Levels	MB	A
	Accuracy/Bias (contamination)	Sampling per QAP/SOP	Field Blanks and/or Equipment Blanks	S&A
	Completeness	Laboratory Analysis	> 90%	S&A
	Representativeness	Sampling per QAP/SOP	Field Notes	S
	Comparability	Use of promulgated Methodology	QAPP compliance, data review	A
	Sensitivity	PQL/EDL to meet project objectives	ICAL level acceptable, MB acceptable, MRL acceptable	A
SW5030C/8260C & VOC-001/VOC-003	Precision	RPD from **Worksheet #28**	Lab duplicates and/or LCS/LCSD, if MS/MSD not performed	A
		Sampling per QAPP/SOP	FD and MS/MSD	S&A
	Accuracy/Bias	% Rec. from **Worksheet #28**	LCS	A
	Accuracy/Bias (contamination)	Acceptable Blanks Levels	MB	
		Sampling per QAPP/SOP	EB and TB	S&A
	Completeness	Laboratory Analysis	> 90%	
	Representativeness	Sampling per QAPP/SOP	Blank Samples and DUA	S

Table C-1: Measurement Performance Criteria
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #12 Measurement Performance Criteria

Analytical Method & SOP	DQIs	MPC	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for S, A or both (S&A)
SW5030C/8260C & VOC-001/VOC-003	Comparability	Use of promulgated Methodology	QAPP compliance, data review	A
	Sensitivity	LOQ or LOD to meet project objectives	ICAL level acceptable, MB acceptable	
SW3510C/8270D & SVOC-001/ SVOC-006	Precision	RPD from **Worksheet #28**	Lab duplicates and/or LCS/LCSD, if MS/MSD not performed	A
		Sampling per QAPP/SOP	FD and MS/MSD	S&A
	Accuracy/Bias	% Rec. from **Worksheet #28**	LCS	A
	Accuracy/Bias (contamination)	Acceptable Blanks Levels	MB	
		Sampling per QAPP/SOP	Equipment Blanks	S&A
	Completeness	Laboratory Analysis	> 90%	
	Representativeness	Sampling per QAPP/SOP	Blank Samples and DUA	S
	Comparability	Use of promulgated Methodology	QAPP compliance, data review	A
	Sensitivity	LOQ or LOD to meet project objectives	ICAL level acceptable, MB acceptable	
EPA 3510C/8270D SIM & SVOC-001/ SVOC-028	Precision	RPD from **Worksheet #28**	Lab duplicates and LCS/LCSD	A
	Precision	Sampling per QAP/SOP	Field duplicates and MS/MSD	S&A
	Accuracy/Bias	% Rec. from **Worksheet #28**	LCS	A
	Accuracy/Bias (contamination)	Acceptable Blanks Levels	MB	A
	Accuracy/Bias (contamination)	Sampling per QAP/SOP	Field Blanks and/or Equipment Blanks	S&A
	Completeness	Laboratory Analysis	> 90%	S&A
	Representativeness	Sampling per QAP/SOP	Field Notes	S
	Comparability	Use of promulgated Methodology	QAPP compliance, data review	A
	Sensitivity	PQL/EDL to meet project objectives	ICAL level acceptable, MB acceptable	A
EPA 3535A/8330B & SVOC-032/ SVOC-031	Precision	RPD from **Worksheet #28**	Lab duplicates and LCS/LCSD	A
	Precision	Sampling per QAP/SOP	Field duplicates and MS/MSD	S&A
	Accuracy/Bias	% Rec. from **Worksheet #28**	LCS	A
	Accuracy/Bias (contamination)	Acceptable Blanks Levels	MB	A
	Accuracy/Bias (contamination)	Sampling per QAP/SOP	Field Blanks and/or Equipment Blanks	S&A
	Completeness	Laboratory Analysis	> 90%	S&A
	Representativeness	Sampling per QAP/SOP	Field Notes	S
	Comparability	Use of promulgated Methodology	QAPP compliance, data review	A
	Sensitivity	PQL/EDL to meet project objectives	ICAL level acceptable, MB acceptable	A

Table C-1: Measurement Performance Criteria
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #12 Measurement Performance Criteria

Analytical Method & SOP	DQIs	MPC	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for S, A or both (S&A)
EPA 6850 & HPLC06	Precision	RPD from **Worksheet #28**	Lab duplicates and LCS/LCSD	A
	Precision	Sampling per QAP/SOP	Field duplicates and MS/MSD	S&A
	Accuracy/Bias	% Rec. from **Worksheet #28**	LCS	A
	Accuracy/Bias (contamination)	Acceptable Blanks Levels	MB	A
	Accuracy/Bias (contamination)	Sampling per QAP/SOP	Field Blanks and/or Equipment Blanks	S&A
	Completeness	Laboratory Analysis	> 90%	S&A
	Representativeness	Sampling per QAP/SOP	Field Notes	S
	Comparability	Use of promulgated Methodology	QAPP compliance, data review	A
	Sensitivity	PQL/EDL to meet project objectives	ICAL level acceptable, MB acceptable	A
RSK-175 & VOC-013	Precision	RPD from Worksheet #28	Lab duplicates and LCS/LCSD	A
	Precision	Sampling per QAPP/SOP	Field duplicates and MS/MSD	S&A
	Accuracy/Bias	% Rec. from Worksheet #28	LCS	A
	Accuracy/Bias (contamination)	Acceptable Blanks Levels	MB	A
	Accuracy/Bias (contamination)	Sampling per QAPP/SOP	Field Blanks and/or Equipment Blanks	S&A
	Completeness	Laboratory Analysis	> 90%	S&A
	Representativeness	Sampling per QAPP/SOP	Field Notes	S
	Comparability	Use of promulgated Methodology	QAPP compliance, data review	A
	Sensitivity	PQL/EDL to meet project objectives	ICAL level acceptable, MB acceptable	A

Notes:

> – Greater Than
% – Percent
% Rec. – Percent Recovery
A – Analytical
DQI – Data Quality Indicator
DUA – Data Usability Assessment
EB – Equipment Blank
EDL – Estimated Detection Limit
FD – Field Duplicate
ICAL – Initial Calibration
LCS – Laboratory Control Sample
LCSD – Laboratory Control Sample Duplicate
LOD – Limit of Detection
LOQ – Limit of Quantitation
MB – Method Blank
MPC – Measurement Performance Criteria
MS – Matrix Spike
MSD – Matrix Spike Duplicate
PAH – Polycyclic Aromatic Hydrocarbon
PQL – Practical Quantification Limits
QAPP – Quality Assurance Project Plan
QC – Quality Control
RPD – Relative Percent Difference
S – Sampling
SIM – Selected Ion Monitoring
SOP – Standard Operating Procedure
SVOC – Semivolatile Organic Compound
SW – Solid Waste 846
TB – Trip Blank
USEPA – United States Environmental Protection Agency
VOC – Volatile Organic Compound

Table C-2: Preliminary Screening Values and Laboratory Specific Limits – Groundwater
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #15 Preliminary Screening Values and Laboratory Specific Limits – Groundwater
RSA-115/116 Analyte List

Analyte	CAS Number	115 CG[1]	115 CG Reference	116 CG[1]	116 CG Reference	Units	Laboratory Specific LOQ	Laboratory Specific LOD	Laboratory Specific DL
Long-Term Monitoring									
Metals by SW846 6010C									
Aluminum, Total	7429-90-5	4000	NC (THQ=0.2)	---	---	µg/L	80	40	20
Metals by SW846 6020A									
Arsenic, Total	7440-38-2	10	MCL	---	---	µg/L	1	0.5	0.25
Vanadium, Total	7440-62-2	17	NC (THQ=0.2)	---	---	µg/L	4	2	1
VOCs by SW846 8260C									
1,1,2,2-Tetrachloroethane	79-34-5	---	---	0.19	C (TR=2.5E-06)	µg/L	1	0.4	0.2
1,1-Dichloroethene	75-35-4	7	MCL	7	MCL	µg/L	2	1	0.5
Benzene	71-43-2	5	MCL	---	---	µg/L	1	0.5	0.25
Bromomethane	74-83-9	1.5	NC (THQ=0.2)	---	---	µg/L	2	1	0.5
cis-1,2-Dichloroethene[2]	156-59-2	70	MCL	70	MCL	µg/L	2	1	0.5
trans-1,2-Dichloroethene[2]	156-60-5	100	MCL	100	MCL	µg/L	2	1	0.5
Trichloroethene[2]	79-01-6	5	MCL	5	MCL	µg/L	1	0.5	0.25
Vinyl chloride[2]	75-01-4	2	MCL	2	MCL	µg/L	1	0.5	0.25
PAHs by SW846 8270E-SIM									
Benzo(a)anthracene	56-55-3	0.06	C (TR=2E-06)	---	---	µg/L	0.4	0.2	0.0495
Naphthalene	91-20-3	0.23	C (TR=2E-06)	0.29	C (TR=2.5E-06)	µg/L	0.4	0.2	0.1
SVOCs by SW846 8270E									
Bis(2-ethylhexyl)phthalate	117-81-7	6	MCL	6	MCL	µg/L	10	5	2.5
Pentachlorophenol	87-86-5	1	MCL	---	---	µg/L	5	2.5	0.96
Explosives by SW846 8330B									
1,3-Dinitrobenzene	99-65-0	0.39	NC (THQ=0.2)	0.65	NC (THQ=0.33)	µg/L	0.3	0.15	0.075
2,6-Dinitrotoluene	606-20-2	0.097	C (TR=2E-06)	---	---	µg/L	0.3	0.15	0.05
2-Nitrotoluene	88-72-2	0.63	C (TR=2E-06)	0.79	C (TR=2.5E-06)	µg/L	0.3	0.15	0.075
3-Nitrotoluene	99-08-1	---	---	0.58	NC (THQ=0.33)	µg/L	0.3	0.15	0.075
Nitrobenzene	98-95-3	0.28	C (TR=2E-06)	0.35	C (TR=2.5E-06)	µg/L	0.3	0.15	0.075
Nitroglycerin	55-63-0	0.39	NC (THQ=0.2)	0.65	NC (THQ=0.33)	µg/L	1	0.5	0.325
Perchlorate by SW846 6850									
Perchlorate	14797-73-0	15	MCL	15	MCL	µg/L	0.2	0.1	0.05
Dissolved Gases by RSK-175									
Ethane	74-84-0	NA	Not a COC	NA	Not a COC	µg/L	4.041	1.347	0.674
Ethene	74-85-1	NA	Not a COC	NA	Not a COC	µg/L	3.726	1.242	0.621
Methane	74-82-8	NA	Not a COC	NA	Not a COC	µg/L	2.151	0.717	0.358

Notes:
1. Cleanup goals for site COCs are established in the 2024 CMIP (see Table 3-2 and Appendix B) except for 1,1-dichloroethene, cis- and trans-1,2-dichloroethene, and vinyl chloride (see Note 2).
2. 1,1-Dichloroethene, cis- and trans-1,2-dichloroethene, and vinyl chloride, are not considered site constituents of concern. They are included as analytes to assess the progress of natural attenuation. Their concentrations will be compared to their respective MCLs.

µg/L – micrograms per liter
mg/L – milligrams per liter
CAS – Chemical Abstract System
C – CG derived based on the cancer endpoint
CG – Cleanup Goal
COC – Constituent of Concern
DL – Detection limit
HI – Hazard Index
LOD – Limit of Detection
LOQ – Limit of Quantitation
MCL – Maximum Contaminant Level
mg/kg – Milligrams per Kilogram
mg/L – Milligrams per Liter
NA – Not Applicable
NC – CG derived based on the noncancer HI
PAH – Polycyclic Aromatic Hydrocarbon
SIM – Selected Ion Monitoring
SVOC – Semivolatile Organic Compound
SW – Solid Waste 846
TR – Target Risk
USEPA – United States Environmental Protection Agency
VOC – Volatile Organic Compound

Table C-3: Sampling Design and Rationale
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet # 17 Sampling Design and Rationale

Sample Locations		Sample Media	Sample Location Rationale[1]
RSA-115 and RSA-116		Groundwater **Baseline** **Semiannually** (Years 1 and 2) **Annually** (Years 3 to 5)	This groundwater monitoring program will be used to evaluate the effectiveness and permanence of the groundwater MNA for RSA-115/116. Results from sampling events will be used to evaluate progress towards meeting the CMOs and CGs. Groundwater monitoring activities include depth-to-water gauging, groundwater sample collection, and inspection of the condition of the monitoring wells in the monitoring well network. Groundwater samples are to be collected from these 15 monitoring wells and the analytical program will monitor for parameters detailed on Worksheets #15.
Bedrock: N115-RS419 N115-RS467 N115-RS468 N116-RS404 N116-RS405 N116-RS1009 116-RS2493 N116-RS463	**Deep Bedrock:** N115-RS432 115-RS2411 115-RS2412 115-RS2413 115-RS2800 N116-RS433 N116-RS464		

Notes:

1. The frequency of sampling and/or analyte lists may be modified over the life of the project, based upon sampling results, if approved by the Alabama Department of Environmental Management (ADEM). Permit modifications will be made in accordance with Permit Condition I.J.

CG – Cleanup Goal
CMO – Corrective Measures Objective
MNA – Monitored Natural Attenuation

Table C-4: Sample Locations, Analytical, and SOPP Requirements
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #18 Sample Locations, Analytical, and SOPP Requirements

Sample Location	Sample Name[e]	Sample Depth (ft bgs)	QC Sample Designation[c]		Analytical Suite (See Worksheet #15)	Field SOPP
			FD	MS/MSD		
RSA-115 & RSA-116 Sample Locations – Baseline						
N115-RS419	N115-RS419-GW-ADP-4000-REG	58.6 - 74.8			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate, Dissolved Gases	SOPP 7.0
N115-RS432	N115-RS432-GW-ADP-4001-REG	197.5 - 207.5				
N115-RS467	N115-RS467-GW-ADP-4002-REG	37.5 - 47.5				
N115-RS468	N115-RS468-GW-ADP-4003-REG	42.5 - 52.5				
115-RS2411	115-RS2411-GW-ADP-4004-REG	146.0 - 161.0	115-RS2411-GW-ADP-4005-FD			
115-RS2412	115-RS2412-GW-ADP-4006-REG	182.0 - 202.0		115-RS2412-GW-ADP-4006-MS/MSD		
115-RS2413	115-RS2413-GW-ADP-4007-REG	121.0 - 151.0				
115-RS2800	115-RS2800-GW-ADP-4008-REG	156.6 - 176.6				
N116-RS404	N116-RS404-GW-ADP-4009-REG	58.6 - 74.8				
N116-RS405	N116-RS405-GW-ADP-4010-REG	197.5 - 207.5				
N116-RS433	N116-RS433-GW-ADP-4011-REG	37.5 - 47.5				
N116-RS463	N116-RS463-GW-ADP-4012-REG	42.5 - 52.5				
N116-RS464	N116-RS464-GW-ADP-4013-REG	146.0 - 161.0				
N116-RS1009	N116-RS1009-GW-ADP-4014-REG	182.0 - 202.0				
116-RS2493	116-RS2493-GW-ADP-4015-REG	121.0 - 151.0	116-RS2493-GW-ADP-4016-FD			
Trip Blanks						
RSA-115-116	RSA-115-116-WA-TB-7000-TB	NA			VOC **(Worksheet #15)**	See notes[a]
RSA-115-116	RSA-115-116-WA-TB-7001-TB	NA				
Equipment Rinsate Sample						
RSA-115-116	RSA-115-116-BW-A-8000-ER	NA			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate, Dissolved Gases **(Worksheet #15)**	See notes[b]
IDW Water Sample[d]						
RSA-115-116	RSA-115-116-WA-A-9000-REG	NA			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate **(Worksheet #15)**	SOPP 4.0
RSA-115 & RSA-116 Sample Locations – Year 1, First Semiannual						
N115-RS419	N115-RS419-GW-ADP-4017-REG	58.6 - 74.8			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate, Dissolved Gases	SOPP 7.0
N115-RS432	N115-RS432-GW-ADP-4018-REG	197.5 - 207.5				
N115-RS467	N115-RS467-GW-ADP-4019-REG	37.5 - 47.5				
N115-RS468	N115-RS468-GW-ADP-4020-REG	42.5 - 52.5				
115-RS2411	115-RS2411-GW-ADP-4021-REG	146.0 - 161.0	115-RS2411-GW-ADP-4022-FD			
115-RS2412	115-RS2412-GW-ADP-4023-REG	182.0 - 202.0		115-RS2412-GW-ADP-4023-MS/MSD		
115-RS2413	115-RS2413-GW-ADP-4024-REG	121.0 - 151.0				
115-RS2800	115-RS2800-GW-ADP-4025-REG	156.6 - 176.6				
N116-RS404	N116-RS404-GW-ADP-4026-REG	58.6 - 74.8				
N116-RS405	N116-RS405-GW-ADP-4027-REG	197.5 - 207.5				

Table C-4: Sample Locations, Analytical, and SOPP Requirements
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #18 Sample Locations, Analytical, and SOPP Requirements

Sample Location	Sample Name[e]	Sample Depth (ft bgs)	QC Sample Designation[c]		Analytical Suite (See Worksheet #15)	Field SOPP
			FD	MS/MSD		
N116-RS433	N116-RS433-GW-ADP-4028-REG	37.5 - 47.5			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate, Dissolved Gases	SOPP 7.0
N116-RS463	N116-RS463-GW-ADP-4029-REG	42.5 - 52.5				
N116-RS464	N116-RS464-GW-ADP-4030-REG	146.0 - 161.0				
N116-RS1009	N116-RS1009-GW-ADP-4031-REG	182.0 - 202.0				
116-RS2493	116-RS2493-GW-ADP-4032-REG	121.0 - 151.0	116-RS2493-GW-ADP-4033-FD			
Trip Blanks						
RSA-115-116	RSA-115-116-WA-TB-7002-TB	NA			VOC **(Worksheet #15)**	See notes[a]
RSA-115-116	RSA-115-116-WA-TB-7003-TB	NA				
Equipment Rinsate Sample						
RSA-115-116	RSA-115-116-BW-A-8001-ER	NA			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate, Dissolved Gases **(Worksheet #15)**	See notes[b]
IDW Water Sample[d]						
RSA-115-116	RSA-115-116-WA-A-9001-REG	NA			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate **(Worksheet #15)**	SOPP 4.0
RSA-115 & RSA-116 Sample Locations – Year 1, Second Semiannual						
N115-RS419	N115-RS419-GW-ADP-4034-REG	58.6 - 74.8			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate, Dissolved Gases	SOPP 7.0
N115-RS432	N115-RS432-GW-ADP-4035-REG	197.5 - 207.5				
N115-RS467	N115-RS467-GW-ADP-4036-REG	37.5 - 47.5				
N115-RS468	N115-RS468-GW-ADP-4037-REG	42.5 - 52.5				
115-RS2411	115-RS2411-GW-ADP-4038-REG	146.0 - 161.0	115-RS2411-GW-ADP-4039-FD			
115-RS2412	115-RS2412-GW-ADP-4040-REG	182.0 - 202.0		115-RS2412-GW-ADP-4040-MS/MSD		
115-RS2413	115-RS2413-GW-ADP-4041-REG	121.0 - 151.0				
115-RS2800	115-RS2800-GW-ADP-4042-REG	156.6 - 176.6				
N116-RS404	N116-RS404-GW-ADP-4043-REG	58.6 - 74.8				
N116-RS405	N116-RS405-GW-ADP-4044-REG	197.5 - 207.5				
N116-RS433	N116-RS433-GW-ADP-4045-REG	37.5 - 47.5				
N116-RS463	N116-RS463-GW-ADP-4046-REG	42.5 - 52.5				
N116-RS464	N116-RS464-GW-ADP-4047-REG	146.0 - 161.0				
N116-RS1009	N116-RS1009-GW-ADP-4048-REG	182.0 - 202.0				
116-RS2493	116-RS2493-GW-ADP-4049-REG	121.0 - 151.0	116-RS2493-GW-ADP-4050-FD			
Trip Blanks						
RSA-115-116	RSA-115-116-WA-TB-7004-TB	NA			VOC **(Worksheet #15)**	See notes[a]
RSA-115-116	RSA-115-116-WA-TB-7005-TB	NA				
Equipment Rinsate Sample						
RSA-115-116	RSA-115-116-BW-A-8002-ER	NA			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate, Dissolved Gases **(Worksheet #15)**	See notes[b]
IDW Water Sample[d]						

Table C-4: Sample Locations, Analytical, and SOPP Requirements
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #18 Sample Locations, Analytical, and SOPP Requirements

Sample Location	Sample Name[e]	Sample Depth (ft bgs)	QC Sample Designation[c]		Analytical Suite (See Worksheet #15)	Field SOPP
			FD	MS/MSD		
RSA-115-116	RSA-115-116-WA-A-9002-REG	NA			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate **(Worksheet #15)**	SOPP 4.0
RSA-115 & RSA-116 Sample Locations – Year 2, First Semiannual						
N115-RS419	N115-RS419-GW-ADP-4051-REG	58.6 - 74.8			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate, Dissolved Gases	SOPP 7.0
N115-RS432	N115-RS432-GW-ADP-4052-REG	197.5 - 207.5				
N115-RS467	N115-RS467-GW-ADP-4053-REG	37.5 - 47.5				
N115-RS468	N115-RS468-GW-ADP-4054-REG	42.5 - 52.5				
115-RS2411	115-RS2411-GW-ADP-4055-REG	146.0 - 161.0	115-RS2411-GW-ADP-4056-FD			
115-RS2412	115-RS2412-GW-ADP-4057-REG	182.0 - 202.0		115-RS2412-GW-ADP-4057-MS/MSD		
115-RS2413	115-RS2413-GW-ADP-4058-REG	121.0 - 151.0				
115-RS2800	115-RS2800-GW-ADP-4059-REG	156.6 - 176.6				
N116-RS404	N116-RS404-GW-ADP-4060-REG	58.6 - 74.8				
N116-RS405	N116-RS405-GW-ADP-4061-REG	197.5 - 207.5				
N116-RS433	N116-RS433-GW-ADP-4062-REG	37.5 - 47.5				
N116-RS463	N116-RS463-GW-ADP-4063-REG	42.5 - 52.5				
N116-RS464	N116-RS464-GW-ADP-4064-REG	146.0 - 161.0				
N116-RS1009	N116-RS1009-GW-ADP-4065-REG	182.0 - 202.0				
116-RS2493	116-RS2493-GW-ADP-4066-REG	121.0 - 151.0	116-RS2493-GW-ADP-4067-FD			
Trip Blanks						
RSA-115-116	RSA-115-116-WA-TB-7006-TB	NA			VOC **(Worksheet #15)**	See notes[a]
RSA-115-116	RSA-115-116-WA-TB-7007-TB	NA				
Equipment Rinsate Sample						
RSA-115-116	RSA-115-116-BW-A-8003-ER	NA			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate, Dissolved Gases **(Worksheet #15)**	See notes[b]
IDW Water Sample[d]						
RSA-115-116	RSA-115-116-WA-A-9003-REG	NA			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate **(Worksheet #15)**	SOPP 4.0
RSA-115 & RSA-116 Sample Locations – Year 2, Second Semiannual						
N115-RS419	N115-RS419-GW-ADP-4068-REG	58.6 - 74.8			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate, Dissolved Gases	SOPP 7.0
N115-RS432	N115-RS432-GW-ADP-4069-REG	197.5 - 207.5				
N115-RS467	N115-RS467-GW-ADP-4070-REG	37.5 - 47.5				
N115-RS468	N115-RS468-GW-ADP-4071-REG	42.5 - 52.5				
115-RS2411	115-RS2411-GW-ADP-4072-REG	146.0 - 161.0	115-RS2411-GW-ADP-4073-FD			
115-RS2412	115-RS2412-GW-ADP-4074-REG	182.0 - 202.0		115-RS2412-GW-ADP-4074-MS/MSD		
115-RS2413	115-RS2413-GW-ADP-4075-REG	121.0 - 151.0				
115-RS2800	115-RS2800-GW-ADP-4076-REG	156.6 - 176.6				
N116-RS404	N116-RS404-GW-ADP-4077-REG	58.6 - 74.8				

Table C-4: Sample Locations, Analytical, and SOPP Requirements
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #18 Sample Locations, Analytical, and SOPP Requirements

Sample Location	Sample Name[e]	Sample Depth (ft bgs)	QC Sample Designation[c]		Analytical Suite (See Worksheet #15)	Field SOPP
			FD	MS/MSD		
N116-RS405	N116-RS405-GW-ADP-4078-REG	197.5 - 207.5			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate, Dissolved Gases	SOPP 7.0
N116-RS433	N116-RS433-GW-ADP-4079-REG	37.5 - 47.5				
N116-RS463	N116-RS463-GW-ADP-4080-REG	42.5 - 52.5				
N116-RS464	N116-RS464-GW-ADP-4081-REG	146.0 - 161.0				
N116-RS1009	N116-RS1009-GW-ADP-4082-REG	182.0 - 202.0				
116-RS2493	116-RS2493-GW-ADP-4083-REG	121.0 - 151.0	116-RS2493-GW-ADP-4084-FD			
Trip Blanks						
RSA-115-116	RSA-115-116-WA-TB-7008-TB	NA			VOC **(Worksheet #15)**	See notes[a]
RSA-115-116	RSA-115-116-WA-TB-7009-TB	NA				
Equipment Rinsate Sample						
RSA-115-116	RSA-115-116-BW-A-8004-ER	NA			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate, Dissolved Gases **(Worksheet #15)**	See notes[b]
IDW Water Sample[d]						
RSA-115-116	RSA-115-116-WA-A-9004-REG	NA			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate **(Worksheet #15)**	SOPP 4.0
RSA-115 & RSA-116 Sample Locations – Year 3, Annual						
N115-RS419	N115-RS419-GW-ADP-4085-REG	58.6 - 74.8			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate, Dissolved Gases	SOPP 7.0
N115-RS432	N115-RS432-GW-ADP-4086-REG	197.5 - 207.5				
N115-RS467	N115-RS467-GW-ADP-4087-REG	37.5 - 47.5				
N115-RS468	N115-RS468-GW-ADP-4088-REG	42.5 - 52.5				
115-RS2411	115-RS2411-GW-ADP-4089-REG	146.0 - 161.0	115-RS2411-GW-ADP-4090-FD			
115-RS2412	115-RS2412-GW-ADP-4091-REG	182.0 - 202.0		115-RS2412-GW-ADP-4091-MS/MSD		
115-RS2413	115-RS2413-GW-ADP-4092-REG	121.0 - 151.0				
115-RS2800	115-RS2800-GW-ADP-4093-REG	156.6 - 176.6				
N116-RS404	N116-RS404-GW-ADP-4094-REG	58.6 - 74.8				
N116-RS405	N116-RS405-GW-ADP-4095-REG	197.5 - 207.5				
N116-RS433	N116-RS433-GW-ADP-4096-REG	37.5 - 47.5				
N116-RS463	N116-RS463-GW-ADP-4097-REG	42.5 - 52.5				
N116-RS464	N116-RS464-GW-ADP-4098-REG	146.0 - 161.0				
N116-RS1009	N116-RS1009-GW-ADP-4099-REG	182.0 - 202.0				
116-RS2493	116-RS2493-GW-ADP-4100-REG	121.0 - 151.0	116-RS2493-GW-ADP-4101-FD			
Trip Blanks						
RSA-115-116	RSA-115-116-WA-TB-7010-TB	NA			VOC **(Worksheet #15)**	See notes[a]
RSA-115-116	RSA-115-116-WA-TB-7011-TB	NA				
Equipment Rinsate Sample						
RSA-115-116	RSA-115-116-BW-A-8005-ER	NA			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate, Dissolved Gases **(Worksheet #15)**	See notes[b]

Table C-4: Sample Locations, Analytical, and SOPP Requirements
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #18 Sample Locations, Analytical, and SOPP Requirements

Sample Location	Sample Name[e]	Sample Depth (ft bgs)	QC Sample Designation[c]		Analytical Suite (See Worksheet #15)	Field SOPP
			FD	MS/MSD		
IDW Water Sample[d]						
RSA-115-116	RSA-115-116-WA-A-9005-REG	NA			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate **(Worksheet #15)**	SOPP 4.0
RSA-115 & RSA-116 Sample Locations – Year 4, Annual						
N115-RS419	N115-RS419-GW-ADP-4102-REG	58.6 - 74.8			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate, Dissolved Gases	SOPP 7.0
N115-RS432	N115-RS432-GW-ADP-4103-REG	197.5 - 207.5				
N115-RS467	N115-RS467-GW-ADP-4104-REG	37.5 - 47.5				
N115-RS468	N115-RS468-GW-ADP-4105-REG	42.5 - 52.5				
115-RS2411	115-RS2411-GW-ADP-4106-REG	146.0 - 161.0	115-RS2411-GW-ADP-4107-FD			
115-RS2412	115-RS2412-GW-ADP-4108-REG	182.0 - 202.0		115-RS2412-GW-ADP-4108-MS/MSD		
115-RS2413	115-RS2413-GW-ADP-4109-REG	121.0 - 151.0				
115-RS2800	115-RS2800-GW-ADP-4110-REG	156.6 - 176.6				
N116-RS404	N116-RS404-GW-ADP-4111-REG	58.6 - 74.8				
N116-RS405	N116-RS405-GW-ADP-4112-REG	197.5 - 207.5				
N116-RS433	N116-RS433-GW-ADP-4113-REG	37.5 - 47.5				
N116-RS463	N116-RS463-GW-ADP-4114-REG	42.5 - 52.5				
N116-RS464	N116-RS464-GW-ADP-4115-REG	146.0 - 161.0				
N116-RS1009	N116-RS1009-GW-ADP-4116-REG	182.0 - 202.0				
116-RS2493	116-RS2493-GW-ADP-4117-REG	121.0 - 151.0	116-RS2493-GW-ADP-4118-FD			
Trip Blanks						
RSA-115-116	RSA-115-116-WA-TB-7012-TB	NA			VOC **(Worksheet #15)**	See notes[a]
RSA-115-116	RSA-115-116-WA-TB-7013-TB	NA				
Equipment Rinsate Sample						
RSA-115-116	RSA-115-116-BW-A-8006-ER	NA			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate, Dissolved Gases **(Worksheet #15)**	See notes[b]
IDW Water Sample[d]						
RSA-115-116	RSA-115-116-WA-A-9006-REG	NA			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate **(Worksheet #15)**	SOPP 4.0
RSA-115 & RSA-116 Sample Locations – Year 5, Annual						
N115-RS419	N115-RS419-GW-ADP-4119-REG	58.6 - 74.8			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate, Dissolved Gases	SOPP 7.0
N115-RS432	N115-RS432-GW-ADP-4120-REG	197.5 - 207.5				
N115-RS467	N115-RS467-GW-ADP-4121-REG	37.5 - 47.5				
N115-RS468	N115-RS468-GW-ADP-4122-REG	42.5 - 52.5				
115-RS2411	115-RS2411-GW-ADP-4123-REG	146.0 - 161.0	115-RS2411-GW-ADP-4124-FD			
115-RS2412	115-RS2412-GW-ADP-4125-REG	182.0 - 202.0		115-RS2412-GW-ADP-4125-MS/MSD		
115-RS2413	115-RS2413-GW-ADP-4126-REG	121.0 - 151.0				
115-RS2800	115-RS2800-GW-ADP-4127-REG	156.6 - 176.6				

Table C-4: Sample Locations, Analytical, and SOPP Requirements
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #18 Sample Locations, Analytical, and SOPP Requirements

Sample Location	Sample Name[e]	Sample Depth (ft bgs)	QC Sample Designation[c]		Analytical Suite (See Worksheet #15)	Field SOPP
			FD	MS/MSD		
N116-RS404	N116-RS404-GW-ADP-4128-REG	58.6 - 74.8			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate, Dissolved Gases	SOPP 7.0
N116-RS405	N116-RS405-GW-ADP-4129-REG	197.5 - 207.5				
N116-RS433	N116-RS433-GW-ADP-4130-REG	37.5 - 47.5				
N116-RS463	N116-RS463-GW-ADP-4131-REG	42.5 - 52.5				
N116-RS464	N116-RS464-GW-ADP-4132-REG	146.0 - 161.0				
N116-RS1009	N116-RS1009-GW-ADP-4133-REG	182.0 - 202.0				
116-RS2493	116-RS2493-GW-ADP-4134-REG	121.0 - 151.0	116-RS2493-GW-ADP-4135-FD			
Trip Blanks						
RSA-115-116	RSA-115-116-WA-TB-7014-TB	NA			VOC **(Worksheet #15)**	See notes[a]
RSA-115-116	RSA-115-116-WA-TB-7015-TB	NA				
Equipment Rinsate Sample						
RSA-115-116	RSA-115-116-BW-A-8007-ER	NA			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate, Dissolved Gases **(Worksheet #15)**	See notes[b]
IDW Water Sample[d]						
RSA-115-116	RSA-115-116-WA-A-9007-REG	NA			VOCs, SVOCs, PAHs, Metals, Explosives, Perchlorate **(Worksheet #15)**	SOPP 4.0

Notes:

a) TBs are laboratory provided VOC vials filled with hazardous constituent free water and no headspace. TBs accompany the VOC sample containers into the field during sample collection and during shipment to the laboratory. One TB per sample shipping cooler containing RSA-115/116 groundwater VOC samples.
b) ERs are collected by pouring de-ionized water (obtained from the on-site deionized water treatment system) over non-dedicated decontaminated sampling equipment. One ER will be collected per sampling event.
c) The MS/MSD and FD locations are subject to change due to field conditions.
d) Optionally, groundwater sample results may be used instead of IDW sampling, which is contingent upon receiving facility.
e) The last four digits in the sample name are sequential.

bgs – Below Ground Surface
ER – Equipment Rinsate
FD – Field Duplicate
ft – Feet
GW – Groundwater
IDW – Investigative Derived Waste
MS – Matrix Spike
MSD – Matrix Spike Duplicate
NA – Not Applicable
PAH – Polycyclic Aromatic Hydrocarbon
QC – Quality Control
REG – Regular sample
SOPP – Standard Operating Project Procedure
SVOC – Semivolatile Organic Compounds
TB – Trip Blank
VOC – Volatile Organic Compounds

Table C-5: Sample Containers, Preservation, and Hold Times
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet # 19 & 30 Sample Containers, Preservation, and Hold Times

Analyte/ Analyte Group [b]	Matrix	Analytical Method	Accreditation Expiration Date	Sample Container/ Preservation Requirements [a]	Holding Time	Data Package Turnaround [c]
Groundwater Samples						
Metals	Water	SW6010C/ SW6020A	31 July 2025	1 – 500 mL poly HNO_3 to pH < 2	Preparation – 180 days Analysis – 180 days	15 days
VOCs		SW8260C	31 July 2025	1 – 40 mL vials; HCl to pH < 2 2 – 40 mL vials; unpreserved	Preserved – 14 days Unpreserved – 7 days	
SVOCs		SW8270D	31 July 2025	1 – 1 Liter amber glass	Extraction – 7 days Analysis – 40 days	
PAHs		SW8270D-SIM	31 July 2025	1 – 250 mL amber glass	Extraction – 7 days Analysis – 40 days	
Explosives		SW8330B	31 July 2025	1 – 1 Liter amber glass	Extraction – 7 days Analysis – 40 days	
Perchlorate		SW6850	30 June 2025	1 – 125 mL polyethylene bottle stored with headspace	Analysis – 28 days	
Dissolved Gases		RSK-175	31 July 2025	1 – 40 mL vials; HCl to pH < 2 2 – 40 mL vials; unpreserved	Preparation – 14 days Analysis – 14 days	
IDW Water						
Metals	Water	SW6010C/ SW6020A	31 July 2025	1 – 500 mL poly HNO_3 to pH < 2	Preparation – 180 days Analysis – 180 days	15 days
VOCs		SW8260C	31 July 2025	1 – 40 mL vials; HCl to pH < 2 2 – 40 mL vials; unpreserved	Preserved – 14 days Unpreserved – 7 days	
SVOCs		SW8270D	31 July 2025	1 – 1 Liter amber glass	Extraction – 7 days Analysis – 40 days	
PAHs		SW8270D-SIM	31 July 2025	1 – 250 mL amber glass	Extraction – 7 days Analysis – 40 days	
Explosives		SW8330B	31 July 2025	1 – 1 Liter amber glass	Extraction – 7 days Analysis – 40 days	
Perchlorate		SW6850	30 June 2025	1 – 125 mL polyethylene bottle stored with headspace	Analysis – 28 days	

Notes:

Table C-5: Sample Containers, Preservation, and Hold Times
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet # 19 & 30 Sample Containers, Preservation, and Hold Times

a) All samples should be cooled to 4 ± 2°C in conjunction with preservation requirements noted prior to shipment to the laboratory.
b) See **Worksheet #15** for the analyte list per method.
c) Sample deliverables should include a Level IV, Contract Laboratory Program (CLP)-like data package and Electronic Data Deliverable (EDD) for all samples with the exception of IDW samples that require certificates of analysis and EDD only.

< – less than
°C – degrees Celsius
HCl – hydrochloric acid
HDPE – High-density polyethylene
HNO_3 – nitric acid
IDW – Investigative-derived waste
mL – milliliter
PAH – Polycyclic Aromatic Hydrocarbon
SIM – Selected Ion Monitoring
SVOCs – Semivolatile organic compound
SW – Solid Waste
USEPA – United States Environmental Protection Agency
VOC – Volatile organic compound

Table C-5: Sample Containers, Preservation, and Hold Times
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama

Worksheet # 19 & 30 Sample Containers, Preservation, and Hold Times

Ship all samples to AEL and AEL will ship to sublabs

Lab Point of Contact:

Mr. Craig Meyers
Advanced Environmental Laboratories (AEL) Client Services Manager
Voice: 904-363-9350 Ext. 202
FAX: 904-363-9354
After Hours/Emergency: 904-710-7158

Perchlorate Samples:

Brielle Luthman
GEL Laboratories, LLC
2040 Savage Road
Charleston, SC 29407
Email: Brielle.Luthman@gel.com
Phone number: 843-556-8171

Laboratory Addresses:

For shipments Monday through Thursday, ship to:

Attn: Sample Receiving
Advanced Environmental Laboratories, Inc.
6681 Southpoint Parkway
Jacksonville, Florida 32216
904-363-9350

For shipments for Friday or Saturday delivery, there are specific instructions, they will be shipped and held for pickup at the following FedEx location across the street from the lab:

Attn: AEL
FedEx Shipping Center
3736 N Salisbury Rd
Jacksonville, Florida 32216
800-463-3339

Table C-6: Field Quality Control Sample Summary
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #20 Field Quality Control Sample Summary
RSA-115

Parameters[a]	Analytical Method	Matrix	Total # of Samples	FD	MS	MSD	ER (1/event)	TB (1/cooler)	TAT Needed[a]	Sample Container/ Preservation Requirements	Holding Time	Total # of Containers
115 and 116 Semiannual & Annual Samples/Event												
Metals	SW6010C SW6020A	Water	15	2	1	1	1		Normal	1 – 500 mL poly HNO_3 to pH < 2	Preparation – 180 days Analysis – 180 days	20
VOCs	SW8260C	Water	15	2	1	1	1	2	Normal	1 – 40 mL vials; HCl to pH < 2 2 – 40 mL vials; unpreserved	Preserved – 14 days Unpreserved – 7 days	22
SVOCs	SW8270D	Water	15	2	1	1	1	0	Normal	1 – 1 Liter amber glass	Extraction – 7 days Analysis – 40 days	20
PAHs	SW8270D-SIM	Water	15	2	1	1	1	0	Normal	1 – 250 mL amber glass	Extraction – 7 days Analysis – 40 days	20
Explosives	SW8330B	Water	15	2	1	1	1	0	Normal	1 – 1 Liter amber glass	Extraction – 7 days Analysis – 40 days	20
Perchlorate	SW6850	Water	15	2	1	1	1	0	Normal	1 – 125 mL polyethylene bottle stored with headspace	Analysis – 28 days	20
Dissolved Gases	RSK-175	Water	15	2	1	1	1	0	Normal	1 – 40 mL vials, HCl to pH < 2 2 – 40 mL vials, unpreserved	Preparation – 14 days Analysis – 14 days	20
IDW Water/Event												
Metals	SW6010C SW6020A	Water	1	0	0	0	0	0	Normal	1 – 500 mL poly HNO_3 to pH < 2	Preparation – 180 days Analysis – 180 days	1
VOCs	SW8260C	Water	1	0	0	0	0	0	Normal	3 – 40 mL vials; HCl to pH < 2	Preserved – 14 days Unpreserved – 7 days	1
SVOCs	SW8270D	Water	1	0	0	0	0	0	Normal	2 – 1 Liter amber glass	Extraction – 7 days Analysis – 40 days	1
PAHs	SW8270D-SIM	Water	1	0	0	0	0	0	Normal	2 – 1 Liter amber glass	Extraction – 7 days Analysis – 40 days	1
Explosives	SW8330B	Water	1	0	0	0	0	0	Normal	1 – 1 Liter amber glass	Extraction – 7 days Analysis – 40 days	1
Perchlorate	SW6850	Water	1	0	0	0	0	0	Normal	1 – 125 mL polyethylene bottle stored with headspace	Analysis – 28 days	1

Table C-6: Field Quality Control Sample Summary
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #20 Field Quality Control Sample Summary

Notes:

a) Sample deliverables should include a Department of Defense (DoD) Quality Systems Manual (QSM) Stage 3-4 data package and Environmental Chemical Corporation (ECC) Environmental Data Management System (EDMS) electronic data deliverable (EDD) for all groundwater samples. IDW samples require Level I/II data package and EDD.

b) TBs are filled containers and not counted as part of the empty container total. TBs must be ordered from the contract laboratory. IDW water will be analyzed for constituents as required by receiving facility.

c) All samples should be cooled to 4°C for shipment to the laboratory.

d) Purge water IDW contamination levels may be determined from groundwater laboratory results, based upon acceptance of IDW water receiving facility, instead of IDW water sampling.

< – less than
°C – degrees Celsius
ER – Equipment Rinsate
FD – Field Duplicate
HCl – Hydrochloric Acid
HDPE – High Density Polyethylene
HNO_3 – Nitric Acid
IDW – Investigation derived waste
mL – Milliliter
MS – Matrix Spike
MSD – Matrix Spike Duplicate
PAH – Polycyclic Aromatic Hydrocarbons
SIM – Selected Ion Monitoring
SVOC – Semivolatile organic compound
SW – Solid Waste 846
TAT – Turnaround Time
TB – Trip Blank
USEPA – United States Environmental Protection Agency
VOC – Volatile Organic Compound

Table C-7: Analytical Laboratory Standard Operating Procedures
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #23 Analytical Laboratory Standard Operating Procedures

SOP Reference Number	Title, Revision, Date	Definitive or Screening Data	Analytical Group	Matrix	Instrument	Organization Performing Analysis	Modified for Project Work (Yes/No)?
Admin-005	Sample Receipt, handling, storage, and Log In Rev.09, Eff. 2022-07-27	Definitive	Samples	NA	NA	AEL	No
Admin-018	Waste Disposal and Pollution Prevention Admin-018 Rev.10 Eff 2020-10-09	Definitive	Samples	NA	NA	AEL	No
AEL QSM 10.4	Quality Manual, Rev. 10.4, Eff 2022-03-31	Definitive	Quality Systems	NA	NA	AEL	No
HPLC06	Perchlorate Method 6850/331.0, 15 April 2019, Revision 8	Definitive	Perchlorate	Water	LC/MS/MS	GEL	No
MET-002	Method EPA SW3010A: Acid digestion of aqueous samples and extracts, Rev. 17, Eff. 2023-03-03	Definitive	Metals Aqueous Sample Preparation	Water	N/A	AEL	No
MET-009	Method SW 6010 B, C, & D: Inductively Coupled Plasma-Atomic Emission Spectrometry, Rev.19, Eff. 2023-02-07	Definitive	Metals Aqueous and Solid Sample Analysis	Water	ICP-AES	AEL	No
MET-016	Method SW 6020A and B: Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry, Rev.16, Eff. 2023-03-06	Definitive	Metals Aqueous and Solid Sample Analysis	Water	ICP-MS	AEL	No
SVOC-001	Method 3510C: Separatory Funnel Liquid-Liquid Extraction, Rev. 09, Eff. 2023-01-17	Definitive	SVOCs/PAHs	Water	NA	AEL	No
SVOC-006	Method 8270C & D & E: Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), Rev. 13, Eff. 2023-01-17	Definitive	SVOCs	Water	GC/MS	AEL	No
SVOC-028	Method 8270C/D/E SIM: Semivolatile Organic Compounds by Gas Chromatography (GC/MS) in Selective Ion Mode (SIM), Rev. 12, Eff. 2020-12-22, Last Reviewed 2023-03-27	Definitive	PAHs	Water	GC/MS (SIM)	AEL	No
SVOC-031	Method 8330B: Explosives by HPLC, Rev. 02, Eff. 2022-02-17	Definitive	SVOA Aqueous and Solid Sample Analysis	Water	HPLC (High Performance Liquid Chromatography)	AEL	No
SVOC-032	Method 3535A: Solid Phase Extraction (SPE) for Nitroaromatics, Nitramines, and Explosives. Rev. 01, Eff 2022-02-17	Definitive	SVOA Aqueous Sample Preparation	Water	NA	AEL	No
VOC-001	Method 5030C: Purge-and-Trap for Aqueous Samples, Rev. 06, Eff. 2020-08-10	Definitive	VOCs	Water	Purge and Trap	AEL	No

Table C-7: Analytical Laboratory Standard Operating Procedures
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #23 Analytical Laboratory Standard Operating Procedures

SOP Reference Number	Title, Revision, Date	Definitive or Screening Data	Analytical Group	Matrix	Instrument	Organization Performing Analysis	Modified for Project Work (Yes/No)?
VOC-003	Methods 8260B, C, & D: VOCs by GC/MS, Rev. 16, Eff. 2021-04-19	Definitive	VOCs	Water	GC/MS	AEL	No
VOC-013	Dissolved Gas Analysis in Water Samples by Headspace-Gas Chromatography (HS-GS) with Flame Ionization Detection (FID) Rev 05, Eff. 2024-05-14	Definitive	Dissolved Gases	Water	GC/FID	AEL	No

Notes:

AEL – Advanced Environmental Laboratories
Eff. – Effective
FID – Flame Ionization Detector
GC/FID – Gas Chromatography – Flame Ionization Detector
GC/MS – Gas chromatography/Mass spectrometry
HPLC – High Performance Liquid Chromatography
HS-GS – Headspace-Gas Chromatography
ICP-MS - Inductively Coupled Plasma-Mass Spectrometry
LC/MS/MS – Liquid Chromatography and Tandem Mass Spectrometry
MET – Metals
NA – Not Applicable
PAH – Polycyclic Aromatic Hydrocarbon
Rev. – Revision
SIM – Selected Ion Monitoring
SOP – Standard Operating Procedure
SPE – Solid Phase Extraction
SVOC – Semivolatile Organic Compound
SVOA – Semivolatile Organic Analyte
USEPA – United States Environmental Protection Agency
VOC – Volatile organic compounds

Table C-8: Analytical Instrument Calibration
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #24 Analytical Instrument Calibration

Instrument	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
ICP-AES	ICAL	Varied per Element. Lead (Pb) GW 0.012 to 1.2 mg/L. Pb Soil 0.4 to 5.6 mg/L	Daily	Linear least squares regression for each analyte ≥0.99	Correct problem, rerun ICAL.	Analyst	MET-009, Sections 12, 13
	ICV	Varied per Element. 0.1 mg/L Pb GW 5 mg/L Pb Soil	Daily after ICAL.	All target elements ± 10% of true value	Correct problem, rerun ICV. If that fails, repeat ICAL.		
	CCV	Varied per Element. 0.06 mg/L Pb GW 1.6 mg/L Pb Soil	Every 10 field samples	All target elements ± 10% of true value	Immediately analyze two additional CCVs. If both pass, samples can be reported. If either fails, repair problem, rerun samples with new passing CCV. May require new ICAL. If reanalysis not possible, data must be qualified with case narration.		
	LLCCV	Varied per Element. 0.012 mg/L Pb GW 0.8 mg/L Pb Soil	Daily	All target elements ± 20% of true value	Correct problem, rerun ICAL.		
ICP-MS	LDR	High standard(s) at the upper limit of the range	At initial setup and every six months	To establish an upper limit where TV ± 10%	Data cannot be reported above upper limit within qualification or running a higher passing standard	Analyst	MET-016, Sections 13
	Tune Check	N/A	Daily before ICAL	Mass Calibration Less than or equal to 0.1 amu from the true value; Resolution < 0.9 amu full width at 10% peak height.	Retune Instrument	Analyst	
	IS	All QC and Samples	All QC and Samples	30-120% of Intensity in ICAL Blank	All samples out of range are to be diluted and rerun until IS returns to calibration range.	Analyst	MET-016, Sections 12, 13

Table C-8: Analytical Instrument Calibration
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #24 Analytical Instrument Calibration

Instrument	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
ICP-MS	ICAL	Low point Varied per Analyte. Pb and Fe are at 10000, 20000, and 100000 ppb. Remaining Analytes are at 10, 20, and 100 ppb.	Daily	Linear least squares regression for each analyte ≥0.99	Correct problem, rerun ICAL.	Analyst	MET-016, Sections 12, 13
	ICV	Pb and Fe at 50,000 ppb. All other analytes at 50 ppb.	Daily after ICAL.	All target elements ± 10% of true value	Correct problem, rerun ICV. If that fails, repeat ICAL.	Analyst	
	CCV	Pb and Fe at 20,000 ppb. All other analytes at 20 ppb.	Every 10 field samples	All target elements ± 10% of true value	Immediately analyze two additional CCVs. If both pass, samples can be reported. If either fails, repair problem, rerun samples with new passing CCV. May require new ICAL. If reanalysis not possible, data must be qualified with case narration.	Analyst	
	LLCCV	Varied per Element.	Daily after ICAL.	All target elements ± 20% of true value	Correct problem, rerun ICAL.	Analyst	
VOCs GC/MS	Tune Check	Ion ratio verified	Every 12 hours and beginning of the analytical batch.	Specific ion abundance criteria for BFB tune solution.	Retune Instrument	Analyst	VOC-003, Section 12.1
	ICAL	On instrument: 1 to 200 µg/L, 0.1 to 1.2 µg/L for SIM	At instrument set-up and after ICV or CCV failure, prior to sample analysis	Either RSD for each analyte ≤15% or linear least squares regression for each analyte ≥ 0.99	Correct problem then repeat ICAL		VOC-003, Sections 10, 13
	RT Windows Verification	NA	At ICAL at midpoint and daily at beginning CCV	IS shift ≤ 10 seconds otherwise reset. Analytes reported within ± 0.06 RRT	NA		VOC-003, Section 13
	ICV	At concentration level ± 25-50% of curve range	Once after ICAL	All target analytes within ± 20% of true value	Correct problem. Rerun ICV. If fails, repeat ICAL		VOC-003, Sections 10, 13

Table C-8: Analytical Instrument Calibration
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #24 Analytical Instrument Calibration

Instrument	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
VOCs GC/MS	CCV	At concentration level ± 25-50% of curve range	Daily before sample analysis, every 12 hours thereafter, and close of analysis	All target analytes within ± 20% of true value. Closing CCV ± 50%	Immediately analyze two additional CCVs. If both pass, samples can be reported. If either fails, repair problem, rerun samples with new passing CCV. May require new ICAL. If reanalysis not possible, data must be qualified with case narration.		VOC-003, Sections 12, 13
	IS	All QC and Samples	All QC and Samples	RT within ± 10 seconds at ICAL midpoint or first daily CCV. Area Counts -50% to +100% midpoint standard	Correct problem, reanalyze samples.		
SVOCs/ PAHs GC/MS	Tune Check	Ion ratio verified	Every 12 hours and beginning of the analytical batch.	Specific ion abundance criteria for DFTPP tune solution.	Retune Instrument	Analyst	SVOC-028, Sections 12, 13, 24
	Tailing and Degradation Check	50 µg/mL		Degradation of DDT ≤ 20%, Benzidine and pentachlorophenol tailing factor < 2	Correct problem (Change liner and/or trim column)		
	Resolution Check	20 µg/mL	Every 12 hours and beginning of the analytical batch.	Resolution Criteria - The height of the valley between the 2 isomers (benzo(b) and benzo(k)) must be less 50% of the average height of the 2 peak heights. Correct problem and re-analyze all QC and project	Correct problem (Change liner and/or trim column)		SVOC-028, Sections 14, 24
	ICAL	For PAH analytes, 0.025 to 100 mg/L on instrument. All other analytes, 5 to 100 mg/L.	At instrument set-up and after ICV or CCV failure, prior to sample analysis	Either RSD for each analyte ≤15%; linear or quadratic least squares regression for each analyte ≥ 0.99	Correct problem then repeat ICAL		SVOC-028, Sections 10, 13, 16, 24
	ICV	At concentration level ± 25-50% of curve range	Once after ICAL	All target analytes within ± 20% of true value	Correct problem. Rerun ICV. If fails, repeat ICAL		

Table C-8: Analytical Instrument Calibration
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #24 Analytical Instrument Calibration

Instrument	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
SVOCs/ PAHs GC/MS	RT Windows Verification	NA	At ICAL at midpoint and daily at beginning CCV	IS shift ≤ 10 seconds otherwise reset. Analytes reported within ± 0.06 RRT	NA		SVOC-028, Sections 12, 14, 16, 24
	CCV	At concentration level ± 25-50% of curve range	Daily before sample analysis, every 12 hours thereafter, and close of analysis	All target analytes within ± 20% of true value. Closing CCV ± 50%	Immediately analyze two additional CCVs. If both pass, samples can be reported. If either fails, repair problem, rerun samples with new passing CCV. May require new ICAL. If reanalysis not possible, data must be qualified with case narration.	Analyst	SVOC-028, Sections 10, 13, 24
Explosives/ HPLC	ICAL	Prepare calibration standards at a maximum of 7 levels: 0.05 ug/mL, 0.1 ug/mL, 0.5 ug/mL, 2.5 ug/mL, 5.0 ug/mL, 10 ug/mL and 20 ug/mL. External calibration is used with Method 8330B because of the internal standard co-elution.	At instrument set-up and after ICV or CCV failure, prior to sample analysis	Either RSD for each analyte ≤20% or linear least squares regression for each analyte ≥0.99	Correct problem then repeat ICAL	Analyst	SVOC-031 Sections 10,12,13
	Initial Calibration Verification (ICV)	At concentration level ± 25-50% of curve range	Once after ICAL	All target analytes within ± 20% of true value	Correct problem. Rerun ICV. If fails, repeat ICAL	Analyst	SVOC-031 Sections 10,12,13
	Retention Time (RT) Windows Verification	NA	At ICAL at midpoint and daily at beginning CCV	Internal Standards shift ≤ 10 seconds otherwise reset. Analytes reported within ± 0.05 min.	NA	Analyst	SVOC-031 Sections 10,12,13

Table C-8: Analytical Instrument Calibration
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #24 Analytical Instrument Calibration

Instrument	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
Explosives/ HPLC	CCV	At concentration level ± 25-50% of curve range	Daily before sample analysis, every 10 field samples, and close of analysis	All target analytes within ± 20% of true value.	Immediately analyze two additional CCVs. If both pass, samples can be reported. If either fails, repair problem, rerun samples with new passing CCV. May require new ICAL. If reanalysis not possible, data must be qualified with case narration.	Analyst	SVOC-031 Sections 10,12,13
Shimadzu Prominence UFLC XR HPLC/ Applied Biosystems API-4000 Triple Quadrupole Mass Spectrometer	Interference Threshold Study	NA	At initial setup and when major changes occur in the method's operating procedures (e.g., addition of cleanup procedures, column changes, mobile phase changes).	Measure the threshold of common suppressors (chloride, sulfate, carbonate, bicarbonate) that can be present in the system without affecting the quantitation of perchlorate. The threshold is the concentration of the common suppressors where perchlorate recovery falls outside an 80-120% window.	NA.	Analyst/ Supervisor	HPLC06
	Mass Calibration	Range must bracket ion masses of interest.	Instrument must have a valid mass calibration prior to any sample analysis. The mass calibration is updated on an as-needed basis (e.g., QC failures, ion masses show large deviations from known masses, major instrument maintenance is performed, or the instrument is moved).	Ions should be within +/- 0.3 m/z of masses 83, 85 and 89.	If the mass calibration fails, recalibrate. If it still fails, consult manufacturer instructions on corrective maintenance.		

Table C-8: Analytical Instrument Calibration
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #24 Analytical Instrument Calibration

Instrument	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
Shimadzu Prominence UFLC XR HPLC/ Applied Biosystems API-4000 Triple Quadrupole Mass Spectrometer	Tune Check	Range must bracket ion masses of interest.	Prior to ICAL and after any mass calibration or maintenance is performed.	Tuning standards must span the mass range of the analytes of interest and meet acceptance criteria outlined in the laboratory SOP.	Retune instrument and verify. If the tune check will not meet acceptance criteria, an instrument mass calibration must be performed and the tuning redone.	Analyst	HPLC06
	ICAL	0.1-10 µg/L Details in SOP section 7.5.2	At instrument setup or after ICV or CCV failure, prior to sample analysis.	ICAL must meet one of the two options below: Option 1: RSD for each analyte ≤ 15%; Option 2: linear least squares regression for each analyte: r2 ≥ 0.995.	Correct problem, then repeat ICAL.		
	ICV	1.0 µg/L	Once after each ICAL.	Perchlorate concentration must be within ± 15% of its true value.	Correct problem. Rerun ICV. If that fails, repeat ICAL.		
	CCV	1.0 µg/L	On days an ICAL is performed, after every 10 field samples, and at the end of the analytical sequence. On days an ICAL is not performed, at the beginning of the sequence, after every 10 field samples, and at the end of the analytical sequence.	Perchlorate concentration must be within ± 15% of its true value.	Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails or if two consecutive CCVs cannot be run, perform corrective action(s) and repeat CCV and all associated samples since last successful CCV. Alternately, recalibrate if necessary; then reanalyze all associated samples since the last acceptable CCV.		

Table C-8: Analytical Instrument Calibration
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #24 Analytical Instrument Calibration

Instrument	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
Shimadzu Prominence UFLC XR HPLC/ Applied Biosystems API-4000 Triple Quadrupole Mass Spectrometer	Isotope Ratio 35Cl/37Cl	NA	Every sample, batch QC sample, and standard.	Monitor for either the parent ion at masses 99/101 or the daughter ion at masses 83/85 depending on which ions are quantitated. Must fall within 2.3 to 3.8.	If criteria are not met, the sample must be rerun. If the sample was not pretreated, the sample must be re-extracted using cleanup procedures. If, after cleanup, the ratio still fails, use alternative techniques to confirm presence of perchlorate, e.g., a post spike sample or dilution to reduce any interference.	Analyst	HPLC06
	Internal Standard (IS)	5 µg/L O18 perchlorate	Addition of 18O-labeled perchlorate to every sample, batch QC sample, standard, instrument blank, and Method Blank.	Addition of 18O-labeled perchlorate to every sample, batch QC sample, standard, instrument blank, and Method Blank.	Rerun the sample at increasing dilutions until the ± 50% acceptance criteria are met. If criteria cannot be met with dilution, the interference is suspected and the sample must be re-prepped using additional pretreatment steps.		
	Interference Check Sample (ICS)	SOP section 7.8	One ICS is prepared with every batch of 20 samples and must undergo the same preparation and pretreatment steps as the samples in the batch. It verifies the method performance at the matrix conductivity threshold (MCT). At least one ICS must be analyzed daily. The ICS shall be prepared at the LOQ.	Perchlorate concentration must be within ± 20% of its true value.	Correct problem. Reanalyze all samples and QC samples in the batch. If poor recovery from the cleanup filters is suspected, a different lot of filters must be used to re-extract all samples in the batch. If column degradation is suspected, a new column must be calibrated before the samples can be reanalyzed.		

Table C-8: Analytical Instrument Calibration
RSA-115/116 Site Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #24 Analytical Instrument Calibration

Instrument	Calibration Procedure	Calibration Range	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
Volatiles (MEE) GC/FID	ICAL	Varied per Analyte.	At instrument set-up and after ICV or CCV failure, prior to sample analysis	Either RSD for each analyte ≤20%; linear or quadratic regression for each analyte ≥0.99	Correct problem then repeat ICAL	Analyst	VOC-013, Sections 10, 12, 13, 24
	RT Windows Verification	NA	Before ICAL and daily before IB.	Set at ± 3 times standard deviation of 72 hour study.	NA	Analyst	VOC-013, Section 12, 24
	ICV	Varied per Analyte.	Once after ICAL	All target analytes within ± 20% of true value	Correct problem. Rerun ICV. If fails, repeat ICAL	Analyst	VOC-013, Sections 10, 12, 13, 24
	CCV	Varied per Analyte.	Daily before sample analysis, every 4 hours thereafter, and close of analysis	All target analytes within ± 20% of true value.	Immediately analyze two additional CCVs. If both pass, samples can be reported. If either fails, repair problem, rerun samples with new passing CCV. May require new ICAL. If reanalysis not possible, data must be qualified with case narration.	Analyst	

Notes:

± – Plus or Minus
< – Less Than
≤ – Less Than or Equal to
> – Greater Than
≥ – Greater Than or Equal to
% – Percent
µg/L – Micrograms per Liter
µg/mL – Micrograms per Milliliter
BFB – Bromofluorobenzene
CA – Corrective Action
CCB – Continuing Calibration Blank
CCV – Continuing Calibration Verification
DDT – Dichlorodiphenyltrichloroethane
DFTPP – Decafluorotriphenylphosphine
Fe – Iron
GC/MS – Gas Chromatography/Mass Spectrometry
HCl – Hydrochloric Acid
IB – Instrument Blank
ICP-AES – Inductively Coupled Plasma-Atomic Emission Spectrometry
ICP-MS – Inductively Coupled Plasma-Mass Spectrometry
ICAL – Initial Calibration
ICV – Initial Calibration Verification
IS – Internal Standard
LDR – Linear Dynamic Range
LLCCV – Low Level Calibration Check Standard
LOD – Limit of Detection
MEE – Methane, ethane, ethene
mg – Milligrams
mg/L – Milligrams per Liter
NA – Not Applicable
PAH – Polycyclic Aromatic Hydrocarbon
Pb – Lead
ppb – parts per billion
QC – Quality Control
R – Coefficient of Correlation
RRT – Relative Retention Time
RPD – Relative Percent Difference
RSD – Relative Standard Deviation
RT – Retention Time
SIM – Selected Ion Monitoring
SOP – Standard Operating Procedure
SVOC – Semivolatile Organic Compound
TIC – Total Inorganic Carbon
TV – True Value
VOC – Volatile Organic Compound

Table C-9: Analytical Instrument and Equipment Maintenance, Testing, and Inspection
RSA-115/116 Groundwater Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet# 25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity/Preventive Maintenance	Frequency	Acceptance Criteria	CA	Title/ Position Responsible for CA	Reference
ICP-AES	Pump/tubing	ICAL and CCVs	• Checked daily • Replaced every 2 to 3 days	As Listed with Inspection	Method blanks < DL, ICAL, ICV, CCV, peak shape, & LCS, Area Counts, surrogate limits as seen on **Worksheet #28**	Normal replacement	Analyst	MET-009
	Sample introduction		• All sample introduction items, nebulizer, injector tip, spray chamber and torch are cleaned and sonicated in a HNO3 and HCl aqua-regia solution as needed. Dependent on sample load and sample concentrations.	As Listed with Inspection	MB, CCB, and QC passing criteria	Normal maintenance	Analyst	
	Optical Alignment		• Zinc daily alignment	As Listed with Inspection	To instruments settings	Clean windows	Analyst	
	Interference Checks		• Performance Maintenance	As needed	MB, CCB, and QC passing criteria	Performance Maintenance	Manufacturer's Instrument Technician	
	Chiller/Compressor		• Clean screens check and add fluid monthly • Drain and replace compressor oil monthly	As Listed with Inspection	Set to proper fluid levels	Set to proper fluid levels	Analyst	
ICP-MS	Pump/tubing	Initial and Continuing Calibration Verifications	• Checked daily • Replaced every 2 to 3 days	As Listed with Inspection	Method blanks < DL, ICAL, ICV, CCV, peak shape, & LCS, Area Counts, surrogate limits as seen on worksheet #28	Normal replacement	Analyst	MET-016

Table C-9: Analytical Instrument and Equipment Maintenance, Testing, and Inspection
RSA-115/116 Groundwater Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet# 25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity/Preventive Maintenance	Frequency	Acceptance Criteria	CA	Title/ Position Responsible for CA	Reference
ICP-MS	Sample introduction	ICV and CCV	• All sample introduction items, nebulizer, injector tip, spray chamber and torch are cleaned and sonicated in a HNO3 and HCl aqua-regia solution as needed. Dependent on sample load and sample concentrations.	As Listed with Inspection	MB, CCB, and QC passing criteria	Normal maintenance	Analyst Analyst	MET-016
	Cones	ICV and CCV	• Cones are removed and cleaned in HNO3 and sonicated. Replaced with new as needed.	As Listed with Inspection	Passing tunes and QC criteria.	Clean or replace as needed		
	Interference Checks	ICV and CCV	• Performance Maintenance	As needed	MB, CCB, and QC passing criteria	Performance Maintenance	Manufacturer's Instrument Technician	
	Chiller/Compressor	ICV and CCV	• Clean screens check and add fluid monthly • Drain and replace compressor oil monthly	As Listed with Inspection	Set to proper fluid levels	Set to proper fluid levels	Analyst.	
VOC Purge and Trap System	Concentrating Trap	ICAL and CCVs	•purge flow rate (40 L/m) at least weekly •bake flow rate (80-120 mL/min) at least monthly •shape and tailing of chromatographic peaks continuously •monitor trending in surrogate & standard recoveries continuously •changes in tuning daily •IB baselines continuously	As Listed with Inspection	MBs < DL, ICAL, ICV, CCV, and surrogate limits as seen on **Worksheet #28**	Trap replacement, sparge tube cleaning and replacement, trap conditioning, check for leaks by flow.	Analyst/ Supervisor	VOC-001
VOCs GC/MS	Column performance		•shape and tailing of chromatographic peaks continuously •monitor trending in surrogate & standard recoveries continuously		MB < DL, ICAL, ICV, CCV, peak shape, & LCS, Internal Area Counts, surrogate limits as seen on **Worksheet #28**	Trim or replace column		VOC-001

Table C-9: Analytical Instrument and Equipment Maintenance, Testing, and Inspection
RSA-115/116 Groundwater Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet# 25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity/Preventive Maintenance	Frequency	Acceptance Criteria	CA	Title/ Position Responsible for CA	Reference
			• changes in tuning daily •IB baselines continuously					
VOCs GC/MS	Vacuum System		•Check level of oil in rotary pump quarterly •Replace oil in vacuum rotary pump annually		Levels within level check marks	Add or change oil	Analyst/ Supervisor	VOC-001
	Ion source/ chamber		•Clean MS ion source, check pre-rods and lenses quarterly •Deep cleaning of MS including ion source, pre-rods and lenses semi-annually or as needed.		Passing Tune criteria	Clean and/or replace ion source parts.		
	Filament		•Check filaments condition (filaments are replaced through the year as needed)		Passing Tune criteria, Passing QC, Area Counts and Sensitivity			VOC-003
SVOCs/ PAHs GC/MS	Column/liner performance	ICAL and CCVs	•shape and tailing of chromatographic peaks continuously •monitor trending in surrogate & standard recoveries continuously •changes in tuning daily •IB baselines continuously	As Listed with Inspection	MBs < DL, ICAL, ICV, CCV, peak shape & LCS, Internal Area Counts, surrogate limits as seen on **Worksheet #28**	Trim or replace column. Replace liner.	Analyst	SVOC-006/ SVOC-028
	Vacuum System		•Check level of oil in rotary pump quarterly •Replace oil in vacuum rotary pump annually		Levels within level check marks	Add or change oil		
	Ion source/ chamber		•Clean MS ion source, check pre-rods and lenses quarterly •Deep cleaning of MS including ion source, pre-rods and lenses semi-annually or as needed.		Passing Tune criteria	Clean and/or replace ion source parts.	Senior Analyst/ Department Supervisor	
	Filament		• Check filaments condition (filaments are		Passing Tune criteria, Passing QC, Area		Analyst	

Table C-9: Analytical Instrument and Equipment Maintenance, Testing, and Inspection
RSA-115/116 Groundwater Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet# 25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity/Preventive Maintenance	Frequency	Acceptance Criteria	CA	Title/ Position Responsible for CA	Reference
			replaced through the year as needed)		Counts and Sensitivity.			
HPLC/ Explosives	Pump/tubing/Inline filters/seals	Initial and Continuing Calibration Verifications	• Replace Teflon frit (Monthly or as needed). • Replace rotor seal (Quarterly or as needed). • Replace gold seal (Quarterly or as needed). • Replace piston seals (Yearly or as needed).	As Listed with Inspection	Method blanks < DL, ICAL, ICV, CCV, peak shape, & LCS, as seen on Worksheet #28	Normal replacement	Analyst.	SVOC-031
HPLC/MS System/ Perchlorate	Monitor and clean curtain plate and nebulizer tip. Clean source of MS.	Perchlorate	• Curtain plate, nebulizer tip, MS source	As needed.	Acceptable initial calibration	Evaluate chromatography, look for contamination, and monitor pressure, correct problems, reanalyze ICAL.	Analyst/ Supervisor	HPLC06
	Change oil in vacuum pump.		• Vacuum pump oil	Every 6 Months.				
Dissolved Gases GC-FID	Column/liner performance	Initial and Continuing Calibration Verifications	• Shape and tailing of chromatographic peaks continuously • Monitor trending in standard recoveries continuously • Instrument blank baselines continuously	As listed with inspection	Method blanks < DL, ICAL, ICV, CCV, peak shape, LCS, and Area Counts, as seen on worksheet #28.	Trim or replace column. Replace liner.	Analyst	VOC-013
	Detector	Initial and Continuing Calibration Verifications	• Shape and tailing of chromatographic peaks continuously • Monitor trending in standard recoveries continuously • Instrument blank baselines continuously		Method blanks < DL, ICAL, ICV, CCV, peak shape, LCS, and Area Counts, as seen on worksheet #28.	Clean or replace as needed	Analyst	VOC-013

Notes:

% – percent
< – Less than
CA – Corrective Action
CCV – Continuing Calibration Verification
DL – Detection Limit
GC-FID – Gas Chromatography – Flame Ionization Detector
GC/MS – Gas Chromatography/Mass Spectrometry
HPLC – High Performance Liquid Chromatography
IB – Instrument Blank
ICAL – Initial Calibration

Table C-9: Analytical Instrument and Equipment Maintenance, Testing, and Inspection
RSA-115/116 Groundwater Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet# 25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection

ICP-AES – Inductively Coupled Plasma-Atomic Emission Spectrometry
ICP-MS – Inductively Coupled Plasma-Mass Spectrometry
ICV – Initial Calibration Verification
LCS – Laboratory Control Sample
MB – Method Blank
mL/min – Milliliter per Minute
MS – Mass Spectrometry
PAH – Polycyclic Aromatic Hydrocarbon
QC – Quality Control
SVOC – Semivolatile Organic Compound
VOC – Volatile Organic Compound

Table C-10: Sample Handing, Custody, and Disposal
RSA-115/116 Groundwater Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #26 Sample Handling, Custody, and Disposal

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT (FIELD)
Sample Collection (Personnel/Organization): ECC/Arcadis Personnel TBD
Sample Packaging (Personnel/Organization): ECC/Arcadis Personnel TBD
Coordination of Shipment (Personnel/Organization): ECC/Arcadis Personnel TBD
Type of Shipment/Carrier: Cooler/Lab Courier, FedEx
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): AEL/GEL Laboratory Personnel
Sample Custody and Storage (Personnel/Organization): AEL/GEL Laboratory Personnel
Sample Preparation (Personnel/Organization): AEL/GEL Laboratory Personnel
Sample Determinative Analysis (Personnel/Organization): AEL/GEL Laboratory Personnel
SAMPLE ARCHIVING
Field Sample Storage (number of days from sample collection): 60 days from receipt
Sample Extract/Digestate Storage (number of days from extraction/digestion): 3 months from sample extraction/digestion
Biological Sample Storage (number of days from sample collection): NA
SAMPLE DISPOSAL
Personnel/Organization: AEL/GEL Laboratory Personnel
Number of Days from Analysis: 30 days from submittal of Final report or 60 days from receipt, whichever is longer

Notes:
AEL – Advanced Environmental Laboratories
ECC – Environmental Chemical Corporation
GEL – GEL Laboratories, LLC
NA – not applicable
TBD – To be determined
Post sample collection in the field will be conducted in accordance with Standard Operating Projected Procedure (SOPP) 15.0 *Non-Hazardous Sample Handling, Packaging, and Shipping.* This procedure is located in the Installation-Wide – Quality Assurance Project Plan (IW-QAPP), Volume II (HGL, 2019).

Specific laboratory sample custody procedures (receipt of samples, archiving, and disposal) will be used for all post-sample handling. Coolers will be received and checked for proper temperature. A sample cooler receipt form will be filled out to note the conditions and any discrepancies. The chain of custody will be checked against the sample containers for correctness. Samples will be logged into the data base and given a unique log number, which can be tracked through processing. The Project Chemist will be notified of any problems.

Table C-11: Analytical Quality Control and Corrective Action
RSA-115/116 Groundwater Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #28 Analytical Quality Control and Corrective Action

Analytical Group: Metals
Analytical Method/SOP Reference: EPA 3010A / 6010C by MET-002 & MET-009

QC Sample	Number / Frequency	Method / SOP QC Acceptance Limits	Corrective Action	Title of Person Responsible for Corrective Action	Project Specific Measurement Performance Criteria (MPC)
MB	Once every prep/analytical batch of 20 or fewer samples	No analyte detected equal to or above the detection limit (DL) or > 1/10 the regulatory limit, whichever is greater (DoD: No analytes > ½ LOQ; common lab contaminants none detected > LOQ)	Correct problem. If required, reprep and reanalyze MB and all QC samples and field samples processed with the contaminated blank. If not enough sample volume to re-prep, data qualified with case narration.	Analyst with Department Supervisor and QA Officer review.	MB detections used to qualify project samples per validation guidance
ICB/CCB	Immediately after the ICV and immediately after every CCV	The absolute values of all analytes must be > ½ LOQ	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 reanalyzed without reanalysis of the associated sample and CCV(s)	Analyst with Department Supervisor review.	Same as Method/SOP
ICS	After ICAL and prior to sample analysis	Absolute value of concentration for all non-spiked target analytes < ½ LOQ (Unless there are a verified trace impurity from one of the spiked analytes)	Stop analysis and locate problem. Correct problem and reanalyze ICS and all associated samples.	If corrective action fails and reanalysis cannot be performed, qualify data accordingly and notify client and or case narrate.	
LCS	Once every prep/analytical batch of 20 or fewer samples	QC limits set in QSM 5.4 LCS tables or in-house generated limits when DoD limits unavailable.	Correct problem. If required, reprep and reanalyze LCS and all QC samples and field samples processed in batch. If not enough sample volume to re-prep, data qualified with case narration.	Analyst with Department Supervisor and QA Officer review.	
MS	Once every prep/analytical batch of 10 or fewer samples	QC limits set in QSM 5.4 LCS tables or in-house generated limits when DoD limits unavailable.	When outside limits examine project specific requirements and/or contact client. Flag data appropriately.	Analyst with Department Supervisor review.	

Table C-11: Analytical Quality Control and Corrective Action
RSA-115/116 Groundwater Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #28 Analytical Quality Control and Corrective Action

Analytical Group: Metals
Analytical Method/SOP Reference: EPA 3010A / 6010C by MET-002 & MET-009

QC Sample	Number / Frequency	Method / SOP QC Acceptance Limits	Corrective Action	Title of Person Responsible for Corrective Action	Project Specific Measurement Performance Criteria (MPC)
MSD	Once every prep/analytical batch of 10 or fewer samples	QC limits set in QSM 5.4 LCS tables or in-house generated limits when DoD limits unavailable. RPD of all target compounds ≤ 20% between MS and MSD.	When outside limits examine project specific requirements and/or contact client. Flag data appropriately.	Analyst with Department Supervisor review.	Same as Method/SOP
Dilution Test	When MS or MSD fails	5-fold dilution must agree within ± 10% of original measurement	No specific corrective action unless a stated project requirement. Flag accordingly.	Analyst with Department Supervisor review.	
PDS Addition	When MS or MSD fails using same parent sample of failure.	Recovery within ±80-120%	No specific corrective action unless a stated project requirement. Flag accordingly.	Analyst with Department Supervisor review.	

Analytical Group: Metals
Analytical Method/SOP Reference: EPA 3010A / 6020A by MET-002 & MET-016

QC Sample	Number / Frequency	Method / SOP QC Acceptance Limits	Corrective Action	Title of Person Responsible for Corrective Action	Project Specific MPC
Method Blank (MB)	Once every prep/analytical batch of 20 or fewer samples	No analyte detected equal to or above the detection limit (DL) or > 1/10 the regulatory limit, whichever is greater (DoD: No analytes > ½ LOQ; common lab contaminants none detected > LOQ)	Correct problem. If required, reprep and reanalyze MB and all QC samples and field samples processed with the contaminated blank. If not enough sample volume to re-prep, data qualified with case narration.	Analyst with Department Supervisor and QA Officer review.	MB detections used to qualify project samples per validation guidance

Table C-11: Analytical Quality Control and Corrective Action
RSA-115/116 Groundwater Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #28 Analytical Quality Control and Corrective Action

Analytical Group: Metals
Analytical Method/SOP Reference: EPA 3010A / 6020A by MET-002 & MET-016

QC Sample	Number / Frequency	Method / SOP QC Acceptance Limits	Corrective Action	Title of Person Responsible for Corrective Action	Project Specific MPC
ICB/CCB	Immediately after the ICV and immediately after every CCV	The absolute values of all analytes must be > ½ LOQ	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 reanalyzed without reanalysis of the associated sample and CCV(s)	Analyst with Department Supervisor review.	Same as Method/SOP
ICS	After ICAL and prior to sample analysis	Absolute value of concentration for all non-spiked target analytes < ½ LOQ (Unless there are a verified trace impurity from one of the spiked analytes)	Stop analysis and locate problem. Correct problem and reanalyze ICS and all associated samples.	If corrective action fails and reanalysis cannot be performed, qualify data accordingly and notify client and or case narrate.	
LCS	Once every prep/analytical batch of 20 or fewer samples	QC limits set in QSM 5.4 LCS tables or in-house generated limits when DoD limits unavailable.	Correct problem. If required, reprep and reanalyze LCS and all QC samples and field samples processed in batch. If not enough sample volume to re-prep, data qualified with case narration.	Analyst with Department Supervisor and QA Officer review.	
MS	Once every prep/analytical batch of 10 or fewer samples	QC limits set in QSM 5.4 LCS tables or in-house generated limits when DoD limits unavailable.	When outside limits examine project specific requirements and/or contact client. Flag data appropriately.	Analyst with Department Supervisor review.	
MSD	Once every prep/analytical batch of 10 or fewer samples	QC limits set in QSM 5.4 LCS tables or in-house generated limits when DoD limits unavailable. RPD of all target compounds ≤ 20% between MS and MSD.			
Dilution Test	When MS or MSD fails	5-fold dilution must agree within ± 10% of original measurement	No specific corrective action unless a stated project requirement. Flag accordingly.		
PDS	When MS or MSD fails using same parent sample of failure.	Recovery within ±80-120%		Analyst with Department Supervisor review.	Same as Method/SOP

Table C-11: Analytical Quality Control and Corrective Action
RSA-115/116 Groundwater Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #28 Analytical Quality Control and Corrective Action

Analytical Group: VOCs
Analytical Method/SOP Reference: USEPA 5030B / 8260C by VOC-001 & VOC-003

QC Sample	Number / Frequency	Method / SOP QC Acceptance Limits	CA	Title of Person Responsible for CA	Project Specific MPC
MB	Once every prep/analytical batch of 20 or fewer samples	No analyte detected ≥ DL or > 1/10 the regulatory limit, whichever is greater. (DoD: No analytes > ½ LOQ; common lab contaminants none detected > LOQ)	Correct problem. If required, reprep and reanalyze MB and all QC samples and field samples processed with the contaminated blank. If not enough sample volume to re-prep, data qualified with case narration.	Analyst with Department Supervisor and QA Officer review.	MB detections used to qualify project samples per validation guidance
LCS		QC limits set in QSM 5.4 LCS tables or in-house generated limits when DoD limits unavailable.	Correct problem. If required, reprep and reanalyze LCS and all QC samples and field samples processed in batch. If not enough sample volume to re-prep, data qualified with case narration.		Same as Method/SOP
MS	Once every prep/analytical batch of 20 or fewer samples	QC limits set in QSM 5.4 LCS tables or in-house generated limits when DoD limits unavailable. RPD of all target compounds ≤ 20% between MS and MSD.	When outside limits examine project specific requirements and/or contact client. Flag data appropriately.	Analyst with Department Supervisor review.	Same as Method/SOP
MSD					
Surr	All samples and QC (except tune)	QC limits set in QSM 5.4 tables or in-house generated limits when DoD limits unavailable.	Action dependent upon type. If MB or LCS, correct problem and reprep-reanalyze all associated samples. If sample, examine matrix. If obvious chromatographic interferences, reanalysis may not be required. Qualify recovery data and notify and/or case narrate.		

Analytical Group: SVOCs/PAHs
Analytical Method/SOP Reference: USEPA 3510C / 8270-SIM by SVOC-001, SVOC-006 & SVOC-028

QC Sample	Number / Frequency	Method / SOP QC Acceptance Limits	CA	Title of Person Responsible for CA	Project Specific MPC
MB	Once every prep/analytical batch of 20 or fewer samples	No analyte detected ≥ DL or > 1/10 the regulatory limit, whichever is greater; (DoD: No analytes > ½ LOQ; common lab contaminants none detected > LOQ)	Correct problem. If required, reprep and reanalyze MB and all QC samples and field samples processed with the contaminated blank. If not enough sample volume to re-prep, data qualified with case narration.	Analyst with Department Supervisor and QA Officer review.	MB detections used to qualify project samples per validation guidance

Table C-11: Analytical Quality Control and Corrective Action
RSA-115/116 Groundwater Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #28 Analytical Quality Control and Corrective Action

Analytical Group: SVOCs/PAHs
Analytical Method/SOP Reference: USEPA 3510C / 8270-SIM by SVOC-001, SVOC-006 & SVOC-028

QC Sample	Number / Frequency	Method / SOP QC Acceptance Limits	CA	Title of Person Responsible for CA	Project Specific MPC
LCS	Once every prep/analytical batch of 20 or fewer samples	QC limits set in QSM 5.4 LCS tables or in-house generated limits when DoD limits unavailable.	Correct problem. If required, reprep and reanalyze LCS and all QC samples and field samples processed in batch. If not enough sample volume to re-prep, data qualified with case narration.	Analyst with Department Supervisor and QA Officer review.	Same as Method/SOP
MS			When outside limits examine project specific requirements and/or contact client. Flag data appropriately.		
MSD		QC limits set in QSM 5.4 LCS tables or in-house generated limits when DoD limits unavailable. RPD of all target compounds ≤ 20% between MS and MSD.			
Surr	All samples and QC (except tune)	QC limits set in QSM 5.4 tables or in-house generated limits when DoD limits unavailable.	Action dependent upon type. If MB or LCS, correct problem and reprep-reanalyze all associated samples. If sample, examine matrix. If obvious chromatographic interferences, reanalysis may not be required. Qualify recovery data and notify and/or case narrate.		

Analytical Group: Explosives
Analytical Method/SOP Reference: USEPA 3535A / 8330B by SVOC-031 & SVOC-032

QC Sample	Number / Frequency	Method / SOP QC Acceptance Limits	CA	Title of Person Responsible for CA	Project Specific MPC
MB	Once every prep/analytical batch of 20 or fewer samples	No analyte detected equal to or above the detection limit (DL) or > 1/10 the regulatory limit, whichever is greater (DoD: No analytes > ½ LOQ; common lab contaminants none detected > LOQ)	Correct problem. If required, reprep and reanalyze MB and all QC samples and field samples processed with the contaminated blank. If not enough sample volume to re-prep, data qualified with case narration.	Analyst with Department Supervisor and QA Officer review.	MB detections used to qualify project samples per validation guidance

Table C-11: Analytical Quality Control and Corrective Action
RSA-115/116 Groundwater Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #28 Analytical Quality Control and Corrective Action

Analytical Group: Explosives
Analytical Method/SOP Reference: USEPA 3535A / 8330B by SVOC-031 & SVOC-032

QC Sample	Number / Frequency	Method / SOP QC Acceptance Limits	CA	Title of Person Responsible for CA	Project Specific MPC
LCS	Once every prep/analytical batch of 20 or fewer samples	QC limits set in QSM 5.4 LCS tables or in-house generated limits when DoD limits unavailable.	Correct problem. If required, reprep and reanalyze LCS and all QC samples and field samples processed in batch. If not enough sample volume to re-prep, data qualified with case narration.		Same as Method/SOP
MS	Once every prep/analytical batch of 20 or fewer samples	QC limits set in QSM 5.4 LCS tables or in-house generated limits when DoD limits unavailable.	When outside limits examine project specific requirements and/or contact client. Flag data appropriately.		
MSD	Once every prep/analytical batch of 20 or fewer samples	QC limits set in QSM 5.4 LCS tables or in-house generated limits when DoD limits unavailable. RPD of all target compounds ≤ 20% between MS and MSD.	When outside limits examine project specific requirements and/or contact client. Flag data appropriately.		
Surr	All samples and QC (except tune)	QC limits set in QSM 5.4 tables or in-house generated limits when DoD limits unavailable.	Action dependent upon type. If MB or LCS, correct problem and reprep-reanalyze all associated samples. If sample, examine matrix. If obvious chromatographic interferences, reanalysis may not be required. Qualify recovery data and notify and/or case narrate.		

Analytical Group: Perchlorate
Analytical Method/SOP Reference: USEPA 6850 by HPLC06

QC Sample	Number / Frequency	Method / SOP QC Acceptance Limits	CA	Title of Person Responsible for CA	Project Specific MPC
LRB	Prior to calibration and at the end of the analytical sequence.	No perchlorate detected > ½ LOQ.	Reanalyze Reagent Blank (until no carryover is observed) and all samples processed since the contaminated blank.	Analyst/ Supervisor	Same as Method/SOP
MB	One per preparatory batch.	No analytes detected > ½ LOQ or > 1/10th the amount measured in any sample or 1/10th the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze MB and all QC samples and field samples processed with the contaminated blank.		MB detections used to qualify project samples per validation guidance

Table C-11: Analytical Quality Control and Corrective Action
RSA-115/116 Groundwater Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #28 Analytical Quality Control and Corrective Action

Analytical Group: Perchlorate
Analytical Method/SOP Reference: USEPA 6850 by HPLC06

QC Sample	Number / Frequency	Method / SOP QC Acceptance Limits	CA	Title of Person Responsible for CA	Project Specific MPC
LCS	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified.	Correct problem. Reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes if sufficient sample material is available.	Analyst/ Supervisor	Same as Method/SOP
MS	One per preparatory batch per matrix.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified.	Examine the project specific requirements. Contact the client as to additional measures to be taken.		
MSD or MD	One per preparatory batch per matrix.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified. MSD or MD: RPD of all analytes ≤ 15% (between MS and MSD or sample and MD).	Examine the project specific requirements. Contact the client as to additional measures to be taken.		
ICS	One ICS is prepared with every batch of 20 samples and must undergo the same preparation and pretreatment steps as the samples in the batch. It verifies the method performance at the MCT At least one ICS must be analyzed daily. The ICS shall be prepared at the LOQ.	Perchlorate concentration must be within ± 20% of its true value.	Correct problem. Reanalyze all samples and QC samples in the batch. If poor recovery from the cleanup filters is suspected, a different lot of filters must be used to re-extract all samples in the batch. If column degradation is suspected, a new column must be calibrated before the samples can be reanalyzed.	Analyst/ Supervisor	Same as Method/SOP

Table C-11: Analytical Quality Control and Corrective Action
RSA-115/116 Groundwater Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #28 Analytical Quality Control and Corrective Action

Analytical Group: Dissolved Gases (MEE)
Analytical Method/SOP Reference: RSK-175 / VOC-013

QC Sample	Number / Frequency	Method / SOP QC Acceptance Limits	Corrective Action	Title of Person Responsible for Corrective Action	Project Specific Measurement Performance Criteria (MPC)
MB	Once every prep/analytical batch of 20 or fewer samples	No analyte detected equal to or above the detection limit (DL) or > 1/10 the regulatory limit, whichever is greater (DoD: No analytes > ½ LOQ; common lab contaminants none detected > LOQ)	Correct problem. If required, reprep and reanalyze MB and all QC samples and field samples processed with the contaminated blank. If not enough sample volume to re-prep, data qualified with case narration.	Analyst with Department Supervisor and QA Officer review.	Same as Method/SOP
LCS	Once every prep/analytical batch of 20 or fewer samples	QC limits set in QSM 5.4 LCS tables or in-house generated limits when DoD limits unavailable.	Correct problem. If required, reprep and reanalyze LCS and all QC samples and field samples processed in batch. If not enough sample volume to re-prep, data qualified with case narration.	Analyst with Department Supervisor and QA Officer review.	Same as Method/SOP
MS	Once every prep/analytical batch of 20 or fewer samples	QC limits set in QSM 5.4 LCS tables or in-house generated limits when DoD limits unavailable.	When outside limits examine project specific requirements and/or contact client. Flag data appropriately.	Analyst with Department Supervisor and QA Officer review.	Same as Method/SOP
MSD	Once every prep/analytical batch of 20 or fewer samples	QC limits set in QSM 5.4 LCS tables or in-house generated limits when DoD limits unavailable. RPD of all target compounds ≤ 20% between MS and MSD.	When outside limits examine project specific requirements and/or contact client. Flag data appropriately.	Analyst with Department Supervisor and QA Officer review.	Same as Method/SOP

Notes:

% – Percent
< – Less Than
≤ – Less Than or Equal To
> – Greater Than
≥ – Greater Than or Equal To
CA– Corrective Action
CCB – Continuing Calibration Blank
DL – Detection Level
DoD – Department of Defense
ICAL – Initial Calibration
ICB – Initial Calibration Blank
ICS – Interference Check Solutions
LCS – Laboratory Control Spike
LCSD – Laboratory Control Spike Duplicate
LOQ – Limit of Quantitation
LRB – Laboratory Reagent Blank
MB – Method Blank
MCT – Matrix Conductivity Threshold

Table C-11: Analytical Quality Control and Corrective Action
RSA-115/116 Groundwater Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #28 Analytical Quality Control and Corrective Action

MD – Matrix Duplicate
MEE – Methane, ethane, ethene
MPC – Measurement Performance Criteria
MS – Matrix Spike
MSD – Matrix Spike Duplicate
PAH – Polycyclic Aromatic Hydrocarbon
PDS – Post Digestion Spike
QA – Quality Assurance
QC – Quality Control
QSM – Quality Systems Manual
RPD – Relative Percent Difference
SOP – Standard Operating Procedure
Surr – Surrogate
SVOC – Semivolatile Organic Compound
USEPA – United States Environmental Protection Agency
VOC – Volatile Organic Compound

Table C-12: Analytical Quality Control and Corrective Action
RSA-115/116 Groundwater Monitoring Plan, Redstone Arsenal, Madison County, Alabama
Worksheet #36 Data Validation Procedures

Data validation is an analyte and sample-specific process for evaluating compliance with contract requirements, methods/Standard Operating Procedures (SOPs), and measurement performance criteria (MPC).

All project field samples will undergo a Tier 1 Plus (Department of Defense [DoD] Quality Systems Manual [QSM] Stage 2B) data validation using lab limits as the MPC. IDW samples will be reviewed for completeness only.

Data validation will be documented on ECC Data Validation Worksheets (DVW). Project electronic data deliverables (EDDs) (ECC Environmental Data Management System [EDMS] EDD and Environmental Remediation Information System [ERIS]) will be updated with IW-QAPP data validation qualifiers and rationale for validation qualifications provided in the DVW).

- U – Not detected by the lab or as a result of qualifying data due to cross-contamination as determined by blank evaluation less than five times blank level) during data validation.
- UJ – Not detected with estimated reporting limits. Assigned due to data validation exceedance.
- R – Rejected data. Data determined to be unusable during data validation.

Step IIa/IIb	Matrix	Analytical Group	Concentration Level	Validation Criteria	Data Validator
IIa	Groundwater	Metals, VOCs, SVOCs/PAHs, Explosives, Perchlorate, Dissolved Gases	Low/Medium	Laboratory MPC evaluated in accordance with applicable USEPA National Functional Guidelines as applicable to analytical methods listed in this Site Monitoring Report	ECC Project Chemist or designate

Notes:
ECC – Environmental Chemical Corporation
MPC – Measurement Performance Criteria
PAH – Polycyclic aromatic hydrocarbon
SVOC – Semivolatile organic compounds
USEPA – United States Environmental Protection Agency
VOC – Volatile organic compound

ATTACHMENT 1

FIELD DOCUMENTATION

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Table 1

Water Level Survey Log
RSA-115/116
Redstone Arsenal, Madison County, Alabama

Date: _____

Personnel: _____

Weather: _____

Other Comments: _____

Well ID	Headspace PID (ppm)	Time	Depth to Water (ft btoc)
RSA-115			
N115-RS432			
N115-RS467			
N115-RS468			
115-RS2411			
115-RS2412			
115-RS2413			
115-RS2800			
RSA-116			
N116-RS404			
N116-RS405			
N116-RS433			
N116-RS463			
N116-RS464			
N116-RS1009			
116-RS2493			

Notes:
ft btoc – feet below top of casing
PID – Photoionization detector
ppm – parts per million

Table 2

Monitoring Well Sampling Log
RSA-115/116
Redstone Arsenal, Madison County, Alabama

Date: _____

Personnel: _____

Weather: _____

Other Comments: _____

Well ID	Top of Casing Elevation (ft amsl)	Ground Elevation (ft amsl)	Installed Well Depth (ft btoc)	Screened Interval (ft bgs)	Date Sampled	Time	Depth to Water (ft btoc)
RSA-115							
N115-RS432	756.6	754.5	207.5	197.5 - 207.5			
N115-RS467	759.63	757.03	47.5	37.5 - 47.5			
N115-RS468	766.61	763.68	52.5	42.5 - 52.5			
115-RS2411	754.7	751.88	161	146.0 - 161.0			
115-RS2412	759.21	756.68	202	182.0 - 202.0			
115-RS2413	759.81	756.82	151	121.0 - 151.0			
115-RS2800	758.06	755.95	181	156.6 - 176.6			
N115-RS432	756.6	754.5	207.5	197.5 - 207.5			
RSA-116							
N116-RS404	655.19	652.55	100	89.0 - 99.0			
N116-RS405	633.77	630.91	59.8	49.7 - 59.8			
N116-RS433	667.6	665.09	170.2	159.6 - 169.6			
N116-RS463	604.22	601.94	32	26.0 - 31.0			
N116-RS464	632.69	631.02	155	144.7 - 154.7			
N116-RS1009	662.02	659.63	97.5	82.4 - 97.4			
116-RS2493	699.3	697.27	83	63.0 - 83.0			

Notes:
amsl – above mean sea level
bgs – below ground surface
btoc – below top of casing
ft – feet

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ATTACHMENT 1

FIELD DOCUMENTATION

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Table 1

Water Level Survey Log
RSA-115/116
Redstone Arsenal, Madison County, Alabama

Date: _____

Personnel: _____

Weather: _____

Other Comments: _____

Well ID	Headspace PID (ppm)	Time	Depth to Water (ft btoc)
RSA-115			
N115-RS432			
N115-RS467			
N115-RS468			
115-RS2411			
115-RS2412			
115-RS2413			
115-RS2800			
RSA-116			
N116-RS404			
N116-RS405			
N116-RS433			
N116-RS463			
N116-RS464			
N116-RS1009			
116-RS2493			

Notes:
ft btoc – feet below top of casing
PID – Photoionization detector
ppm – parts per million

Table 2

Monitoring Well Sampling Log
RSA-143
Redstone Arsenal, Madison County, Alabama

Date: _____

Personnel: _____

Weather: _____

Other Comments: _____

Well ID	Top of Casing Elevation (ft amsl)	Ground Elevation (ft amsl)	Installed Well Depth (ft btoc)	Screened Interval (ft bgs)	Date Sampled	Time	Depth to Water (ft btoc)
RSA-115							
N115-RS432	756.6	754.5	207.5	197.5 - 207.5			
N115-RS467	759.63	757.03	47.5	37.5 - 47.5			
N115-RS468	766.61	763.68	52.5	42.5 - 52.5			
115-RS2411	754.7	751.88	161	146.0 - 161.0			
115-RS2412	759.21	756.68	202	182.0 - 202.0			
115-RS2413	759.81	756.82	151	121.0 - 151.0			
115-RS2800	758.06	755.95	181	156.6 - 176.6			
N115-RS432	756.6	754.5	207.5	197.5 - 207.5			
RSA-116							
N116-RS404	655.19	652.55	100	89.0 - 99.0			
N116-RS405	633.77	630.91	59.8	49.7 - 59.8			
N116-RS433	667.6	665.09	170.2	159.6 - 169.6			
N116-RS463	604.22	601.94	32	26.0 - 31.0			
N116-RS464	632.69	631.02	155	144.7 - 154.7			
N116-RS1009	662.02	659.63	97.5	82.4 - 97.4			
116-RS2493	699.3	697.27	83	63.0 - 83.0			

Notes:
amsl – above mean sea level
bgs – below ground surface
btoc – below top of casing
ft – feet

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APPENDIX D

REGULATORY COMPLIANCE LETTERS

LANCE R. LEFLEUR
DIRECTOR

KAY IVEY
GOVERNOR

Alabama Department of Environmental Management
adem.alabama.gov

1400 Coliseum Blvd. 36110-2400 • Post Office Box 301463
Montgomery, Alabama 36130-1463
(334) 271-7700 • FAX (334) 271-7950

October 19, 2020

ELECTRONICALLY TRANSMITTED

Mr. A. Keith Cook, Chief
Environmental Management Division
US Army Garrison – Redstone Arsenal
4488 Martin Road
Redstone Arsenal, AL 35898

Re: **ADEM Review and Concurrence**:
Revision 3 RCRA Facility Investigation (RFI) Report RSA-115, Inactive East Side Blowdown Lagoon at Test Area 5, Operable Unit 13, US Army Garrison – Redstone, Madison County, Alabama, dated August 6, 2020
Redstone Arsenal (RSA)
U.S. EPA I.D. No. AL7 210 020 742

Dear Mr. Cook:

The Alabama Department of Environmental Management (ADEM or the Department) has completed the review of the response to comments on *Revision 3 RCRA Facility Investigation (RFI) Report RSA-115, Inactive East Side Blowdown Lagoon at Test Area 5, Operable Unit 13*, received on August 6, 2020. Based on this review, the Department has determined that all comments on the previous version of this RFI Report have been resolved and no further information will be required at this time.

The Department concurs with the recommendation for no further action required for soil/surface media and with corrective measures implementation (CMI) to be performed for the groundwater. As stated in this RFI Report, CMI is needed at this site because groundwater at the site poses a current threat to human health.

In accordance with Permit Condition VI.E.2., CMI plans must be completed within 120 calendar days following notification from the Department that a CMI Plan is required. Therefore, RSA should submit a CMI Plan for RSA-115 within 120 calendar days of receipt of this letter.

ADEM will move RSA-115 to Table VI.6 (Sites requiring a corrective measures implementation work plan) in the facility's Alabama Hazardous Wastes Management and Minimization Act (AHWMMA) permit as part of the forthcoming permit renewal.

If you have any questions on this matter, please contact Mr. Keith West of the Remediation Engineering Section via e-mail at knw@adem.alabama.gov or at (334) 271-7925.

Sincerely,

Jason Wilson, Chief
Governmental Hazardous Waste Branch
Land Division

JJW/ATM/KNW/tlp

cc (via email): Clint Howard, RSA
Robert Pope, US EPA Region IV
Robert Morris, US EPA Region IV
Kevin Greaney, US EPA Region IV
Brian Roberson, NASA MSFC
Ashley T. Mastin, ADEM
Daniel Arthur, ADEM
Kelley Hartley, ADEM

LANCE R. LEFLEUR
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KAY IVEY
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(334) 271-7700 • FAX (334) 271-7950

May 26, 2021

ELECTRONICALLY TRANSMITTED

Mr. A. Keith Cook, Chief
Environmental Management Division
US Army Garrison – Redstone Arsenal
4488 Martin Road
Redstone Arsenal, AL 35898

RE: **ADEM Review and Concurrence**
Modified RCRA Facility Investigation Report RSA-116, South Side Blowdown Lagoon at Test Area 5, Operable Unit 13, Revision 4,
U.S. Army Garrison – Redstone, Madison County, Alabama, dated March 2021
Facility ID No: AL7 210 020 742

Dear Mr. Cook:

The Alabama Department of Environmental Management (ADEM or the Department) has completed the review of the *RCRA Facility Investigation Report RSA-116, Southside Blowdown Lagoon at Test Area 5, Operable Unit 13, Revision 4*. Based on this review, the Department has determined that all comments on previous versions of this RCRA Facility Investigation (RFI) Report have been resolved and no further information is needed at this time. The Department concurs with the Army's recommendation for corrective measures to be performed for groundwater on this site and for No Further Action (NFA) required for soils at this site.

Therefore, Redstone Arsenal (RSA) should submit a Corrective Measures Implementation (CMI) Plan for groundwater at RSA-116 within 120 calendar days of receipt of this letter. ADEM will move RSA-116 to Table VI.6 (sites requiring a Corrective Measures Implementation Plan) in the facility's Alabama Hazardous Wastes Management and Minimization Act (AHWMMA) permit as part of the next permit modification.

If any questions or concerns should arise regarding this matter, please contact Chaz Ganey of the Facilities Engineering Section, Governmental Hazardous Waste Branch at (334)-271-7816 or by email at chaz.ganey@adem.alabama.gov.

Sincerely,

Jason Wilson, Chief
Governmental Hazardous Waste Branch
Land Division

JJW/RDA/CWG/tlp

cc (via email): Robert Morris, US EPA Region IV
Robert Pope, US EPA Region IV
Yolanda Negroni, Redstone Arsenal
Clint Howard, Redstone Arsenal
Daniel Arthur, ADEM

APPENDIX E

REDSTONE ARSENAL RCRA PERMIT MODIFICATION REQUEST

REQUEST FOR PERMIT MODIFICATION
RSA-115, INACTIVE EAST SIDE BLOWDOWN LAGOON AT TEST AREA 5
RSA-116, SOUTH SIDE BLOWDOWN LAGOON AT TEST AREA 5
OPERABLE UNIT 13
U.S. ARMY GARRISON – REDSTONE
MADISON COUNTY, ALABAMA
JULY 2023

1.0 INTRODUCTION

As specified in Section VI.E.3 of the United States Army Garrison–Redstone's (hereinafter referred to as the Army) Alabama Hazardous Wastes Management and Minimization Act (AHWMMA) Hazardous Waste Storage Facility/Thermal Treatment/Solid Waste Management Unit (SWMU) Corrective Action Permit, Modification No. 1 (hereafter referred to as the Permit) (dated 12 August 2022) (Alabama Department of Environmental Management [ADEM], 2022), a request for permit modification is to be submitted along with a Corrective Measures Implementation (CMI) Work Plan. Therefore, the Army has prepared this request for modification to the Permit for RSA-115, Inactive East Side Blowdown Lagoon at Test Area 5 and RSA-116, South Side Blowdown Lagoon at Test Area 5, Operable Unit 13, at Redstone Arsenal (RSA) in Madison County, Alabama.

Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) reports were prepared for both RSA-115 (APTIM 2020a) and RSA-116 (APTIM 2020b) to determine the nature and extent of contamination. The RSA-115 and RSA-116 RFI reports received concurrence from ADEM on October 20, 2020 and May 26, 2021, respectively. The Army has prepared the CMI Work Plan and is ready to implement corrective measures (monitored natural attenuation [MNA] and land use controls [LUCs]) to meet the Corrective Measures Objective (CMO) for groundwater at both sites.

ADEM has listed RSA-115/116 in Table VI.6 in the Permit as requiring corrective measures for groundwater. As specified in Section VI.E.3 of the Permit, this modification will serve to incorporate the proposed remedy, including all procedures necessary to implement and monitor the final corrective measure for RSA-115/116, into the Permit in accordance with Alabama Administrative Code (AAC) R. 335-14-8-.04(2).

2.0 FACILITY AND SITE DESCRIPTION

RSA is located in the southwestern portion of Madison County, which is in the northern portion of Alabama. RSA is an Army facility that encompasses approximately 38,300 acres and is approximately 10 miles long from north to south and six miles wide from east to west. The Army controls 36,459 acres of the total acreage, of which approximately 15,500 acres are woodlands, 5,360 acres are leased for agricultural use, and approximately 12,000 acres are managed as military test areas/ranges. Development within RSA has largely centered on the historical production (and later disposal) of conventional and chemical munitions and, more recently, development and testing of missiles and rockets. These processes have produced chemical wastes since operations began in the early-1940s.

2.1 RSA-115 SITE DESCRIPTION

RSA-115, the inactive East Side Blowdown Lagoon at Test Area 5, is a 0.78-acre site at Test Area 5 and lies within groundwater units RSA-156/157. The lagoon occupies an area of 7,500 square feet

(approximately 0.17 acre) within the 0.78-acre site approximately 300 feet east-northeast of the Attitude Test Stand (Building 8877) (see Figure 1-3 of the CMI Work Plan).

The site is located on a level area within Test Area 5 and bordered to the south by Arsenal Road and to the east by Raspberry Road, both paved roads. A concrete flume, which transported the cooling water used during the tests to the lagoon, leads from the test stand at Building 8877 to the earthen lagoon. The lagoon is unlined and bounded on three sides by an earthen berm and surrounded by young pine trees. The inactive lagoon at RSA-115 is usually dry and is covered with sparse vegetation, likely due to exposed fractured sandstone and lack of soil.

The lagoon was used as a holding basin for cooling water discharged during test firing of Redstone rocket engines from Attitude Test Stand 8877. Tests were conducted up to five times a week during the 1960s, using a kerosene-based fuel. Subsequent testing during the development of the Lance rocket between 1964 and 1970 utilized unsymmetrical dimethylhydrazine (UDMH) as the primary active fuel ingredient and nitric acid as the primary oxidant. Between 1975 and 1990, a variety of rocket motors were tested at the site. The concrete flume transported cooling water used during tests to the earthen lagoon to ultimately evaporate or seep into the ground. Cooling water may have contained dissolved solid rocket propellant and rocket engine exhaust.

The blowdown lagoon has been generally inactive since the mid-1980s. The test stand associated with this lagoon is now used exclusively for static tests, which do not require a blowdown lagoon. The concrete flume that carried water from the test stand is not functional and is inactive. Reportedly, the lagoon never held cooling water because of poor integrity, and it is reported that no plans exist to line and refit the lagoon for use in the future (Parsons Engineering Science, Inc. [Parsons] 1995).

2.2 RSA-116 SITE DESCRIPTION

RSA-116, the South Side Blowdown Lagoon at Test Area 5, is a triangular, lined lagoon, approximately 0.7 acres in size, within the 2.4-acre site at Test Area 5 and lies within groundwater units RSA-156/157. The lagoon is approximately 500 feet west of Test Stand 8879 (see Figure 1-6 of the CMI Work Plan).

The site is located south of Buxton and Pershing Roads, on the south side of Test Area 5, in a ravine within a heavily wooded area. The ravine is a topographically low feature trending roughly north to south, which received rainfall runoff from the surrounding slopes. Initially, the lagoon was created by constructing an earthen dam 35 feet in height and 40 feet in width across the unlined ravine. A concrete flume transported cooling water from the test stand and entered the lagoon on the east side. Although the concrete flume is present within the site boundary, the concrete flume is not included as part of the permitted site.

The lagoon began operation in the mid-1960s as a holding basin for cooling water discharged during test firing of rocket engines at Test Stand 8879. Tests were conducted as frequently as once every 10 days. Cooling water from the test stand was discharged to a concrete apron that channeled the water to the concrete flume and ultimately to the lagoon. Cooling water may have contained dissolved rocket propellant and rocket engine exhaust from UDMH as the active fuel ingredient and nitric acid as the primary oxidant. It is also reported that JP-1 and JP-4 fuels were used. Site personnel reported that trichloroethene (TCE) was used regularly as a solvent on the test stand until the mid- to late 1970s (ADEM 2008).

Natural drainage also continued to enter the lagoon, as the ravine entered the lagoon from the north. Water contained in the lagoon was allowed to evaporate or seep into the soil. If water levels in the lagoon were too high, water was allowed to flow over the spillway on the west side of the dam or released through an 18-inch-diameter drainpipe at the base of the dam. The discharged water followed the ravine south to the Tennessee River, approximately 1 mile downstream.

In 1993, the lagoon was regraded, expanding its size from approximately 0.5 acre to approximately 0.6 acre. The purpose of the lagoon expansion was to facilitate the addition of a high-density polyethylene (HDPE) liner. The HDPE material, 0.080 millimeter thick, was designed and manufactured specifically for containment of liquids in hydraulic structures (Parsons 1999). A containment berm was constructed surrounding the lagoon to prevent surface runoff from entering the lagoon. In addition, an 8-foot-high chain-link fence was installed around the lagoon to prevent unauthorized access.

The site is currently inactive. Test firings are not currently being conducted, although the facility is operational and may resume at any time. The concrete flume is not currently in use. Leaf litter and broken pieces of tree branches are present in the flume, and cracks exist in the concrete base and sidewalls in some places along the flume. Vegetation from outside the flume is growing down into it along various sections. Water levels in the lagoon fluctuate based on precipitation events and evaporation; however, accumulated water is periodically pumped out to maintain the water levels.

3.0 INVESTIGATIVE HISTORY AND INTERIM REMEDIAL ACTIONS

Environmental investigations have been conducted at RSA-115 and RSA-116 since 1991. Complete discussions of these previous site investigations are available in the RFI Report for each site (APTIM 2020a,b). These investigations include:

- Visual Site Inspection (Geraghty and Miller, Inc. 1991)
- RFI for RSA-115 and RSA-116 (Parsons 1995)
- Supplemental RFI for RSA-115 (Parsons 1997)
- Baseline Risk Assessment for OU-13, OU-12 (RSA-140), and OU-7 (RSA-129 and RSA-58) (Parsons 1998)
- Focused Feasibility Study for RSA-115 and RSA-116 (Parsons 1999)
- Basewide spring/seep sampling (Shaw 2004)
- Redstone Arsenal RCRA Facility Assessment (ADEM 2008)
- RSA-156/157 Groundwater Unit RFI (APTIM 2019)
- RSA-115 RFI Report (Revision 3) (APTIM 2020a)
- RSA-116 RFI Report (Revision 4) (APTIM 2020b).

A summary of the results of the above-listed investigations is provided below in **Section 6.0**.

4.0 SCOPE OF THE CORRECTIVE MEASURES FOR RSA-115/116

The overall strategy for cleanup at RSA has been presented to the regulators in two cleanup strategy documents, the *Installation-Wide Groundwater (IWGW) Cleanup Strategy* (Shaw, 2009) and the *Installation-Wide Strategy for Cleanup of Impacted Wetlands* (Shaw, 2010). The overall RSA cleanup strategy includes the following elements:

1. Expedite evaluation and release of surface media sites to allow for efficient, mission-related property reuse.

2. Expedite cleanup of sources area at surface media sites and secondary sources of ongoing groundwater contamination, including dense nonaqueous-phase liquid (DNAPL).
3. At SWMUs without approved decision documents, exposures to surface media will be managed through the use of the Army's Site Access Control (SAC) program, and exposure to groundwater that may result in unacceptable risks will be prevented or managed as required by RSA's Installation-wide Groundwater (IWGW) Interim Record of Decision (IROD).
4. Coordinate the evaluation of groundwater units and their associated surface sites so that approval of groundwater RFIs is not delayed by unresolved surface media site issues.
5. Design and implement an IWGW monitoring network to monitor remedial progress and ensure that the selected remedies are protective of human health and the environment on a long-term basis.

Based on identified groundwater constituents of concern (COCs), corrective measures are needed at RSA-115/116 to prevent or manage human exposure to groundwater contaminated with any of the identified COCs at concentrations that exceed their groundwater cleanup goals (CGs). The Army has elected to perform corrective measures to address groundwater contamination:

- Groundwater monitoring through MNA for groundwater until all COCs requiring action (aluminum, arsenic, vanadium, perchlorate, 1,3-dinitrobenzene, 2,6-dinitrotoluene, 2-nitrotoluene, 3-nitrotoluene, nitrobenzene, nitroglycerin, benzo[a]anthracene, bis[2-ethylhexyl] phthalate, naphthalene, pentachlorophenol, UDMH, 1,1,2,2-tetrachloroethane [TeCA], benzene, bromomethane, and TCE) achieve CGs for three successive monitoring events;
- LUCs for groundwater implemented in accordance with AAC 335-5 (ADEM, 2013), to prevent potable use of groundwater and manage non-potable uses such that exposure to contaminated groundwater is minimized;
- Groundwater monitoring at RSA-115/116 would be combined with the monitoring at associated underlying groundwater units (RSA-156 or RSA-157) after Year 5 of the corrective action, assuming that the Corrective Measures Implementation Plan for the groundwater units will have been approved by ADEM.

5.0 SITE CHARACTERISTICS

5.1 RSA-115 SITE CHARACTERISTICS

RSA-115 is situated on a northerly trending ridge that is likely underlain by a groundwater divide (APTIM, 2019). Groundwater on the eastern side of the ridge appears to be controlled by topography and to move east-southeast; groundwater on the western side of the ridge appears to move west-southwest. However, the general direction of groundwater flow of the water table is south towards the Tennessee River, the regional drain for this aquifer.

The overburden in the lagoon is very shallow, generally less than 1 foot thick, and consists of sandy clay with some silt and gravel. The overburden outside of the lagoon is approximately 7 feet thick and consists of predominantly reddish-brown clays with some silt, sand, and/or limestone fragments (APTIM, 2020a). Groundwater beneath the site generally occurs in two groundwater vertical zones entirely within bedrock, and flow is governed by the orientation and interconnectivity of bedrock fractures. The shallow bedrock and deep bedrock groundwater vertical zones are poorly connected hydraulically (Parsons 1997). Groundwater flow in this area is fully discussed in the RSA-156/157 groundwater unit RFI report (APTIM 2019) and summarized in the RFI Report for RSA-115 (APTIM 2020a).

5.2 RSA-116 SITE CHARACTERISTICS

The lithologic logs from well borings advanced at RSA-116 indicate native soils consist of predominantly red-to yellow-brown clays with some silt, sand, and/or limestone fragments. Based on depth of auger refusal, thickness of the overburden ranges from approximately 1 to 24 feet (APTIM 2020b). Groundwater beneath the site is entirely within bedrock, and its flow is governed by the orientation and interconnectivity of bedrock fractures. Potentiometric surface maps in this type of flow regime do not necessarily predict flow directions.

Regionally, groundwater flow direction at RSA-116 is controlled by topography in the form of steep slopes and ridges, which divert flow to the south-southwest towards the Tennessee River, the regional drain for this aquifer. Groundwater flow in this area is fully discussed in the RSA-156/157 groundwater RFI report (APTIM, 2019) and summarized in the RFI Report for RSA-116 (APTIM 2020b).

5.3 RSA-115/116 CONCEPTUAL SITE MODEL

The potential release locations and potential contaminant types in groundwater include the following:

- Release of cooling water discharged from rocket engine test firing containing perchlorate, volatile organic compounds (VOCs), explosives, metals, semi-volatile organic compounds (SVOCs)/polycyclic aromatic hydrocarbons, and UDMH to the unlined lagoons, and then to the groundwater beneath them via seepage.
- Cooling water was also released from the lagoon to soil from a drainage/ outfall pipe at RSA-116.

Potential receptors could be exposed to contaminated groundwater. Current human receptors are limited to commercial and construction workers. Future potential receptors include all current receptors plus, under a residential land reuse scenario, hypothetical child and adult residents.

6.0 INVESTIGATIVE RESULTS

Comprehensive discussions of the previous site investigations are available in the RSA-115 and RSA-116 RFI Reports (APTIM 2020a,b) and Section 2.0 of the CMI Work Plan. The RFI reports were completed in August 2020 (RSA-115) and March 2021 (RSA-116), with approval from ADEM granted in October 2020 and May 2021, respectively.

Potential source area investigations for RSA-115/116 occurred from 2008 to 2013 as part of a larger investigation of both RSA as a whole and the underlying RSA-156/157 groundwater units. RFI activities specific to RSA-115/116 occurred from 2013 to 2020. The usable data set from those investigation activities used in the risk assessments in the RFT reports for RSA-115/116 included the following:

- For RSA-115:
  - Nine surface soil samples (2014)
  - Nine subsurface soil samples (2014)
  - One spring sample from one location (2017)
  - Thirty-eight (38) groundwater samples:
    - Twenty-three (23) in 2014/2015/2016
    - Five in 2017
    - Six in 2019
    - Four in 2020.

- For RSA-116:
  - Sixteen (16) surface soil samples (2013/2014)
  - Thirty-one (31) subsurface soil samples (2013/2014)
  - One spring sample from one location (2017)
  - One stormwater (lagoon) sample (2013)
  - Forty-four (44) groundwater samples:
    - Twenty-seven (27) in 2014/2015/2016
    - Four in 2017
    - Twelve (12) in 2019
    - One in 2020.

The RFI reports concluded that the nature and extent of groundwater contamination has been delineated sufficiently to support remedy selection, and that aluminum, arsenic, vanadium, perchlorate, 1,3-dinitrobenzene, 2,6-dinitrotoluene, 2-nitrotoluene, 3-nitrotoluene, nitrobenzene, nitroglycerin, benzo(a)anthracene, bis(2-ethylhexyl) phthalate, naphthalene, pentachlorophenol, UDMH, 1,1,2,2-TeCA, benzene, bromomethane, and TCE were detected at levels that pose an unacceptable risk to human health in a hypothetical residential use scenario.

Figures 2-1 and 2-2 of the CMI Work Plan present the detected concentrations of COCs in groundwater by location for RSA-115 and RSA-116, respectively. Data collected between 1992 and 2012 from previous investigations are also included on the figures to present concentration trends. These historical data are not considered to be representative of current conditions and were not used in the Alabama Risked Based Corrective Action (ARBCA). The nature and extent of COC exceedances in groundwater are summarized below:

- Exceedances of aluminum, arsenic, and vanadium preliminary screening values (PSVs) were detected in a single well associated with RSA-115 (115-RS2411). Metals were not detected at concentrations above their respective PSVs in wells associated with RSA-116. Metals were not detected at concentrations above PSVs in wells or springs downgradient of RSA-115/116 during the most recent sampling events.
- Exceedances of 1,1,2,2-TeCA, benzene, bromoethane, and TCE PSVs were detected across four wells associated with RSA-115 and five wells associated with RSA-116. VOCs were not detected at concentrations above PSVs in wells or springs downgradient of RSA-115/116 during the most recent sampling events.
- Exceedances of benzo(a)anthracene, bis(2-ethylhexyl)phthalate, naphthalene, and pentachlorophenol PSVs were detected across seven wells associated with RSA-115 and seven wells associated with RSA-116. SVOCs were not detected at concentrations above their respective PSVs in wells or springs downgradient of RSA-115/116 during the most recent sampling events. UDMH was not detected in any of the groundwater monitoring wells associated with RSA-115 or RSA-116, however the analytical detection limit exceeded its PSV.
- Exceedances of 1,2-dinitrotoluene, 2,6-dinitrotoluene, 2-nitrotoluene, 3-nitrotoluene, nitrobenzene, and nitroglycerin PSVs were detected across five wells associated with RSA-115 and six wells associated with RSA-116.
- Exceedances of the perchlorate PSV were detected in one well associated with RSA-115 and one well associated with RSA-116. Perchlorate was not detected at concentrations exceeding its PSV in wells or springs downgradient of RSA-115/116 during the most recent sampling events.
- PSV exceedances are relatively low level and observed sporadically across groundwater. Detected concentrations do not form any mappable plumes.

6.1 FATE AND TRANSPORT

The detailed fate and transport evaluations for analytes detected in RSA-115 and RSA-116 soil samples are presented in the RFI Reports for each site (APTIM 2020a,b). For all non-naturally occurring analytes detected above the RSA-specific dilution-attenuation factor 4 soil screening levels (Shaw 2011) in soil, the following additional weight-of evidence evaluations were performed:

- Presence or absence of an exceedance in groundwater
- Magnitude of exceedances in soil
- Frequency of exceedances in soil
- Spatial distribution of exceedances

Based on the results of the soil-to-groundwater migration evaluation, no further evaluation of any constituent detected in soil is warranted (APTIM 2020a,b). These results indicate that constituents detected in soil at RSA-115 and RSA-116 do not pose a threat to groundwater from the soil-to-groundwater migration pathway.

Since the sites have been out of operation, the primary migration pathway moving contamination from the groundwater source zone has been advective flow through shallow and deep aquifer zones. Groundwater contaminant mass and concentration are reduced over time due to natural attenuation, consisting of the combined effects of physical/ abiotic attenuation mechanisms (adsorption, dilution, and sorption) and biotic attenuation.

- ***Physical/ Abiotic Attenuation Mechanisms***: Generally, dilution and dispersion cause a net decrease in contaminant concentrations at each location over time through the flow of groundwater carrying contaminant mass further from the source area. As the plume area expands, varying amounts of contaminant mass can be adsorbed to the surface of the saturated medium, with contaminants having a higher affinity to organic matter or clay minerals sorbing more productively. The degree of overall concentration reduction depends on the groundwater velocity and rate of mixing. Other abiotic processes include chemical reduction/ oxidation, dehydrochlorination, dichloroelimination, hydrolysis, hydrogenolysis, or other similar processes.
- ***Biotic/ Biochemical Attenuation Mechanisms***: Biotic attenuation mechanisms refers to a collective of naturally occurring reactions by microorganisms living within the immediate environment containing the contaminant that result in the attenuation of contaminant mass. These naturally occurring reactions can be both aerobic and anaerobic in nature.

Groundwater COCs at RSA-115/116 are expected to attenuate over time due to their relatively low concentrations and sporadic CG exceedances. The primary attenuation mechanism for the groundwater COCs at RSA-115/116 is expected to be physical attenuation (adsorption, dilution, and sorption).

7.0 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCES USE

The RSA Master Plan identifies the current and future land use for RSA-115 and RSA-116 as industrial. Both sites largely consist of lagoons that formerly received discharges of rocket motor cooling water. Both sites are currently inactive.

7.1 LAND USE

The current use of RSA-115/116 is not residential, nor is it expected to be in the future. The residential scenario was included in the ARBCA evaluations to determine whether these sites are eligible for unrestricted reuse in accordance with ADEM requirements. In RSA's RCRA Permit, ADEM has specified that investigations must comply with the Alabama Environmental Investigation and Remediation Guidance (AEIRG, ADEM 2017b) and ARBCA guidance (ADEM 2017a). To determine whether these sites are eligible for unrestricted reuse as defined in Alabama Administrative Code 335-5, risks to a residential site user were assessed.

7.2 CURRENT GROUNDWATER USE

There is currently no potable use of groundwater at RSA-115/116. An IWGW IROD was instituted and implemented by the Army's SAC program to prevent potable use and provide management control over non-potable uses of all groundwater beneath RSA (Shaw, 2007).

7.3 FUTURE GROUNDWATER USE

Future use of groundwater beneath RSA-115/116 is possible. Currently, under the provisions of the IWGW IROD (Shaw, 2007) and the Army's SAC program (Army, 2012), groundwater resources beneath RSA-115/116 and elsewhere on RSA may not be developed for potable purposes without a final remedy, and groundwater withdrawals for non-potable uses are subject to Army review and approval. The IWGW IROD is interim in nature and is not a final remedy. RSA's SAC program was designed to be used at sites that have not implemented a final remedy. This interim remedy will remain in place for groundwater under RSA-115/116 until final corrective measures are in place for the groundwater units.

As part of the Permit, ADEM has required that the Army perform ongoing annual and semi-annual monitoring of wells located within the RSA perimeter (ADEM, 2019). This annual and semiannual monitoring will allow the Army and ADEM to assess the rate of long-term groundwater recovery and also ensure protection for residents living outside of the boundary of RSA (CB&I, 2016). Following regulatory approval of the CMI Work Plan, the Army will begin groundwater monitoring for RSA-115/116 (as detailed in Appendix G to the CMI Work Plan) to evaluate the effectiveness and permanence of the MNA corrective action to protect human health and the environment.

8.0 SITE RISKS

An ARBCA evaluation for human health and an ecological risk evaluation were performed for RSA-115 and RSA-116 in accordance with the ARBCA guidance manual (ADEM, 2017a) as part of the RSA-115 and RSA-116 RFI reports (APTIM 2020a,b). The complete ARBCA evaluations for human health and the ecological risk evaluations are provided in each site's respective RFI Report.

8.1 HUMAN HEALTH RISK ASSESSMENT

The human health risk assessments for RSA-115 and RSA-116 were prepared and presented in the RFI Reports (APTIM 2020a,b) in accordance with the ARBCA guidance (ADEM 2017a). Each assessment consisted of a three-tiered process, as follows:

- Preliminary screening level (PSL) evaluation (first tier), which involves comparing the maximum detected concentrations (MDC) of constituents of potential concern (COPCs) with PSVs. Constituents with MDCs that exceed their PSVs are designated COCs and carried to the next tier.
- Risk Management (RM)-1 evaluation (second tier); which involves a cumulative risk assessment based on ADEM (2017a) default risk models and exposure assumptions. The RM-1 evaluation was not performed for RSA-115 and RSA-116; instead, the evaluation proceeded directly to the RM-2 (tier 3) evaluation.
- RM-2 evaluation (third tier), which is similar to the RM-1 evaluation but permits the application of regulator-approved site-specific risk models and exposure assumptions.

The PSL evaluation consists of a simple comparison of site concentrations with PSVs, which accomplishes risk-based screening for direct exposure pathways and is conducted for all constituents that are determined to be site related. Inorganics with MDCs that do not exceed their background screening values or are shown in a site-to-background evaluation to be naturally occurring, are judged as not site related and are not evaluated further (Shaw 2013). Detected organic constituents are subject to PSL evaluation. A substance was identified as a COC if the MDC was greater than its PSV. The protocol for the PSL evaluation is described in the RFI Reports for each site (APTIM 2020a,b) and the Installation-Wide Work Plan (Shaw 2010).

The PSVs for soil were the USEPA (2018a) Regional Screening Levels (RSLs) based on the lower of the individual excess lifetime cancer risk of 1×10^{-6} or the noncancer hazard index of 0.1. Residential PSVs were selected for the RSA-115 and RSA-116 evaluations in accordance with ARBCA guidance (ADEM 2017a) to consider corrective measures alternatives (CMAs) that would allow unrestricted land use. The PSVs for groundwater were USEPA maximum contaminant levels (MCLs) (USEPA 2018b), if available. For analytes without MCLs, the PSVs were the USEPA tap water RSLs (USEPA 2018a). It should be noted that the Army does not normally use MCLs in a contaminant-screening capacity. However, MCLs were used in the subject assessment to comply with AEIRG and ARBCA guidance.

The MDCs for all COPCs in soil at RSA-115 and RSA-116 fell below their PSVs; therefore, no constituents in soils were identified as COCs.

The identified groundwater COCs were brought forward for evaluation in cumulative risk assessments (RM-2 evaluations). The protocol for the RM-2 cumulative risk evaluation is presented in the RFI Reports for each site (APTIM 2020a,b). Receptor scenarios evaluated in the cumulative risk assessment included a commercial worker, a construction worker, and a hypothetical residential receptor. Although RSA's current mission makes residential site use unlikely, a hypothetical future residential receptor was evaluated for both sites as required by ADEM (2017a) to evaluate if the site is eligible for unrestricted use as defined in Alabama Administrative Code 335-5-1-.03(r) or if LUCs will be needed as a component of the selected remedy. Groundwater was evaluated as if it were developed as a source of potable water in the future.

8.2 SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT

Screening Level Ecological Risk Assessments (SLERAs) were completed for RSA-115 and RSA-116 as part of the RFI Reports for each site (APTIM, 2020a,b). The SLERA for RSA-115 was conducted in accordance with the guidelines set forth in the ARBCA guidance manual (ADEM 2017a), the Redstone Arsenal Installation-Wide Work Plan (IT, 2002), and final SLERA supplements to the Installation-Wide Work Plan (Shaw, 2010). The Army and the USEPA frequently find preparation of a SLERA unnecessary for very small sites (less than 2 or 3 acres in size) because these sites do not support populations of those species for which site cleanups could realistically proceed. SLERAs were performed for RSA-115 and

RSA-116 to comply with administrative requirements and to determine whether these sites are eligible for no further action in accordance with ADEM requirements.

The SLERAs concluded that no ecological hazards were present and further evaluation ecological hazards at RSA-115 or RSA-116 were not warranted (APTIM, 2020a,b).

9.0 CORRECTIVE MEASURE OBJECTIVE

Based on the results of the RFI Reports for each site (APTIM, 2020a,b), the CMO for RSA-115/116 is to:

- Prevent human exposure to site groundwater contaminated with COCs that exceed their groundwater CGs via any exposure route (ingestion, inhalation, or dermal contact).

10.0 DESCRIPTION AND COMPARISON OF ALTERNATIVES

The following information summarizes the analysis of technologies and alternatives as well as the selection of the corrective measures for groundwater at RSA-115/ 116. Considering the limited areas where COC exceed CGs, and the relatively low-level COC concentrations, the screening of treatment technologies resulted in the identification of the following alternatives to address COCs:

- **Alternative 1** – No Action
- **Alternative 2** – MNA with LUCs

10.1 ALTERNATIVE 1- NO ACTION

Under the no-action alternative, no active corrective measures would be taken to address the site-related COCs present in groundwater. Because this alternative would not be protective of human health and the environment, it is not considered eligible to be selected as the final corrective measure for RSA-115/116. Evaluation of the no action alternative will serve as a baseline for evaluating other CMAs.

10.2 ALTERNATIVE 2- MNA WITH LUCS

Alternative 2 would protect human health by continuing the LUCs currently in place. The LUCs would continue to prevent exposure to groundwater until the concentrations of COCs were reduced to the groundwater CGs. Available data indicate that the present groundwater concentrations do not pose an unacceptable risk to current receptors. The monitoring program implemented under the MNA component of the alternative would track the progress of natural attenuation processes in reducing COC concentrations until CGs were attained.

Fifteen monitoring wells were selected for the monitoring program based on previous detections of PSV exceedances. After five years of monitoring, groundwater monitoring at RSA-115/116 would be combined with monitoring at associated underlying groundwater units (RSA-156 or RSA-157) if CGs have not been met within that timeframe.

11.0 SELECTED CORRECTIVE MEASURE

Alternative 2 (MNA with LUCs) is recommended as the corrective measure for groundwater contamination at RSA-115/116 because site-related COCs in groundwater were detected at the sites at relatively low concentrations, and CGs for these COCs are expected to be met in a reasonable timeframe.

Alternative 2 consists of groundwater LUCs and groundwater MNA for 5 years at RSA-115 and RSA-116. After Year 5, LUCs and groundwater monitoring for these sites would be combined with the monitoring program for the underlying groundwater unit (RSA-156/157). Groundwater monitoring to assess contaminant concentration reductions would be conducted using the existing monitoring well network at RSA-115 and RSA-116.

To meet the CMO identified for RSA-115/116, Alternative 2 would consist of the following:

- Establishment of LUCs.
- Year 0 – One baseline groundwater sampling event to establish current groundwater conditions.
- Years 1 and 2 – Semiannual groundwater monitoring and reporting. Groundwater monitoring would begin approximately six months after completion of the baseline groundwater sampling event. During years 1 and 2, the 15 wells identified for monitoring would be sampled on a semiannual basis. A data summary report would be submitted after each sampling event and a detailed analysis would be presented in an annual report.
- Years 3 to 5 – Annual groundwater monitoring and reporting. Groundwater monitoring would be conducted annually for all COCs. A detailed data summary and analysis would be presented in an annual report.
- Post Year 5 – Groundwater monitoring at RSA-115/116 would be combined with monitoring at associated underlying groundwater units (RSA-156 or RSA-157) assuming that the Corrective Measures Implementation Plan for the groundwater units will have been approved by ADEM.

LUCs would be implemented under this CMA in accordance with AAC 335-5 (ADEM 2013) to prevent potable use of groundwater and manage non-potable uses such that exposure to contaminated groundwater is minimized. The Army's SAC program would be used to implement the LUCs. Via the SAC program, the installation of wells for drinking water would be prevented, and all requests for the installation of wells for industrial processes or agricultural purposes for RSA-115/116 would be subject to Army review and approval. The following LUC measures would be implemented at these sites:

- Implementation of an Environmental Use Restriction (EUR) in accordance with ADEM to restrict groundwater use at RSA-115/116 (ADEM 2013).
- Incorporation of the EUR into the facility Master Plan as required by ADEM (ADEM 2013).
- Recording of the EUR in the land records for the property, as required by AAC 335-5-1-.02(3).

RSA-115/116 is located on RSA and access to the site by the general public is restricted by Army badging and access restrictions and the installation-wide perimeter fence. Under this alternative, after Year 5, the LUC program at RSA-115/116 would also be combined with those for the underlying groundwater units.

12.0 PUBLIC PARTICIPATION

Public participation requirements specified under AAC 335-14-8-0.8(6) will be met during the permit modification process for the RSA-115/116 corrective measures.

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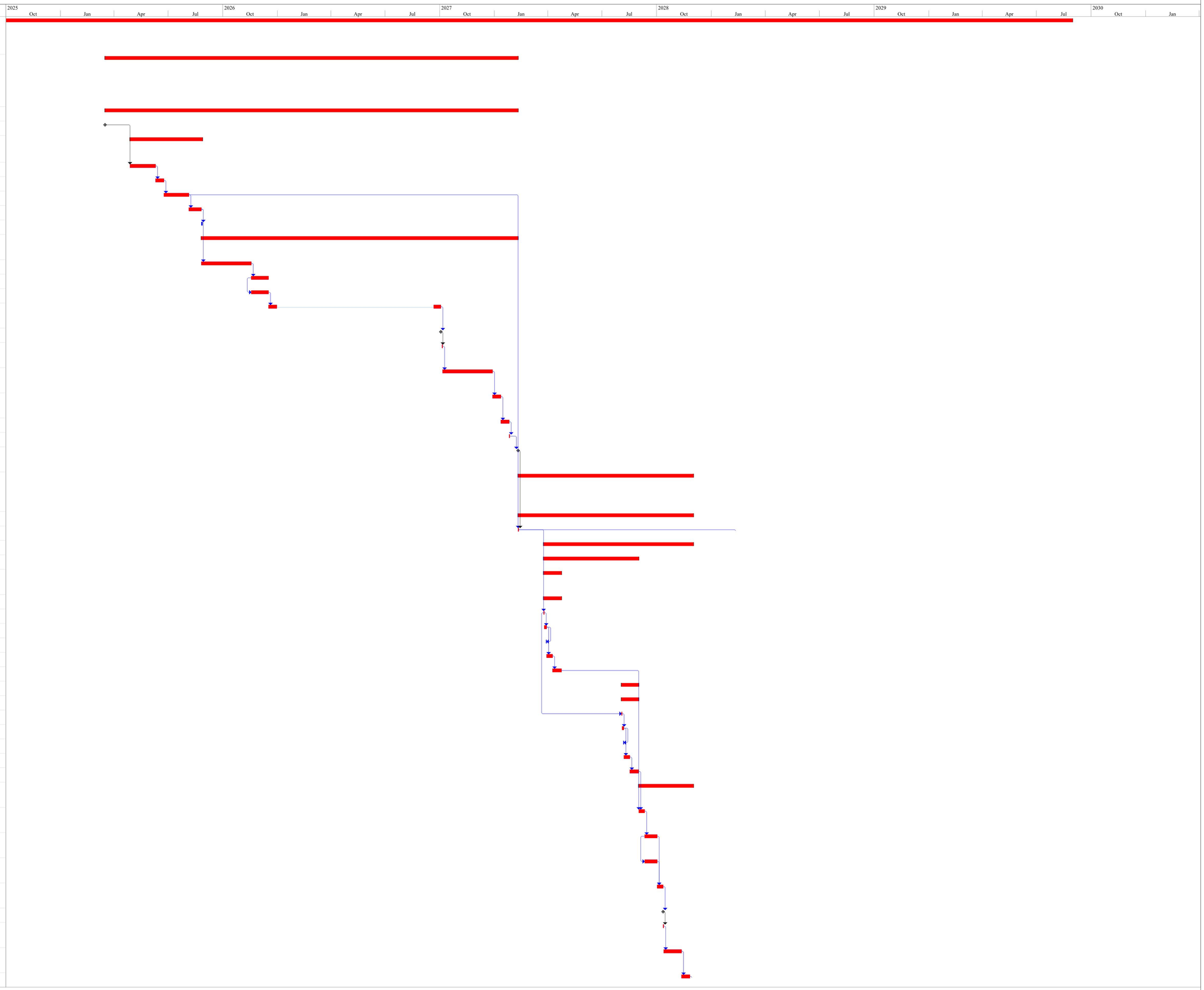
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APPENDIX F

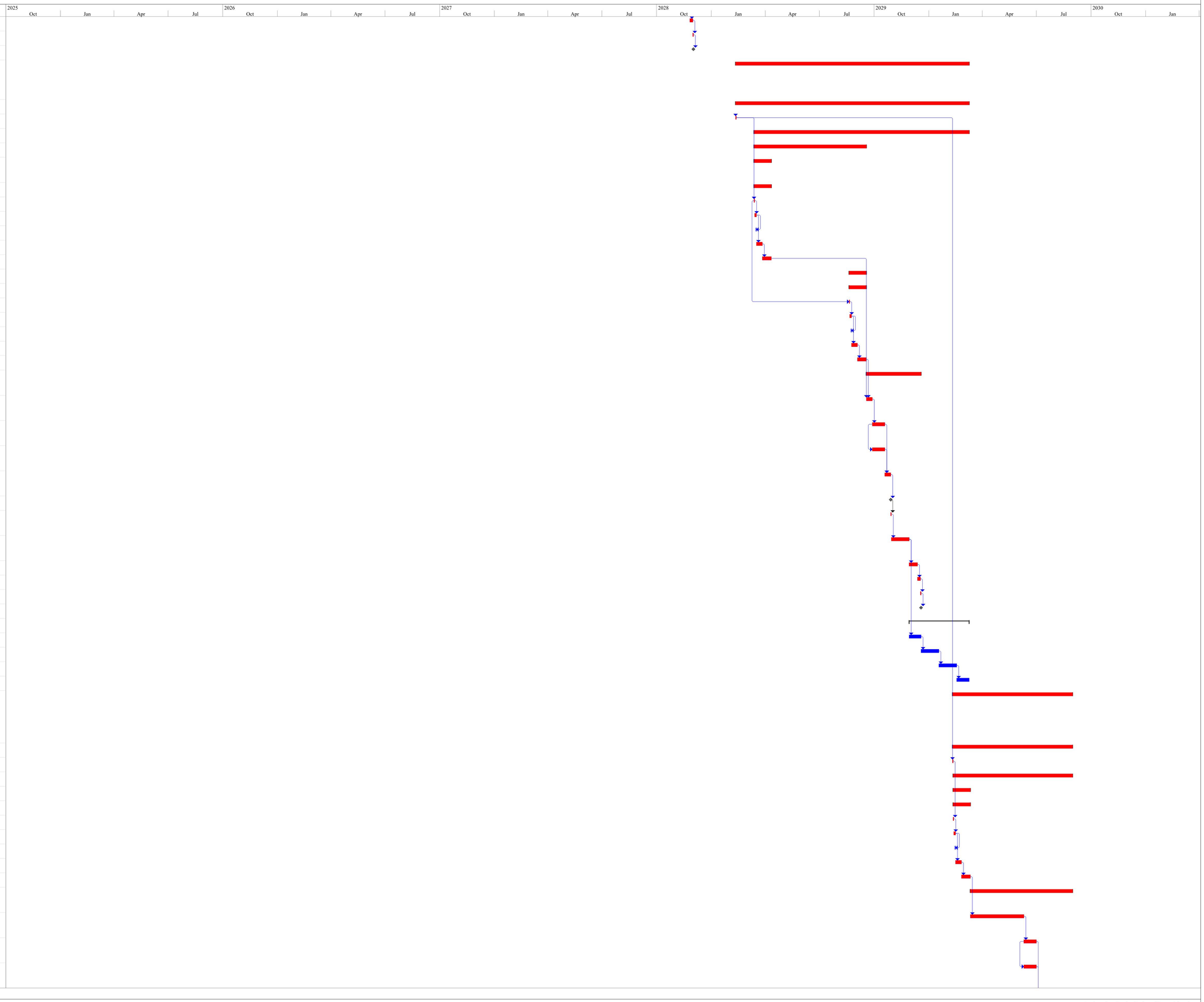
CORRECTIVE MEASURES IMPLEMENTATION PLAN SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**Environmental Remediation Multiple Award Indefinite Delivery Indefinite Quantity (IDIQ) Contract Redstone Arsenal, AL**	**2473 days**	**Fri 1/15/21**	**Thu 8/30/29**
861	**CLIN 0016 And CLIN 0017 - Achieve Corrective Measures Implementation – Construction (CMI-C) and Corrective Measures Implementation Report (CMIR) for Site RSA-115 and CCSWMU-116- OPTION (24 Months)**	**497 days**	**Mon 3/17/25**	**Tue 2/9/27**
862	**RSA-115 & CCSWMU-116**	**497 days**	**Mon 3/17/25**	**Tue 2/9/27**
863	Notice to Proceed	0 days	Mon 3/17/25	Mon 3/17/25
864	**Corrective Measures Implementation – Construction (CMI-C) - Field Work**	**88 days**	**Mon 4/28/25**	**Wed 8/27/25**
865	Subcontractor Procurement	31 days	Mon 4/28/25	Mon 6/9/25
866	Baseline Groundwater Sampling	10 days	Tue 6/10/25	Mon 6/23/25
867	Laboratory Analysis	30 days	Tue 6/24/25	Mon 8/4/25
868	Data Validation	15 days	Tue 8/5/25	Mon 8/25/25
869	Demobilization	2 days	Tue 8/26/25	Wed 8/27/25
870	**Corrective Measures Implementation Report (CMIR)**	**381 days**	**Tue 8/26/25**	**Tue 2/9/27**
871	Prepare and Develop Draft CMIR	60 days	Tue 8/26/25	Mon 11/17/25
872	Army Review of Draft CMIR	21 days	Tue 11/18/25	Tue 12/16/25
873	OPSEC Review of Draft CMIR	21 days	Tue 11/18/25	Tue 12/16/25
874	Respond to Army Comments on Draft CMIR	20 days	Wed 12/17/25	Fri 10/2/26
875	Army approve of Draft CMIR	0 days	Fri 10/2/26	Fri 10/2/26
876	Submit Draft Final CMIR to ADEM / EPA	1 day	Mon 10/5/26	Mon 10/5/26
877	ADEM / EPA Review of Draft Final CMIR	60 days	Tue 10/6/26	Mon 12/28/26
878	Develop response to ADEM / EPA Comments on Draft Final CMIR	10 days	Tue 12/29/26	Mon 1/11/27
879	Army Review of RTCs	10 days	Tue 1/12/27	Mon 1/25/27
880	Submit Final (Revision 1) CMIR	1 day	Tue 1/26/27	Tue 1/26/27
881	ADEM / EPA Approval of Final (Revision 1) CMIR	0 days	Tue 2/9/27	Tue 2/9/27
1071	**Achieve Corrective Measures Implementation – Operations (CMI-O) Option Year 1 for site RSA-115 & CCSWMU-116**	**282 days**	**Wed 2/10/27**	**Wed 12/1/27**
1072	**RSA-115 and CCSWMU-116**	**282 days**	**Wed 2/10/27**	**Wed 12/1/27**
1073	Notice to Proceed	1 day	Wed 2/10/27	Wed 2/10/27
1074	**CMI-O Field Work**	**251 days**	**Thu 3/25/27**	**Wed 12/1/27**
1075	**Annual Sampling and Reporting**	**159 days**	**Thu 3/25/27**	**Tue 8/31/27**
1076	**Semi-Annual Groundwater Sampling Event 1**	**29 days**	**Thu 3/25/27**	**Fri 4/23/27**
1077	**Field Work**	**29 days**	**Thu 3/25/27**	**Fri 4/23/27**
1078	Mobilization	1 day	Thu 3/25/27	Thu 3/25/27
1079	Groundwater Monitoring	3 days	Fri 3/26/27	Mon 3/29/27
1080	Demobilization	1 day	Mon 3/29/27	Mon 3/29/27
1081	Laboratory Analysis	10 days	Tue 3/30/27	Thu 4/8/27
1082	Data Validation	15 days	Fri 4/9/27	Fri 4/23/27
1083	**Semi-Annual Sampling Event 2**	**29 days**	**Tue 8/3/27**	**Tue 8/31/27**
1084	**Field Work**	**29 days**	**Tue 8/3/27**	**Tue 8/31/27**
1085	Mobilization	1 day	Tue 8/3/27	Tue 8/3/27
1086	Groundwater Monitoring	3 days	Wed 8/4/27	Fri 8/6/27
1087	Demobilization	1 day	Fri 8/6/27	Fri 8/6/27
1088	Laboratory Analysis	10 days	Sat 8/7/27	Mon 8/16/27
1089	Data Validation	15 days	Tue 8/17/27	Tue 8/31/27
1090	**Annual Corrective Measures Implementation Operations (CMI-O) Report**	**92 days**	**Wed 9/1/27**	**Wed 12/1/27**
1091	Prepare and Develop Draft Annual CMI-O Report	10 days	Wed 9/1/27	Fri 9/10/27
1092	Army Review of Draft Annual CMI-O Report	21 days	Sat 9/11/27	Fri 10/1/27
1093	OPSEC Review of Draft Annual CMI-O Report	21 days	Sat 9/11/27	Fri 10/1/27
1094	Respond to Army Comments on Draft Annual CMI-O Report	10 days	Sat 10/2/27	Mon 10/11/27
1095	Army approval of Draft CMI-O Report	0 days	Mon 10/11/27	Mon 10/11/27
1096	Submit Draft Final Annual CMI-O Report to ADEM / EPA	1 day	Tue 10/12/27	Tue 10/12/27
1097	ADEM Review of Draft Final CMI-O Report	30 days	Wed 10/13/27	Thu 11/11/27
1098	Prepare Responses to ADEM comments	14 days	Fri 11/12/27	Thu 11/25/27



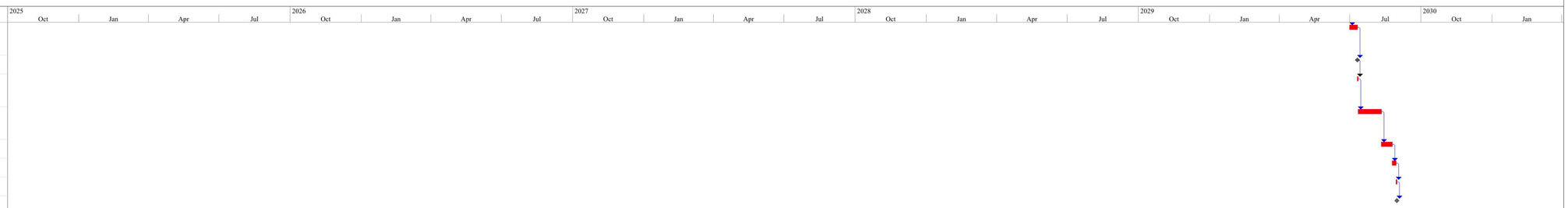
Project duration is displayed in working days
Critical path activities are displayed as red bars

ID	Task Name	Duration	Start	Finish
1099	Army review of RTCs	5 days	Fri 11/26/27	Tue 11/30/27
1100	Submit Final CMI-O Report	1 day	Wed 12/1/27	Wed 12/1/27
1101	ADEM approval of Final annual Report	0 days	Wed 12/1/27	Wed 12/1/27
1102	**Achieve Corrective Measures Implementation – Operations (CMI-O) Option Year 2 for site RSA-115 and CCSWMU-116 (Outside of Contract POP)**	**393 days**	**Fri 2/11/28**	**Fri 3/9/29**
1103	**RSA-115 and CCSWMU-116**	**393 days**	**Fri 2/11/28**	**Fri 3/9/29**
1104	Notice to Proceed	1 day	Fri 2/11/28	Fri 2/11/28
1105	**CMI-O Field Work**	**362 days**	**Mon 3/13/28**	**Fri 3/9/29**
1106	**Semi-Annual Sampling and Reporting**	**189 days**	**Mon 3/13/28**	**Sun 9/17/28**
1107	**Semi-Annual Groundwater Sampling Event 1**	**29 days**	**Mon 3/13/28**	**Mon 4/10/28**
1108	**Field Work**	**29 days**	**Mon 3/13/28**	**Mon 4/10/28**
1109	Mobilization	1 day	Mon 3/13/28	Mon 3/13/28
1110	Groundwater Monitoring	3 days	Tue 3/14/28	Thu 3/16/28
1111	Demobilization	1 day	Thu 3/16/28	Thu 3/16/28
1112	Laboratory Analysis	10 days	Fri 3/17/28	Sun 3/26/28
1113	Data Validation	15 days	Mon 3/27/28	Mon 4/10/28
1114	**Semi-Annual Sampling Event 2**	**29 days**	**Sun 8/20/28**	**Sun 9/17/28**
1115	**Field Work**	**29 days**	**Sun 8/20/28**	**Sun 9/17/28**
1116	Mobilization	1 day	Sun 8/20/28	Sun 8/20/28
1117	Groundwater Monitoring	3 days	Mon 8/21/28	Wed 8/23/28
1118	Demobilization	1 day	Wed 8/23/28	Wed 8/23/28
1119	Laboratory Analysis	10 days	Thu 8/24/28	Sat 9/2/28
1120	Data Validation	15 days	Sun 9/3/28	Sun 9/17/28
1121	**Annual Corrective Measures Implementation Operations (CMI-O) Report**	**92 days**	**Mon 9/18/28**	**Mon 12/18/28**
1122	Prepare and Develop Draft Annual CMI-O Report	10 days	Mon 9/18/28	Wed 9/27/28
1123	Army Review of Draft Annual CMI-O Report	21 days	Thu 9/28/28	Wed 10/18/28
1124	OPSEC Review of Draft Annual CMI-O Report	21 days	Thu 9/28/28	Wed 10/18/28
1125	Respond to Army Comments on Draft Annual CMI-O Report	10 days	Thu 10/19/28	Sat 10/28/28
1126	Army approval of Draft CMI-O Report	0 days	Sat 10/28/28	Sat 10/28/28
1127	Submit Draft Final Annual CMI-O Report to ADEM / EPA	1 day	Sun 10/29/28	Sun 10/29/28
1128	ADEM Review of Draft Final CMI-O Report	30 days	Mon 10/30/28	Tue 11/28/28
1129	Prepare Responses to ADEM comments	14 days	Wed 11/29/28	Tue 12/12/28
1130	Army review of RTCs	5 days	Wed 12/13/28	Sun 12/17/28
1131	Submit Final CMI-O Report	1 day	Mon 12/18/28	Mon 12/18/28
1132	ADEM approval of Final annual Report	0 days	Mon 12/18/28	Mon 12/18/28
1133	**Permit Modification**	**101 days**	**Wed 11/29/28**	**Fri 3/9/29**
1134	Prepare and Submit Permit Modification	20 days	Wed 11/29/28	Mon 12/18/28
1135	ADEM Review	30 edays	Mon 12/18/28	Wed 1/17/29
1136	Public Comment	30 edays	Wed 1/17/29	Fri 2/16/29
1137	ADEM Issue Permit	21 edays	Fri 2/16/29	Fri 3/9/29
1138	**Achieve Corrective Measures Implementation – Operations (CMI-O) Option Years 3 to 5 for site RSA-115 & CCSWMU-116, only dates for year 3, subsequent years will have same durations)**	**202 days**	**Sat 2/10/29**	**Thu 8/30/29**
1139	**RSA-115 and CCSWMU-116**	**202 days**	**Sat 2/10/29**	**Thu 8/30/29**
1140	Notice to Proceed	1 day	Sat 2/10/29	Sat 2/10/29
1141	**CMI-O Field Work**	**201 days**	**Sun 2/11/29**	**Thu 8/30/29**
1142	**Annual Groundwater Sampling Event 1**	**29 days**	**Sun 2/11/29**	**Sun 3/11/29**
1143	**Field Work**	**29 days**	**Sun 2/11/29**	**Sun 3/11/29**
1144	Mobilization	1 day	Sun 2/11/29	Sun 2/11/29
1145	Groundwater Monitoring	3 days	Mon 2/12/29	Wed 2/14/29
1146	Demobilization	1 day	Wed 2/14/29	Wed 2/14/29
1147	Laboratory Analysis	10 days	Thu 2/15/29	Sat 2/24/29
1148	Data Validation	15 days	Sun 2/25/29	Sun 3/11/29
1149	**Annual Corrective Measures Implementation Operations (CMI-O) Report**	**172 days**	**Mon 3/12/29**	**Thu 8/30/29**
1150	Prepare and Develop Draft Annual CMI-O Report	90 days	Mon 3/12/29	Sat 6/9/29
1151	Army Review of Draft Annual CMI-O Report	21 days	Sun 6/10/29	Sat 6/30/29
1152	OPSEC Review of Draft Annual CMI-O Report	21 days	Sun 6/10/29	Sat 6/30/29



Project duration is displayed in working days
Critical path activities are displayed as red bars

ID	Task Name	Duration	Start	Finish
1153	Respond to Army Comments on Draft Annual CMI-O Report	10 days	Sun 7/1/29	Tue 7/10/29
1154	Army approval of Draft CMI-O Report	0 days	Tue 7/10/29	Tue 7/10/29
1155	Submit Draft Final Annual CMI-O Report to ADEM / EPA	1 day	Wed 7/11/29	Wed 7/11/29
1156	ADEM Review of Draft Final CMI-O Report	30 days	Thu 7/12/29	Fri 8/10/29
1157	Prepare Responses to ADEM comments	14 days	Sat 8/11/29	Fri 8/24/29
1158	Army review of RTCs	5 days	Sat 8/25/29	Wed 8/29/29
1159	Submit Final CMI-O Report	1 day	Thu 8/30/29	Thu 8/30/29
1160	ADEM approval of Final annual Report	0 days	Thu 8/30/29	Thu 8/30/29



Project duration is displayed in working days
Critical path activities are displayed as red bars

APPENDIX G

QUALITY CONTROL PLAN

RSA-115/116 PROJECT QUALITY CONTROL PLAN

ENVIRONMENTAL REMEDIATION SERVICES REDSTONE ARSENAL

June 2023

Prepared for:

U.S. ARMY ENVIRONMENTAL COMMAND
Southeast-Environmental Service and Support Division
2455 Connell Road, Building 2266
Fort Sam Houston, TX 78234-7664

Prepared by:

ECC
9200 Church St
Suite 305
Manassas, VA 20110

Contract No.: W9124J-18-D-0004, Delivery Order W9124J21F0045

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QUALITY CONTROL PLAN

ENVIRONMENTAL REMEDIATION SERVICES AT

REDSTONE ARSENAL

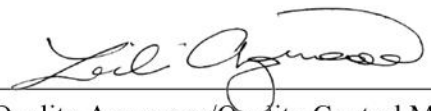
W9124J-18-D-0004

I hereby certify that the enclosed Quality Control Plan (QCP) is in compliance with contract specifications and is submitted for Army approval. Once approved, the QCP will be implemented during the project W9124J-18-D-0004 execution of "*Environmental Remediation Services at Redstone Arsenal, Alabama".*

Approvals

Date:

Deputy Program Manager,
Pam Foti, Certified Hazardous Materials Manager (CHMM), Project Management Professional (PMP)



Date: June 14, 2023

Quality Assurance/Quality Control Manager,
Leili Arjomand, Professional Engineer (PE), PMP, Quality Control Manager (QCM)

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Figure 2-1 Project Quality Control Plan Organizational Structure

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Appendix A Quality Control Plan Forms

Appendix B ECC Causal Analysis System

ACRONYMS AND ABBREVIATIONS

AHA	Activity Hazard Analysis
APP	Accident Prevention Plan
CHHM	Certified Hazardous Materials Manager
COC	Chain of Custody
COR	Contracting Officer's Representative
CMI	Corrective Measures Implementation
CQM	Certified Quality Manager
DoD	Department of Defense
DFW	Definable Feature of Work
DQCR	Daily Quality Control Report
ECC	Environmental Chemical Corporation
ERMA	Environmental Remediation Multiple Award
IDW	Investigative Derived Waste
LNAPL	Light Non-Aqueous Phase Liquid
LSP	Licensed Site Professional
LUC	Land Use Control
MEC	Munitions and Explosives of Concern
NCR	Nonconformance Report
PE	Professional Engineer
PG	Professional Geologist
PGM	Program Manager
PM	Project Manager
PMP	Project Management Professional
POD	Plan of the Day
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QCM	Quality Control Manager
QCP	Quality Control Plan
QMS	Quality Management System
RSA	Redstone Arsenal
SSHP	Site Safety and Health Plan
SSHO	Site Safety and Health Officer
USAEC	United States Army Environmental Command
USEPA	United States Environmental Protection Agency

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1.0 INTRODUCTION

Environmental Chemical Corporation (ECC) will implement a Quality Management System (QMS) to ensure all activities, products, information, data, and decisions resulting from quality-affecting activities are technically sound and defensible. The quality system and implementing procedures form the basis of ECC's QMS. The System was developed and is maintained per applicable State and Federal laws, rules, standards, guidance, contractual requirements and sound risk management practices.

The project consists of environmental services at Redstone Arsenal (RSA). The following are the definable features of work (DFWs) identified for RSA-115/116:

- Procurement and Subcontracting
- Mobilization/Demobilization
- Utility Marking / Dig Permits
- Vegetation Clearing
- Groundwater Monitoring
- Record Keeping
- Decontamination
- Implementation of Land Use Controls (LUCs)
- Corrective Measures Implementation (CMI) Reporting

1.1 Quality Control Objectives

ECC's QMS consist of plans, procedures, and an organization that will produce an end product that complies with the requirements of the contract. The QMS covers all environmental operations, both on-site and off-site.

This Quality Control Plan (QCP) defines the procedures to manage and control activities of ECC personnel, subcontractors, and suppliers and to ensure that the completed project complies with all contract documents.

ECC will maintain responsibility for its work and the work of its subcontractors. To ensure compliance with contract requirements and maintain responsibility of all work performed under this deliverable, ECC will provide a continuous Three Phase Control inspection program to examine the quality of work, maintain standards of workmanship, ensure environmental quality standards of excellence, evaluate performances, identify and correct deficiencies, and provide finished work products which meet or exceed the requirements, while maintaining qualified personnel and equipment, and facilities which are necessary for the completion of the project.

The objective of this QCP is to ensure that the project activities are conducted and documented in an organized, efficient, and safe manner. This plan will define the management structure, organization, responsibilities, and authorities necessary for successful completion of the project. Performing quality work, implementing an effective quality control (QC) system and to ensure project compliance is the responsibility of all ECC staff members and subcontractors and can be achieved through a cooperative effort and commitment to quality by all program personnel.

All QC and quality assurance (QA) procedures related to sampling and analytical methods are included in the *Revision 4 Installation-Wide Quality Assurance Program Plan* , *U.S. Army Garrison Redstone, Madison County, Alabama*, completed by HydroGeoLogic, Inc. in 2019, and the site-specific work plans being prepared by ECC, as needed.

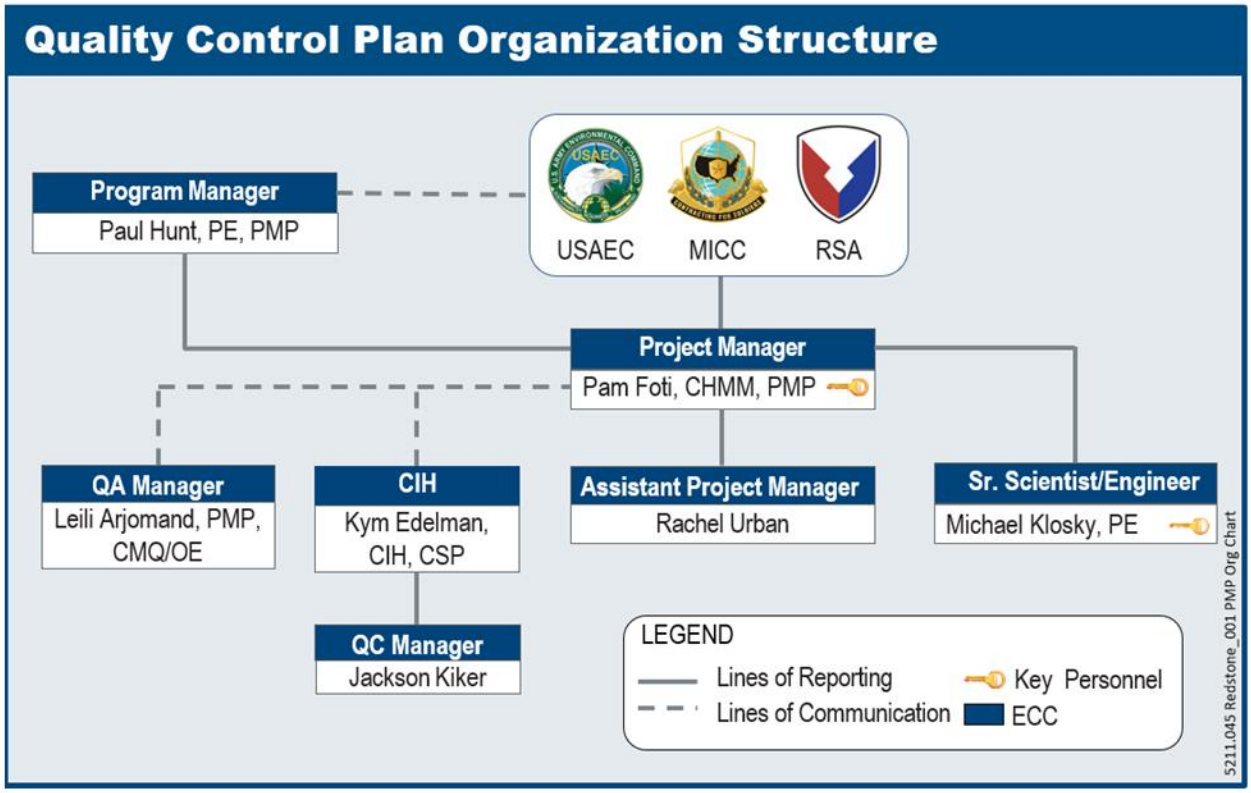
2.0 QUALITY CONTROL ORGANIZATION

The functions of the QC staff are to describe, integrate, monitor, evaluate, and document all QC practices of ECC and its subcontractors, and to ensure safety and contract compliance. The quality staff has the full support of management and has independent and delegated authority to accomplish assigned tasks, including stop work authority. The ECC quality control organizational structure, functional responsibilities, level of authority, lines of communication, and interfaces for activities affecting quality are identified and documented for assigned work tasks in the following sections.

Changes to ECC's QC staff organization requires the Army's Contracting Officer acceptance. Changes will be submitted in writing prior to the proposed change. Requests will include the names, qualifications, duties, and responsibilities of each proposed replacement.

Figure 2-1 shows the project organization chart identifying key personnel, responsibilities, and lines of authority for the QC personnel.

Figure 2-1: Quality Control Plan Organization Structure



2.1 Program Manager

The Environmental Remediation Multiple Award (ERMA) Program Manager (PGM), Mr. Paul Hunt, Professional Engineer (PE), Project Management Professional (PMP), Licensed Site Professional (LSP), is responsible for the quality of work performed by the assigned project staff. He is responsible for all operations associated with the implementation of the project and will ensure quality and schedule compliance. He will also be responsible for addressing all customer complaints and/or feedback.

2.2 Project Manger

The Project Manager (PM), Ms. Pam Foti, Certified Hazardous Materials Manager (CHMM), PMP, controls the budget and schedule with the concurrence of the PGM, ensuring the contract requirements are met. The PM is responsible for all environmental services related to the requirements of the contract and specifications, including subcontractors. The PM reports directly to the PGM and is responsible for ensuring that all project activities conform to requirements and specifications. The PM's duties also include the assignment of responsibilities for the preparation of various reports and the review of each form/report for accuracy and content. In addition to monitoring and appraising performance of staff and subcontractors, the PM has the primary responsibility of tracking any proposed changes to the contract and for the overall project and will report any proposed changes to the PGM.

2.3 Program Quality Assurance/Quality Control Manager

The Program QA/QC Manager, Ms. Leili Arjomand, Professional Engineer (PE), Certified Quality Manager (CQM), PMP, will have overall responsibility for the control and implementation of the approved QC program. She will be responsible for the management, training, and performance of all QC personnel and will serve as a technical resource to the QC officer and QC staff. All project QC records and activities are subject to review by the QA/QC Manger.

2.4 Quality Control Manager

The QC Manager (QCM), Mr. Jackson Kiker, is responsible for supervising all QC aspects of the project to ensure compliance with contract plans and specifications. The QCM has indirect reporting responsibilities to the PM so that the required authority and organizational freedom is provided, including sufficient independence from cost and schedule implications. The QCM has the authority to act in all QC matters for ECC. The QCM has overall responsibility and authority for the administration of all QC Program-related activities. The QCM will conduct QC project surveillances throughout the life of the project and ensure that the reporting requirements as defined in this QCP are implemented.

2.5 Site Superintendent

The Site Superintendent, Mr. Aaron Glad, reports to the PM. He will manage field operations and monitor and oversee field personnel, subcontractors, QC, and safety activities to ensure compliant work. He will host the plan of the day (POD) meetings and participate in preconstruction meetings, preparatory meetings, initial inspections, final acceptance inspections, and ensure that substandard work is corrected as soon as possible.

2.6 Field Personnel and Subcontractor

All field personnel and subcontractors will be required to adhere to the procedures set forth in this QCP. The Site Superintendent will be responsible for overall management and coordination of field personnel and subcontractors and ensuring they perform all aspects of the work in accordance with the Work Plans, the Site Safety and Health Plan (SSHP), and this QCP. The QCM will be responsible for ensuring the field personnel and subcontractors perform all aspects of the work in accordance with this QCP. The Site Safety and Health Officer (SSHO) will be responsible for ensuring the field personnel and subcontractors perform all aspects of the work in compliance with the SSHP.

3.0 MEETINGS

While performing work, ECC will take part in various meetings during which they will update the client, and when applicable, other stakeholders, on the progress, results, deviations or modifications, and recommendations for the fulfillment of the scope of work.

3.1 Coordination and Mutual Understanding Meeting

If needed, and in addition to the meetings specified in the Project Management Plan, the QCM shall meet with the Contracting Officer's Representative (COR) and/or RSA Army Environmental Coordinator or designated representative prior to the start of the site work to discuss the QC Project Plan required by this project.

During the meeting, a mutual understanding of the system details will be developed, including the forms for recording the QC operations, administration of the system for both on-site and off-site work, coordination of ECC's management, and the interrelationship of ECC's management and control with the Army's QA, production, and the QCM's duties with the COR.

As a minimum, ECC's personnel required to attend will include the PM, Site Manager, and QCM.

3.2 On-site Meetings

When field activities are being performed, meetings may take place, whether planned or unplanned, at the site to discuss specific issues or concerns. The QCM or her designated representative will be responsible for documenting discussions and decisions made at the meeting on the Daily Quality Control Report (DQCR).

3.3 Meeting Minutes

Minutes of all meetings will be prepared describing the general discussion, decisions, changes in approach, and action items. If requested, ECC will submit the meeting minutes to participants.

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4.0 QUALITY CONTROL REQUIREMENTS

4.1 Definable Features of Work

To ensure quality, ECC will implement the QC program, including the Three Phase Control Process for each DFW. A DFW is any task, which is separate and distinct from other tasks, has separate control requirements, or is identified by different disciplines. There may be more than one DFW in each activity. The Three Phase Control Process is used to ensure that all project activities comply with the approved plans and procedures. The DFWs for this project are included in **Section 1**.

4.2 Three-Phase Control System

The Three Phases of Control process assures control of work at every stage of an activity, from planning through execution and completion. The process includes the preparatory, initial, and follow-up phases. Work will only begin on a DFW when successful preparatory and initial phases are completed.

Additional preparatory and/or initial phases may be conducted on the same DFW if new crews or subcontractors are added to a DFW, when acceptable levels of quality are not being met, if there are changes in the applicable QC organization, if work on a DFW is resumed after a substantial period of inactivity, or if other problems develop.

4.2.1 Preparatory Phase

The preparatory phase will be performed prior to the beginning of work on each DFW after all required submittals have been approved and is typically conducted by the SSHO with other applicable site personnel in attendance (e.g., field personnel, subcontractors, etc.). The United States Army Environmental Command (USAEC) COR and Army Environmental Coordinator will also be invited to attend the meeting. Any subcontractors involved in the DFW will participate in this review as well. The QCM or designated representative will give the Army 48-hours' notice prior to the preparatory phase meeting. The results of the preparatory phase actions will be documented in the DQCR.

During this phase, it is imperative to review the specifications and drawings to ensure all preparatory steps have been taken, to verify that submittals have been prepared and reviewed, qualified manpower is assigned, and safety issues have been identified and addressed. Specifically, this phase will include, if applicable:

- Review each paragraph of applicable specifications and drawings
- Review of the applicable work plans, etc. including discussion of procedures for controlling quality of the work and how deficiencies are corrected
- Review provisions that have been made to provide required control testing and inspection
- Concurrence that required project training and qualifications are complete (QC, health and safety, technical, etc.)
- Review to ensure that all materials and/or equipment have been tested, submitted, and approved
- Review of applicable permit status and requirements
- Examine the work area to ensure that all required preliminary work has been completed and is in compliance with the contract
- Review the appropriate activity hazard analysis (AHA) to ensure safety requirements are met
- Discuss sampling methods, applicable standard operating procedures, and the testing facility

- Check to ensure the portion of the plan for the work to be performed has been accepted by the client
- Discuss the initial control phase

4.2.2 Initial Phase

This phase of inspection will document the completeness and acceptability of the particular items at the beginning of the work activity after a representative portion of the items has been completed is typically conducted by the SSHO or Site Superintendent.

This is the time to ensure that ECC's and our subcontractor's personnel/workers understand, through immediate inspection, the contract standards, and the standards of workmanship desired. If there is a difference of opinion in the interpretation of contract requirements, this is the time to settle the issue. The initial inspection phase is a practical method of performing preventive inspection and resolving conflicts. The following will be accomplished during this phase, if applicable:

- Review minutes of the preparatory meeting for open items
- Check the work to ensure it is in full compliance with the project requirements
- Establish level of workmanship and verify it meets the desired acceptable workmanship standards.
- Resolve all differences between personnel and subcontractors
- Check safety to include compliance with and upgrading (if necessary) of the Accident Prevention Plan (APP)/SSHP and AHA. Review the AHA with each worker, if deemed necessary.
- Prepare documentation of the initial phase inspection, including a narrative description of detailed inspection procedures, minutes of meetings, inspection results, corrective measures, etc., using forms presented in **Appendix A** of this QCP or included in field book.
- The initial phase will be repeated for each new crew member arriving to work on-site or any time acceptable specified quality standards are not being met.

4.2.3 Follow-up Phase

Follow-up inspection is geared toward a level of effort to verify the continuation of project compliance and standards of workmanship established during the previous two phases. This inspection is typically conducted periodically by the SSHO, or Site Superintendent to ensure a continuation of satisfactory quality standards. Follow-up inspections will be made a matter of record in the DQCR. The QCM will verify proper procedure technique, sample handling, and Chain of Custody (COC), if required. The SSHO or Site Superintendent will monitor testing results and compare them with the project requirements, and if acceptable, document the results and provide a timely authorization to proceed with subsequent work. If the QCM determines the work is otherwise, not acceptable, he will notify the PM for stopping work and initiating a conformance action. Final follow-up checks will be conducted, and all deficiencies will be corrected before the start of additional DFWs.

4.3 Additional Preparatory and Initial Phases

Additional preparatory and initial phases will be conducted on the same DFW if the quality of ongoing work is unacceptable; if there are changes in the applicable QC staff, on-site supervision, or work crew; if work on a DFW is resumed after a substantial period of inactivity; or if other problems develop.

4.4 Control for Off-Post Work

When necessary to complete the objectives required in the PWS and as acknowledged in Table 1-1 of the Project Management Plan, work may take place off-post (laboratory analysis). To the extent practicable, ECC will monitor the quality and workmanship of products developed off-site by implementing the same control measures as work that takes place at a project site to ensure the products and/or materials meet the overall quality and technical standards (i.e., Work Plans or equivalent documents with Quality Assurance Project Plan [QAPP]-like requirements). Should any off-Post work be of a complexity that would warrant an effort beyond these measures (and those referenced in **Section 5.1** below), it would be discussed and agreed to by the ECC PM and the Army COR.

4.5 Deficiency Management

The ECC quality program evaluates the effectiveness of our QC program and ensures continuous improvement in the quality of our work. The primary goals of our quality program are to prevent non-conformances and to facilitate continual process improvement. If the first goal is not achieved, the identified deficiencies or non-conformances will be corrected in a timely and cost-effective manner in order to prevent their recurrence. This QCP includes provisions for preventing quality issues, facilitating process improvements, as well as identifying, documenting, and tracking deficiencies until corrective actions have been verified.

4.5.1 Preventive Measures

While the entire QC program is directed toward problem prevention, certain elements of the program have greater potential to be pro-active. The primary tools for preventing problems include:

- Employee qualification and training
- Preparatory, initial, and follow-up inspections
- Equipment calibration and maintenance.

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5.0 TESTING AND INSPECTION

5.1 Analytical Testing

ECC will procure the services of an independent analytical laboratory with DoD Environmental Laboratory Accreditation Program certification to perform analytical testing required by this project. The testing laboratory will have an established and documented quality system in compliance with the DoD Quality Systems Manual for Environmental Laboratories.

Laboratories must possess any required state or host nation certification and/or be accredited for each applicable method by a nationally recognized laboratory accreditation body.

Changes to the Laboratory Accreditation Status will be notified in writing to the Army within 30 calendar days of the change.

Chemical analysis will be performed using current USEPA procedures and in conformance with DoD Quality Systems Manual for Environmental Laboratories and State agency requirements unless otherwise specified in the project Performance Work Statement.

ECC will provide the analytical results citing applicable contract requirements or test procedures used. Analytical results will also provide a statement indicated if the analysis performed "conforms" or "does not conform" to the requirements.

5.2 Inspection

Inspection activities involve the evaluation of a characteristic as it relates to a specific requirement. ECC may perform the following inspections below, as appropriate to the DFW.

5.2.1 Punch-Out Inspection

A "punch list" of items that do not conform to the approved work plan, specifications, etc. will be prepared and included in the QC documentation. The list of deficiencies will include the estimated date by which the deficiencies will be corrected. The QCM or staff will make a second inspection to ascertain that all deficiencies have been corrected. Once this is accomplished, ECC will notify the Army that the item(s) is ready for their pre-final inspection.

5.2.2 Pre-Final Inspection

ECC will notify the Army when all of the items from the Punch-Out Inspection have been corrected and a Pre-Final Inspection will be scheduled. The Army will conduct the Pre-Final Inspection and a Pre-Final punch list may be developed if deficiencies are noted. The punch list will include estimated dates of completion that will ensure the deficiencies are completed timely and within the contract dates. When the punch list items are completed and verified by the QCM (or designee), the Army will be notified that a final inspection can be scheduled.

5.2.3 Final Acceptance Inspection

ECC will notify the Army 14 days prior to the Final Acceptance Inspection and the Army will formally schedule this inspection. The notification will include assurance that all items previously identified as being unacceptable along with all remaining work performed under the project will be complete and acceptable by the date scheduled for the final acceptance inspection. The QCM, Site Manager, or other primary

management person will represent ECC at the final acceptance inspection. Army personnel will be present as required.

5.3 Instrumentation/Equipment Testing, Inspection, and Maintenance

All equipment used at a project site shall be manufacturer-calibrated to national standards. Each time the instrument is about to be used, the calibration shall be verified and tested for functionality in accordance with *Final Revision 1 Installation-Wide QAPP* completed by Shaw Environmental, Inc. in 2013. Equipment found to be damaged, inoperable, or out of calibration shall not be used until the discrepancy is corrected and verified by the QCM (or designated representative). As necessary, a detector sensitivity or test grid may be used to test the functionality prior to daily use and results documented in the field logbook. Once equipment has been used, it shall be maintained following manufacturer's recommendations. The QCM, SSHO or Site Manager will make periodic verification/audits of the logs and procedures and report the findings in the DQCR.

6.0 QUALITY CONTROL DOCUMENTATION

The QCM serves a critical role in documenting, reporting, and storing data in support of the QC process and its effectiveness in attaining a high-quality work product.

6.1 Reporting Requirements

The QCM will complete and maintain the QC records to provide factual evidence of compliance with project requirements and to document all QC activities, including maintaining a record of all tests and inspections performed. These records include all work performed by subcontractors and suppliers. The QCM will sign each report and provide copies to the PM and USAEC, if requested. The primary QC reports are listed below.

6.1.1 Daily Reports

During field operations, DQCRs will be prepared describing QC and operations activities performed each day as well as the resources on-site and activities performed, including work performed by subcontractors. The reports will present an accurate and complete picture of QC and operations activities and site management. The report will include both conforming and deficient conditions in a precise, factual, legible, and objective manner. Copies of supporting documentation such as checklists and test reports will be attached as required, if requested. Work will be reported by terminology consistent with the work schedule.

The DQCR will be prepared, signed, and dated by the QCM (or her designated representative) and maintained on ECC's project SharePoint site. A copy of the DQCR will be submitted to RSA and the COR on a daily basis.

6.1.2 Monthly Summary Report

When field activities are being performed, the PM will submit a monthly summary report electronically to the client.

6.1.3 Quality Control Meeting Minutes

The QCM shall submit one copy of the meeting minutes within seven calendar days of the meeting.

6.1.4 Safety and Health Deficiency Tracking

6.1.5 Field Logbook

The QCM (or designee) shall be assigned a QC logbook for documenting details of field activities during QC monitoring activities. The logbook will be a bound manuscript with pre-printed page numbers. The QCM (or designated representative) will document his/her daily duties, summarize field activities, including arrival and departure time, note QC tests and results, depict the site layout, and other data. The information in the QC logbook will serve as a detailed description of events to aid in the preparation of the DQCR and in addressing follow-up questions that may arise.

All entries made in the QC logbook shall be made in ink. Any changes shall be made by a single strike through the error and initials. At the beginning of each day, notes will begin on the following page in the logbook. Descriptions shall be made in coherent English and in a manner, that would allow others to

recreate the daily events in the absence of the QCM. At the end of each day, the QCM (or designee) will mark the remainder of the page with a single line and sign across or under it.

6.2 Records Management

Records are considered completed documents, validated data, and other materials that provide objective evidence of the quality of items or activities. A document that contains objective information can become a record once it is complete and identified as a record. Records include, but are not limited to:

- Work plans, technical proposals, and other work assignment planning documents
- Field plans and procedures
- Training records
- Project reports, including letter reports
- Field logbooks and project notebooks
- Three phase inspection records
- DQCR and Production Reports
- COC records
- Audit, surveillance, and independent project self-assessment reports
- Field change notices
- Laboratory data

The PM will define work assignment documents that are expected to become records.

Records will be maintained in the project office in a manner that prevents deterioration and provides for the safeguarding of the records. A record indexing system that allows for easy retrieval and provides sufficient information to permit the correlation of records with the items or activities to which they apply will be used. Inactive records will be stored for the mutually agreed upon time after which they are either archived or properly disposed

Disposition of records is controlled and documented. Records are destroyed only after the proper notification to USAEC and the approval of the ERMA PGM.

7.0 SUBMITTALS

Preparation of submittals is the responsibility of the PM at the project level using project staff resources. For preparation of technical submittals, the appropriate staff will be chosen; those who have the background and knowledge required for assuring the technical submittal is complete and accurate. Additionally, the PM will perform a separate technical peer review for highly technical submittals.

The QCM will review submittals for acceptance with QC requirements before transmitting to the client or other required approval authorities. Submittals requiring modifications or changes will be returned to the originator, subcontractor, or vendor for correction and resubmission. Submittals from subcontractors and vendors will be reviewed for technical content and accepted as a part of this submittal preparation procedure.

7.1 Transmittal Form

Transmittals by ECC to the Army will be documented via email correspondence and/or Project Portal upload (with corresponding email to notify the parties of document availability). The transmittal and distribution of documents to Regulators will be managed directly by RSA and supported by ECC as discussed in Section 3.4.2.3 of the Project Management Plan.

7.2 Comment Response Matrix

Upon receiving comments from Army, regulatory, or other outside reviewers, ECC will prepare a comment response matrix to document each reviewer's comment along with a response describing how the comment will be resolved, incorporated, or addressed. To expedite reviews of the comment responses, ECC may request that the Army schedule a conference call or meeting with reviewers to discuss their comments. The completed comment response matrix will then be submitted to the client for review and approval prior to submitting elsewhere, as appropriate and applicable. At such a time when all responses are accepted, ECC will incorporate changes into the document.

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8.0 NONCONFORMANCE REPORTING

8.1 Nonconformance Definition

The definition of a nonconforming condition can be a deviation from product, process, procedure or compliance specifications. All items determined to be nonconforming must be corrected through systematic corrective actions. Any time a condition exists not in compliance with drawings, specifications, codes, workmanship standards, facility requirements, or Army requirements, the nonconformity must be documented, corrected, and closed-out through the following means. All personnel are responsible for identifying deficiencies and the QCM is responsible for ensuring the proper tracking and documentation of deficiencies, including those identified by the Army. ECC will implement the ECC Causal Analysis System (see **Appendix B**) to determine the root causes of quality related incidents and non-conformances. We will perform trend analyses at least annually by reviewing all incidents and identifying common basic causes that need to be addressed to prevent similar occurrences.

8.2 Deficiency Identification

The QCM (or designee) will be responsible for managing the nonconformance process. All nonconforming items must be reported to the QA/QC Manager. Anyone finding a deficient item is responsible for reporting it to the appropriate management staff.

8.3 Nonconformance Determination

During routine site activities, the majority of corrective actions can be implemented immediately (within 48 hours) by the field personnel and documented in field logbook. If the condition is not quickly corrected, the individual initiates a Nonconformance Report (NCR) as shown in **Appendix A** and submits it to the QCM (or designee). The QCM (or designee will notify the PM and identify the person responsible for implementing corrective action (often the Site Superintendent), sets a date on which the response is due, and distributes the NCR.

8.4 Planning and Implementing the Corrective Action

The responsible person to initiate corrective actions should identify the cause of the problem, if known or suspected, on the NCR. The responsible person will develop a Corrective Action Plan, identify the date the corrective action has been or will be accomplished, describe the action taken on the form, and return the form to QCM (or designee) by the response due date. If possible, objective evidence that the corrective action has been completed should be included with the NCR response. If this is not possible, the responsible person should return the NCR by the due date and provide the evidence as soon as possible.

8.5 Accepting Corrective Action

The QCM (or designee) will review the NCR response to determine the adequacy of the corrective action. If the stated corrective action is unacceptable, the NCR will be returned to the responsible person for further discussion and corrective action.

8.6 Verifying Corrective Action

If the evidence provided to the QCM (or designee) concerning completed corrective action is acceptable, the NCR will be signed and dated. If evidence is obtained through an audit, surveillance, or follow-up

review, the individual conducting the follow-up will sign and date the form once the corrective action has been verified.

A distribution list for NCRs will be determined at the initial project-planning meeting. At a minimum, distribution will include the USAEC Representative, QCM, PGM, QA/QC Manager, PM, Site Superintendent, and any other applicable client-related individuals.

9.0 AUDITS AND ASSESSMENTS

Assessments are a learning process intended to increase the user's understanding of the program or system being assessed and to provide a basis for improving such programs or systems. The purpose of assessments is to improve the quality of work by comparing the system or element to the specified requirements. Assessments are conducted at all levels: corporate, contract, project, and activity. Response refers to the actions taken by the assessed organization as a result of the assessment. Typically, responses involve corrective actions to rectify the deficiencies identified in the assessment.

Project assignments will be monitored and assessed as deemed appropriate by the QCM (or designee) and QA/QC Manager. The following sections identify and describe many assessment types. Not all types may be applicable for this project. The requirement to conduct applicable assessment types may be further defined in the work plans and field plans. The ERMA PGM, PM, or the QA/QC Manager may specify additional assessments, as necessary, to ensure that the quality of work meets the Army and ECC's expectations. Assessment reports generated under this project will be made available to the Army, upon request.

9.1 Management System Reviews

Management systems reviews are self-assessments conducted annually, or as determined appropriate by the QA/QC Manager, to establish whether the quality management structure, policies, and procedures are adequate to ensure quality data. Management systems reviews may cover multiple contracts and quality plans. The primary focus of the management systems review is performance improvement through:

- Fostering individual ownership of the quality program by increasing employee involvement in quality
- Encouraging employees to routinely identify opportunities for quality improvement
- Meeting with management, technical, and QA staff to solicit specific suggestions to improve quality, such as more practical implementation methods, procedural modifications, etc.
- Training the management, technical, and QC staff on quality plan requirements
- Communicating lessons learned from other management systems reviews
- Checking on implementation and effectiveness of the quality program within the office.

9.2 Project Audits

Project audits may be conducted on ECC and subcontractor work activities by QC staff independent of the work activities or the appropriate staff appointed by RSA or the USAEC. The implementation and use of appropriate quality measures identified in this QCP, work plans, field plans, specifications, procedures, and any other applicable document specifying requirements can be used for checking during the audit. The auditor will also ensure that obsolete documentation has been removed from project work areas and check briefly on preparation of required deliverables and the condition of project files.

Project auditors will be trained in auditing procedures and authorized by the QA/QC Manager.

9.3 Project Self-Assessments

Project self-assessments are evaluations of work activities conducted by project personnel who are knowledgeable in the project requirements to determine if the technical requirements are being met. They are intended to provide rapid feedback to the project staff to facilitate timely corrective action.

The ERMA PGM makes the selection of project assignments or activities for project self-assessment and the personnel to conduct them with the assistance of the QA/QC Manger or QCM. Project self-assessments are conducted using a standardized or customized checklist.

Appendix A

QCP Forms

DAILY SITE REPORT

Project Title: Redstone Arsenal
Date: _____
Activity Name: _____
Location: _____
Contract No.: W9124J-18-D-0004, DO W9124J21F0045

Weather	Sunny	Clear	Overcast	Rain	Snow
Temperature	< 32	32 – 50	50 – 70	70-85	> 85
Wind	Still	Moderate	High		
Humidity	Dry	Moderate	Humid		

Personnel On Site:

Name	Hrs.	Affiliation	Location/ Description of Work

Field Changes: YES _____ NO _____

If yes, filed Nonconformance and Corrective Action Report number (NCR No.):_____

Work Performed:	
Equipment Used:	
Health & Safety (Briefing held, PPE, injuries, near misses, etc.):	
Samples Collected/ Shipped:	
IDW Generated and Disposition:	
Verbal Instructions Received/Given:	
Changed Conditions/ Delays/ Conflicts Encountered or Resolved:	
Other Comments or Additional Information:	
Next Day's Planned Activities:	

Contractor Verification: On behalf of the contractor, ECC, I certify this report is complete and correct, and all materials and equipment used and work performed during this reporting period are in compliance with the contract plans and specifications, to the best of my knowledge, except as may be noted above.

_____ _____ _____ _____
Signature Date Reviewer Signature Date

INSTRUMENT CALIBRATION LOG

Project: Redstone Arsenal **Site:** **Date**

Calibrated By Instrument Serial Number

Weather:

Parameters	Calibration	Calibration Temp	Post Calibration	Comments
Conductivity (mS/cm^c)				
pH (7)				
pH (4)				
pH (10)				
ORP (mV)				
Dissolved Oxygen (%)				
Barometric Pressure (mmHg)				
Turbidity	**<0.10 NTU**	**15.0 NTU**	**100 NTU**	**750 NTU**
PID		**Isobutylene / 100ppm**		

	Environmental Chemical Corporation	EQUIPMENT DAILY CHECK LIST

Equipment Name /Number _____ **Date** _____

Engine Hrs/Mileage _____ **Project Name** _____

BRAKES	COOLING WATER
AIR SYSTEM	OPERATING CONTROLS
TIRES/TRACKS	LIGHTS/REFLECTORS
HORN	WINDSHIELD WIPERS
SAFETY DEVICES	FIRE EXTINGUISHER
GLASS	BACKUP ALARM
MIRRORS	ENGINE OIL Add/Check
DEFROSTER	EXHAUST SYSTEM
STEERING SYSTEM	FLUID LEVELS
WIRE ROPE	ELECTRICAL SYSTEM
APPEARANCE	BREATHING AIR BOTTLES

These items are to be checked each shift before operating this piece of equipment.
Report ALL items requiring repair to supervisor prior to operation of equipment.

Note:

_____

_____

_____

_____

_____

_____

_____

_____

_____

OPERATOR'S NAME	(Please Print Name)

	Environmental Chemical Corporation	FIELD WORK VARIANCE

Project Name _____ Variance No _____

Project No _____ Page ___ of ___

Contract No. _____ CTO No. _____ Date: _____

Variance (include justification and present requirements) Requested by: _____

Proposed Change

Technical Justification

Cost/Schedule Impact

Reason for Change ☐ Addition ☐ Deletion

Change Order Required ☐ No ☐ Yes Change Order No. _____

Applicable Document

Approved By		
	Project Manager	**Date**
Approved By		
	CQC Manager	**Date**
Approved By		
	Contracting Officer	**Date**

	Environmental Chemical Corporation	MATERIALS DELIVERIES STORAGE CHECKLIST

Project Name:	Date:	Serial No.

Building Name:		Control #	
Specified Location:		Reference #	
Drawing Reference:			

Description of Activities	Disposition			Inspection Date (Initials)
	ACCEPT	REJECT	HOLD	
1 Material:				
2 Date of Delivery				
3 Handling method				
4 Storage method				
5 Protection				

Remarks:

Checked By:	Inspected By:	Witnessed By:
Contractor Representative	Q.C. Inspector, Contractor	Prime Contractor Representative
Date:	Date:	Date:

	Environmental Chemical Corporation	NON-CONFORMANCE REPORT TRACKING

Contract _____ **Project No** _____

CTO No _____ **NCR Number** _____

Nonconformance Description (include specific requirement violated):	
Identified By	**Date**

Root Cause of Nonconforming Action:

Corrective Action(s) to be Taken (include date when action(s) will be complete):	
To Be Performed By	**Date**

Action(s) to be Taken to Preclude Recurrence:	
To Be Performed By	**Date**

Acceptance By		
	Project Manager	**Date**
	CQC Manager	**Date**

Corrective Action(s) Completed by and Date:	Verification Completed by and Date:

Environmental Chemical Corporation

NON-CONFORMANCE REPORT TRACKING LOG

Contract _____ **Project Name** _____

CTO No _____ **Page** ____ **Of** ____

NCR No.	Orig. Date	Initiated By	Nonconformance Description			Status	
Project No.	Close Date	Close By		Resp. Party	C/A Due	C/A Recommended And Approved	Re-inspection Results

Environmental Chemical Corporation	RECORD OF TESTING ON -OR- OFF SITE

To: _____

Testing To Be Carried Out By: _____

Contract Number: _____ Contractor: _____

Item or Work for Test: _____

_____

Location of Test: _____

Proposed Date & Time of Test: _____

Specified Testing Requirements: _____

_____

Notified By: _____ Date: _____

To Be Inspected By: _____ ☐ _____ ☐ _____ ☐

_____ ☐ _____ ☐ _____ ☐

Test Record

Date of Test: _____ Location or Grid Ref. _____

Type of Test: _____

Test Conditions Maintained: Start ☐ Finish ☐

Accepted ☐ Rejected ☐

Test Result

Comments/Observations: _____

_____

_____

_____

Test Witnessed By:

_____ _____

QC Inspector (Signature) Supplier (Signature)

_____ _____

Contractor Repr (Signature) Prime Contractor Repr (Signature)

	Environmental Chemical Corporation	REWORK ITEMS LIST

Contract _____ **Project No** _____

CTO No _____

Item	Date Identified	Date Corrected
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		
18.		
20. 21.		
22.		
23.		
24.		

	Environmental Chemical Corporation	STATUS SUMMARY ON NON-CONFORMANCE NOTICES

PROJECT: _____ DATE: _____

SEQUENTIAL SERIAL NO.	DATE OF ISSUE	DESCRIPTION	DATE RECEIVED BY CONTRACTOR	DATE RETURNED BY CONTRACTOR	Q.C. ENGINEER		COMMENTS
					ACCEPTED DATE	REJECTED DATE	

	Environmental Chemical Corporation	STOP WORK ORDER

Project Name		**Date**	
SWO No.		**Page**	
Contract No.		**CTO Number**	

1. Written Notice			
Issued to:		P.O. # or Activity:	
Name:		Location:	
Title:		Issued by (name):	
Origination:		Issued by (title):	
2. Verbal Notice			
Issued to:		Date:	
Title:		Time	

3. Associated NCR No.	**4. Associated CAR No.**

5. Stop Work Order Condition Description

6. Remedial Action Required:			
By Whom		By When	

7. Required Remedial Action Determined by:	
Project Manager	Date
CQC Manager	Date

8. Follow-up of Remedial Action Taken:

Verbal Notice to Resume Operations Given to:

Name	Title	Date	Time

Stop Work Order Cancellation Authorized by:

Program CQC Manager:	Date

Appendix B

ECC Causal Analysis System

ECC CAUSAL ANALYSIS SYSTEM

Step 1. Incident Description

Type of incident:

- Quality
- Vehicle/property loss >$500
- Environmental release or permit exceedance
- Injury or illness
- UXO-related
- Security
- High loss potential (HiPo)

Describe what happened:

_____

Evaluation of future risk if not controlled:

Probability of Recurrence	*Severity of Loss Potential*		
	Minor	*Serious*	*Major*
Will probably occur soon	Medium	High	High
Reasonable likelihood in future	Low	Medium	High
Unlikely	Low	Low	Medium

Step 2. Select Event Type

- Fall from elevation
- Fall on same level
- Struck by vehicle, equipment, load or moving object
- Struck against or bump into
- Caught in, between or under
- Caught on, snagged or hung
- Contact with harmful agent (chemical, biological, radiological, noise, temperature extreme, vibration)
- Ergonomic, overexertion, stress, strain, sprain
- Overpressurization, excessive temperature
- Equipment failure
- Environmental release
- Permit exceedence
- Product or process non-conformity
- Customer/stakeholder complaint, poor project performance rating
- Cost/schedule overrun

ECC Core Values

Service

Prosperity

People

Friendship

Safety

Step 3. Identify the Immediate Cause(s)

Identify those behaviors or conditions that directly resulted in the event or loss.

Substandard Acts or Behaviors	
• Failure to follow established procedure	• Poor body positioning
• Operating equipment without authority	• Using tools or equipment improperly
• Exceeding the boundaries of the task envelope	• Substance abuse or working under influence of prescription medication
• Operating at improper speed	• Inappropriate behavior
• Failure to warn or secure	• Failure to check/monitor
• Failure to control hazardous energy (de-energize, secure, lockout)	• Failure to coordinate work activity
• Making safety devices inoperable (including jumpering interlocks)	• Failure to identify customer/stakeholder expectations
• Using wrong or defective tools or equipment	• Failure to identify and reject non-conforming parts, materials or workmanship
• Poor lifting, pulling, turning technique	

Substandard Conditions	
• Exposure to chemical, physical or biological agents	• Fire or explosion hazard
• Inadequate engineering controls	• Hazardous weather conditions
• Inadequate administrative controls	• Improper maintenance of infrastructure or plant facilities
• Inadequate PPE	• Failure to comply with designs, stakeholder expectations
• Inadequate warning system or barricade	• Inadequate resources on project
• Inadequate site layout or design	• Inadequate identification of regulations, codes, standards, specifications, permits to operate
• Defective tools or equipment	• Inadequate communications equipment, software or process controls
• Congestion/restricted action	
• Housekeeping/disorder	

Step 4. Identification of Root Cause(s)

Identify the system or personal factors that caused or permitted the immediate causes to be present.

System Factors

1. Leadership and Management

- Management commitment
  - to processes, policies and procedures
  - lead by example
- Management involvement
  - in ESQ activities (meetings, inspections, audits)
  - visible leadership
- Supervision
  - employee tasking, direction, follow-up
  - subcontractor oversight
- Line management accountability
- Adequate budgeting
- Assessment of risks and hazards
- Qualifications of supervisors and managers
- Performance evaluations and feedback
- Reporting relationships
- Employee involvement/inclusion in hazard evaluation and decision making

2. Communications and Training

- Training
  - Formal
  - OJT
- Evaluation of training effectiveness
  - Testing
  - Demonstration
  - OJE
- Competency determination
- Communications with client
- Communications with stakeholders
- Communications with employees
- Communications between organizations
- Communications between work groups or shifts
- Communications between individuals
- Communications with subcontractors

3. Project Development and Planning *(Plan)*

- Project Development
  - Understand SOW
  - Understand contract
  - Understand client and stakeholder relationships
  - Understand client and stakeholder expectations
- Risk analysis and management plan
  - PIP
  - Bid analysis
  - Process Safety Reviews
- Identification of codes, standards, specifications, SOPs
- Engineering and task planning
  - Multi-disciplinary, SME involvement
  - Review procedures
  - Value engineering
  - Site layout
  - Work task planning
- Project plans
- AHAs/JSAs
- Submittal process
- Hazardous work permits
- Regulatory permits
- Procurement
  - Subcontractor evaluation and selection
  - Requirements in RFP/SOW
  - Material specifications

4. Project or Work Task Execution *(Do)*

- Implementation of plan/procedure
- Schedule/work sequence
- Tools/equipment/PPE
  - Tools
  - Construction equipment
  - Infrastructure
  - Facilities
  - Process equipment
- Qualified personnel
- Compliance with codes/standards
- Documentation
- Document control
- Incident identification, notification, investigation and reporting

5. Measuring and Monitoring of Work Activities and Products *(Check)*

- Document reviews
- Design reviews
- Readiness reviews
- Four phase process
- Subcontractor oversight
- Exposure monitoring procedures
- Testing
  - Materials
  - Process equipment
  - Alarms and interlocks
  - Commissioning
  - Pilot and bench scale
  - Weights and measures
  - Calibration
- Inspections
  - Tools
  - Equipment
  - PPE
  - Competent person
  - Hazardous work activities
  - Materials receipt
  - Workmanship
  - Superintendent weekly safety
  - PM monthly safety
- Audits
- Customer feedback solicitation
- Employee feedback solicitation
- Internal Project Management Reviews
- Change identification, notification and impact assessment

6. Follow Through and Improvement *(Act/React)*

- Corrective action follow up
- Lessons learned
  - Develop
  - Communicate
  - Consult
  - Implement
- Response to client, user and employee feedback
- Emergency response
- Change management/risk management

Personal Factors

7. Capabilities

- Size, strength, reach
- Pre-existing physical limitations or medical conditions
- Sensory deficiency
- Intelligence
- Aptitude
- Memory
- Emotional disturbance
- Mental illness
- Fears/phobias

8. Stress

- Fatigue due to task load, duration or repetition
- Fatigue due to extended work schedule/ lack of rest
- Boredom
- Sensory overload
- Emotional overload
- Conflicting demands/confusion
- Frustration

9. Knowledge or Skills

- Experience
- Training
- Orientation
- Infrequent activity/lack of practice
- Coaching, evaluation and feedback

10. Motivation

- Convenience – save time or effort
- Improper behavior is approved, allowed, condoned or rewarded
- Proper behavior is ignored or punished by intended or unintended consequences
- Inadequate reinforcement of proper behavior
- Peer pressure
- Inadequate discipline
- Resistance to change

11. Abuse or Misuse

- Intended
- Unintended

Step 5. Corrective Action Plan

Development of an Action Plan to correct the root cause(s). Consider various systems, and whether or not 1) we have a process [P]; 2) our process consists of adequate standards [S]; and 3) whether we have sufficient compliance with our standards [C].

Improvement Action Guide

1. Leadership (P S C)

Core values
Mission
Policies
Balanced score card
Client alignment
Business processes
Visible leadership
Lead by example

2. Management, Supervision, and Employee Involvement (P S C)

Operations management responsibilities and accountability
Project management procedures
Qualified supervision
Adequate resources
Involvement of SMEs
Employee involvement activities
Standard operating procedures

3. Risk Evaluation (P S C)

PIP
Incorporation of PIP/RMP into project plans
Hazard identification and evaluation
Environmental impact assessment
Customers and stakeholders expectations and change probability
Process risk or hazard analysis
Activity hazard analysis

4. Project Development (P S C)

Understanding requirements
Understanding the contract
Estimating procedures
Bid/proposal review procedures
Inclusion of SMEs

5. Planning (P S C)

Understanding requirements
Understanding the contract
Handoff and tasking
Integration of risk management plans
Identification of requirements
Project plans and plan reviews
Client alignment meetings
Kickoff, MUM, pre-construction meetings
Schedule procedures
Engineering design and review procedures
Submittal development and review
Site layout, facility arrangement and task design
Means and methods
Communication of plans and procedures

6. Procurement and Subcontractor Management (P S C)

Subcontractor pre-qualification
RFP/SOW
Materials and equipment specifications
Selection
Integration
Oversight
Evaluation

7. Risk Controls (P S C)

Risk management plans
Standard operating procedures
Quality control system
Engineering controls
Administrative controls
PPE procedures
Permit procedures
Environmental policies, procedures and controls
Process controls
Accident prevention signs, tags and barricades
Hazardous work permits
Preventive maintenance
Rules
Security controls

8. Human Resources (P S C)

Hiring
Placement/assignment
Training
Competency
Evaluation and feedback
Incentive plans
Level of effort requirements and resource allocation

9. Emergency Procedures (P S C)

Analysis
Plans
Communication and training
Drills and tests
Critique and follow-up
Dedicated supplies
Warnings and alarm systems

10. Communications and Promotions (P S C)

ECCONET postings
Meetings
Tailgates
Orientation, new employee and site-specific
Postings
Promotion campaigns

11. Monitoring and Measuring (P S C)

Progress meetings and reporting
Four-phase process
Inspections
Audits and surveillances
Testing
Exposure monitoring
BSC progress reporting
Client feedback solicitation
Employee perception surveys
Hotline and reporting mechanisms
ECCOSLIPS
PMRs

12. Continuous Improvement (P S C)

Incident reporting
Lessons learned
Action item tracking
Client and stakeholder feedback and follow-through
Employee feedback system
Consultation of LL and incident databases
Change management procedures

13. Management Reviews (P S C)

PMR process
Audit tracking
BSC progress monitoring
Client reporting

Never Compromising Safety

Never Compromising Quality

APPENDIX H

SITE SAFETY AND HEALTH PLAN

ADVANCE REVIEW
SITE SAFETY AND HEALTH PLAN

Environmental Remediation Services
U.S. Army Garrison-Redstone

July 2023

Prepared for:

U.S. ARMY ENVIRONMENTAL COMMAND
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Contract No.: W9124J-18-D-0004, Delivery Order W9124J-22-F-045

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SITE SAFETY AND HEALTH PLAN

Site RSA-115_116
Redstone Arsenal
Madison County, Alabama

July 2023

I hereby certify that the enclosed Site Safety and Health Plan, shown and marked in this submittal, is that proposed to be incorporated with Contract Number W9124J-18-D-0004, Delivery Order W9124J0F0014. This Site Safety and Health Plan is in compliance with contract specifications and is submitted for Government approval.

Plan Preparer:

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Attachment 5 Resumes
Attachment 6 COVID-19 Prevention Plan

<	Less than
>	Greater than
%	percent
°C	degrees Celsius
°F	degrees Fahrenheit
Abs	skin absorption
AED	Automated external defibrillator
AHA	Activity Hazard Analysis
ACGIH	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
APP	Action Prevention Plan
APTIM	Aptim Federal Services, LLC
ARBCA	Alabama Risk-Based Corrective Action
bpm	beats per minute
BTEX	benzene, toluene, ethylbenzene and xylene
C	Ceiling Limit
Ca	Carcinogen.
CFR	Code of Federal Regulations
CHMM	Certified Hazardous Material Manager
CIH	Certified Industrial Hygienist
CM	Construction Manager
Con	Skin and/or eye contact
COPC	Contaminants of Potential Concern
COR	Contracting Officer's Representative
CP	Competent Person
CRC	Contamination Reduction Corridor
CRZ	Contamination Reduction Zone
CSP	Certified Safety Professional
dBA	decibels (adjusted)
DCE	Dichloroethene
DFW	Definable Features of Work
DIA	Defense Intelligence Agency
DNT	Dinitrotoluene
DOT	U.S. Department of Transportation
ECC	Environmental Chemical Corporation
EGDN	Ethylene glycol dinitrate
ESQ	Environment, Safety and Quality
EZ	Exclusion Zone
HEMSI	Huntsville Emergency Medical Services Inc.
HGL	HydroGeoLogic, Inc.
IDLH	Immediately Dangerous to Life and Health
IDW	Investigation-derived waste
IOC	Installation Operations Center
Ing	Ingestion
Inh	Inhalation
ISEB	in situ Enhanced Bioremediation
LEL	Lower explosive limit
LTM	Long-Term Monitoring/Long-Term Management
LUC	Land Use Controls
MEC	Munitions and Explosives of Concern
mg/m^3	milligrams per cubic meter

MNA	Monitored Natural Attenuation
MTBE	methyl tert-butyl ether
NA	Not applicable
ND	Not determined
NFA	No Further Action
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NT	Nitrotoluene
O&M	Operations and Maintenance
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic aromatic hydrocarbons
PEL	Permissible Exposure Limit
PETN	Pentaerythritol tetranitrate
PG	Professional Geologist
PM	Project Manager
PMP	Project Management Professional
PPE	Personal Protective Equipment
ppm	parts per million
QC	Quality Control
QCP	Quality Control Plan
QP	Qualified Person
RCRA	Resource Conservation and Recovery Act
RDX	1,3,5-trinitro-1,3,5-triazine
REL	NIOSH Reportable Exposure Limit
RFI	RCRA Facility Investigation
RSA	U.S. Army Garrison, Redstone Arsenal
SAP	Sampling and Analysis Plan
Shaw	Shaw Environmental, Inc.
SHM	Safety and Health Manager
SLERA	Screening-Level Ecological Risk Assessment
SOH	Safety and Occupational Health
SOP	Standard Operating Procedure
SSHO	Site Safety and Health Officer
SSHP	Site Safety and Health Plan
SSHS	Site Safety and Health Supervisor
STEL	Short-term Exposure Limit
SVOC	Semivolatile organic compound
SZ	Support Zone
TCE	Trichloroethene
TLV	Threshold Limit Value
TTZ	Targeted Treatment Zone
TWA	Time Weighted Average
UL	Underwriters Laboratories
U.S.	United States
USAEC	United States Army Environmental Command
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
UXO	Unexploded Ordinance
VOC	Volatile Organic Compound

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1.0 INTRODUCTION

This Site Safety and Health Plan (SSHP) has been prepared by Environmental Chemical Corporation (ECC) under contract number W9124J-18-D-0004, Delivery Order W9124J20F0014 for U.S. Army Environmental Command (USAEC), Fort Sam Houston, Texas, for environmental fieldwork to be conducted at United States (U.S.) Army Garrison Redstone Arsenal (RSA), Madison County, Alabama. Additional health and safety requirements are presented in the Activity Hazard Analysis (AHA) sheets (**Attachment 1**), and ECC's Corporate Health and Safety Standard Operating Procedures (SOP) as identified in this SSHP.

1.1 Redstone Arsenal History and Description

The RSA occupies approximately 38,300 acres in Madison County, Alabama. The RSA is bounded on the north and east by the city of Huntsville, on the west by the city of Madison, on the west and southwest by Wheeler National Wildlife Refuge, and on the south by the Tennessee River. Huntsville has a population of nearly 165,000; Madison County population is about 320,000. Approximately 330 military families reside in government quarters on RSA and approximately 40,000 government employees and contractors work at the facility. The primary mission of RSA is the development, acquisition, testing, fielding, and sustainment of aviation and missile weapon systems. Most of the installation tenants support this effort; however, RSA is also home to such diverse activities as training for handling explosives and ordnance devices, Defense Intelligence Agency (DIA) activities, and the production of iron carbonyl. The RSA is home to over 70 different tenant organizations.

1.2 Site Description and Scope of Work

RSA-115, Inactive East Side Blowdown Lagoon at Test Area 5, and RSA-116, South Side Blowdown Lagoon at Test Area 5, are located in the southern portion of Redstone Arsenal, within groundwater units RSA-156 and RSA-157. RSA-115 consists of an unlined holding lagoon that was used for cooling water discharged during test firing of rocket engines at Test Stand 8877, and RSA-116 consists of a lined holding lagoon that was used for cooling water discharged during test firing of rocket engines at Test Stand 8879. Due to their close proximity and similar historical operations and nature of contamination, a combined SSHP report for both RSA-115 and RSA-116 is considered appropriate and will streamline the review and future corrective measure planning and implementation activities (APTIM 2020a).

The Revision 3 RFI Report for RSA-115 (APTIM 2020a) and the Revision 4 RFI Report for RSA-116 (APTIM 2020b) both recommended no further action for soils and concluded that the nature and extent of contaminated groundwater have been sufficiently delineated to support development of corrective measures for groundwater at the sites.

The corrective measures selected involves the following components:

- Groundwater MNA
- Land Use Controls

The provisions of this plan are mandatory for all contractor and subcontractor onsite personnel engaged in activities at RSA-115_116 and Installation-Wide Groundwater Long-Term Management (LTM). The SSHP will be reviewed upon award of these optional sites to ensure that the provisions of this plan address all hazards. Revisions to the SSHP will be made accordingly if needed. The scope of field services includes Long-Term Monitoring (LTM). The Definable Features of Work (DFWs) addressed in this plan include, but are not limited to:

- Mobilization and site preparation
- Environmental Sampling
- Equipment decontamination
- Monitoring well and borehole abandonment
- Investigation-Derived Waste (IDW) Handling and Storage
- Monitoring well installation and development
- Monitoring Well Gauging, Inspection and Maintenance
- Site reconnaissance and LUC inspections
- Groundwater, surface water, and spring sampling
- Site Land Use Control Inspections
- Site Landfill Cap Repair and Maintenance

If hazards or conditions are identified that are not covered by this SSHP, the Contractor's staff must contact the Project Manager (PM) or the Site Safety and Health Officer (SSHO).

Table 1-1 reviews applicable safety, health, and emergency response requirements for this project.

Table 1-1: Site Safety and Health Plan Requirements

	Applicable to this Project?	**If Required, Location or Reference**
Site Layout and Support Facilities		
Haul road plan	No	
Night operations lighting plan	No	
Public safety requirements	No	
Site layout plans	Yes	SAPs
Site sanitation plan	Yes	APP Attachment 5*
Emergency Preparedness		
Emergency phone numbers	**Yes**	SSHP/**Section 5**
Emergency route to the hospital	**Yes**	SSHP/**Section 5/Attachment 3**
Emergency procedures and tests	**Yes**	SSHP/**Section 5**
Fire protection plan	**Yes**	ECC EHS-SOP-02-09/**Attachment 2B**
Spill plans	**Yes**	SSHP/**Section 5.3**
Wild land fire prevention plan	No	
Man overboard/abandon ship	No	
Severe weather contingency plan for floating plant or marine operations	No	
Emergency rescue (tunneling)	No	
Underground construction fire plan	No	
Hazard Assessment and Control	**Required Yes/no**	**If Required, Location or Reference**
Abrasive blasting plan	No	
Activity Hazard Analyses	**Yes**	AHA list SSHP/**Attachment 1**
Drug free workplace	**Yes**	HR-SOP-1.8
Asbestos abatement plan	No	
Blasting plan	No	
Confined space entry	No	
Compressed air plan	No	

	Applicable to this Project?	If Required, Location or Reference
Critical lift procedures and plans	No	
Demolition plan	No	
Diving plan	No	
Electrical safety	No	
Excavations	No	
Fall protection plan	No	
Formwork and shoring erection and removal plans	No	
Hazard communication program	**Yes**	ECC EHS-SOP-02-10
Hazardous energy control plan	**Yes**	ECC EHS-SOP-04-03
Health hazard control program	**Yes**	SSHP all sections
Lead abatement plan	No	
Jacking and slab plans	No	
Scaffolding	No	
Machinery and mechanized equipment including drilling	**Yes**	ECC EHS-SOP-02-03
Respiratory protection plan	No	
Steel erection plan	No	

Notes:
*– ECC. 2021. *Accident Prevention Plan, Environmental Remediation Services, U.S. Army Garrison- Redstone Arsenal*, June.
AHA – Activity Hazard Analysis
APP – Accident Prevention Plan
ECC – Environmental Chemical Corporation
SAP – Sampling and Analysis Plan
SSHP – Site Safety and Health Plan
SOP – Standard Operating Procedures

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2.0 HAZARD ASSESSMENT

The following section outlines the AHAs, referenced SOPs, chemical, and physical hazards associated with this project. The AHAs outline personnel risk minimization.

Table 2-1 lists ECC's applicable SOPs for this project. AHAs related to the field activities at the site are presented in **Attachment 1**. The AHAs will be reviewed periodically and revised as applicable.

During daily safety tailgate meetings, applicable AHAs will be reviewed with the work crew prior to commencing work. All site visitors will be required to review the daily tailgate safety issues and sign the visitor log. If necessary, the AHAs will be revised for site-specific activities, and reviewed with work crew before commencing any work.

Table 2-1. Referenced Standard Operating Procedures

SOP Number	SOP Title
1.0	Field Documentation
2.0	Collection And Field Screening of Soil Samples
3.0	Field Equipment Decontamination
4.0	Investigation-Derived Waste
7.0	Groundwater Sampling
8.0	Standards for Conducting Well Development
11.0	Field Generated Records Management
12.0	Field Measurable Physical Characteristics
13.0	Field Measurable Chemical Characteristics
15.0	Non-Hazardous Sample Handling, Packaging, and Shipping
16.0	Groundwater Level Measurements
17.0	Monitoring Well Installation
18.0	Surface Water Sampling
19.0	Sediments/Sludge Sampling
20.0	Drilling Unconsolidated Materials
21.0	Monitoring Well And Borehole Abandonment
22.0	Description of Geologic Materials
24.0	Field Equipment Calibration
ECC SOP HS-5.9	Fire Protection Plan
ECC HR-SOP-1.8	Drug Free Workplace
ECC EHS-SOP-02-10	Hazard Communication Program
ECC EHS-SOP-04-03	Hazardous Energy Control Program
ECC EHS-SOP-02-03	Machinery and Mechanized equipment including Drilling

[1] – Program Standard Operating Procedures (SOPs) are included in *Revision 4 - Installation-Wide Quality Assurance Program Plan (IW-QAPP)* for the Program Management Contract (HydroGeoLogic, Inc. [HGL], 2019).

2.1 Chemical Hazards

Based on their historical detections in surface soil, subsurface soil, or groundwater samples collected at RSA-115_116, specific potential contaminants are listed below:

Table 2-2: Site-Related Groundwater Constituents of Concern

RSA-115 Site-Related COCs in Groundwater	RSA-116 Site-Related COCs in Groundwater
Metals	
Aluminum	None
Arsenic	

Vanadium

	Perchlorate
Perchlorate	Perchlorate
	Explosives
1,3-Dinitrobenzene	2-Nitrotoluene
2,6-Dinitrotoluene	3-Nitrotoluene
2-Nitrotoluene	Nitrobenzene
Nitrobenzene	Nitroglycerin
Nitroglycerin	
	VOCs
Benzene	1,1,2,2-Tetrachloroethane
Bromomethane	Trichloroethene
Trichloroethene	
	SVOCs
Benzo(a)anthracene	bis(2-ethylhexyl)phthalate
bis(2-ethylhexyl)phthalate	Naphthalene
Naphthalene	Unsymmetrical dimethyl hydrazine
Pentachlorophenol	
Unsymmetrical dimethyl hydrazine	

Table 2-3 outlines the chemical hazards for sites RSA-115_116, respectively, including Permissible Exposure Limits (PELs) and Threshold Limit Values (TLVs) for the applicable chemicals.

Table 2-3: Toxicological and Physical Properties of Chemicals, RSA-115_116

Chemical	Site	TWA[(a)]	STEL/ C (b)	Source (c)	IDLH (NIOSH) (d)	Route	Symptoms of Exposure
RSA-115_116							
TCE	RSA-115 RSA-116	100 ppm 50 ppm 25 ppm	100 ppm	PEL TLV REL	Ca (1,000 ppm)	Inh, Abs, Ing, Con	Irritation of eyes, skin; headache, vertigo; visual disturbances, fatigue, tremor, nausea, vomiting; dermatitis.
Arsenic	RSA-115	0.01 mg/m^3 0.01 mg/m^3 0.01 mg/m^3	Ca 0.002 mg/m^3	PEL TLV REL	5 mg/m^3	Inh, Ing, Con	Cough, diarrhea, shortness of breath, vomiting, grey skin. Redness.
Aluminum	RSA-115	10 mg/m3 (total) 5 mg/m3 (resp) 15 mg/m3 (total) 5 mg/m3 (resp)	NA	REL REL PEL PEL	N.D.	Inh, Con	irritation eyes, skin, respiratory system
Vanadium	RSA-115	1 mg/m3 ST 3 mg/m3 1 mg/m3	NA	REL PEL	500 mg/m3	Inh, Con	irritation eyes, respiratory system;
Perchlorate	RSA-115 RSA-116	10 mg/m^3 Inhalable particles 3.0 mg/m^3	NA	PEL TLV REL	NA	Inh, Ing, Con, Abs	Local irritation or stinging effect. Chronic ingestion of sufficient quantities may interfere with uptake of iodine

Chemical	Site	TWA[(a)]	STEL/ C (b)	Source (c)	IDLH (NIOSH) (d)	Route	Symptoms of Exposure
		Respirable Particles					by the thyroid which may cause hypothyroidism. Irritation of the eyes will cause stinging effect.
1,3-Dinitrobenzene	RSA-115	1 mg/m^3 1 mg/m^3 1 mg/m^3	NA	PEL TLV REL	50 mg/m^3 (f)	Inh, Abs, Ing, Con	Anoxia, cyanosis; visual disturbance, central scotomas; bad taste, burning mouth, dry throat, thirst; yellowing hair, eyes, skin; anemia; liver damage.
2,6-Dinitrotoluene	RSA-115	1.5 mg/m^3 1.5 mg/m^3 1.5 mg/m^3	NA	PEL TLV REL	200 mg/m^3	Con	headache, irritability, dizziness, weakness, nausea, vomiting, dyspnea, drowsiness, unconsciousness, and possibly death. Repeated or prolonged exposure may cause anemia [potential occupational carcinogen].
2-Nitrotoluene	RSA-115 RSA-116	5 ppm 2 pm 2 ppm	NA	PEL TLV REL	200 ppm	Inh, Abs, Ing, Con	Anoxia, cyanosis; headache, lassitude, dizziness; ataxia; dyspnea; tachycardia; nausea, vomiting.
3-Nitrotoluene	RSA-116	2 ppm (11 mg/m3) [skin] 5 ppm (30 mg/m3) [skin]	NA	REL PEL	200 ppm	Inh, Abs, Ing, Con	Anoxia, cyanosis; headache, lassitude, dizziness; ataxia; dyspnea; tachycardia; nausea, vomiting
Nitrobenzene	RSA-115 RSA-116	1 ppm 1 ppm 1 ppm	NA	PEL TLV REL	200 ppm	Inh, Abs, Ing, Con	irritation eyes, skin; anoxia; dermatitis; anemia; methemoglobinemia.
Nitroglycerin	RSA-115 RSA-116	0.05 ppm 0.05 ppm 0.05 ppm	(C) 0.2 ppm 0.1 (C) 0.2 ppm 0.1 (C) 0.2 ppm 0.1	PEL TLV REL	200 mg/m^3 (e)	Inh, Abs, Ing, Con	throbbing headache; dizziness; nausea, vomiting, abdominal pain; flush; palpitations; delirium; angina; skin irritation.
Benzene	RSA-115	1 ppm 0.5 ppm 0.1 ppm	4 ppm 2.5 ppm 1 ppm	PEL TLV REL	Ca (500 ppm)	Inh, Abs, Ing, Con	Irritated eyes, skin, nose, respiratory system, giddiness, headache, nausea, dermatitis, bone marrow depression.
Bromomethane	RSA-115	C 20 ppm (80 mg/m3) [skin]	NA	PEL	Ca [250 ppm]	Inh, Abs, Con	irritation eyes, skin, respiratory system; muscle weak, incoordination, visual disturbance, dizziness; nausea, vomiting, headache; malaise; hand tremor; convulsions; dyspnea; skin vesiculation;

Chemical	Site	TWA[(a)]	STEL/ C (b)	Source (c)	IDLH (NIOSH) (d)	Route	Symptoms of Exposure
							liquid: frostbite; [potential occupational carcinogen]
1,1,2,2-Tetrachloroethane	RSA-116	5 ppm 1 ppm 1 ppm	NA	PEL TLV REL	Ca (100 ppm)	Inh, Abs, Ing, Con	Nausea, vomiting, abdominal pain; tremor fingers; jaundice, hepatitis, dermatitis; kidney damage; [potential occupational carcinogen].
Benzo(a)anthracene	RSA-115	0.2 mg/m^3 Ca 0.1 mg/m^3	NA	PEL TLV REL	Ca (80mg/m^3)	Inh, Con	Dermatitis, bronchitis [potential occupational carcinogen].
bis(2-ethylhexyl)phthalate	RSA-115 RSA-116	5 mg/m^3 5 mg/m^3	10 mg/m^3	REL, PEL	Ca [5000 mg/m^3]	Inh, Ing, Con	irritation eyes, mucous membrane; In Animals: liver damage; teratogenic effects; [potential occupational carcinogen]
Naphthalene	RSA-115 RSA-116	50 mg/m^3 50 mg/m^3	75 mg/m^3	REL, PEL	250 ppm	Inh, Abs, Ing, Con	irritation eyes; headache, confusion, excitement, malaise (vague feeling of discomfort); nausea, vomiting, abdominal pain; irritation bladder; profuse sweating; jaundice; hematuria (blood in the urine), renal shutdown; dermatitis, optical neuritis, corneal damage
Pentachlorophenol	RSA-115	0.5 mg/m3 [skin] 0.5 mg/m3 [skin]	NA	REL PEL	2.5 mg/m3	Inh, Abs, Ing, Con	irritation eyes, nose, throat; sneezing, cough; lassitude, anorexia, weight loss; sweating; headache, dizziness; nausea, vomiting; dyspnea, chest pain; high fever; dermatitis

Notes:
(a) The TWA concentration for a normal workday (usually eight or 10 hours) and a 40-hour work week, to which nearly all workers may be repeatedly exposed, day after day without adverse effect.
(b) STEL. A 15-minute TWA exposure that should not be exceeded at any time during a workday, even if the TWA is not exceeded.
(c) Occupational Safety and Health Administration (OSHA) PEL (29 Code of Federal Regulations [CFR] 1910.1000, Table Z).
(d) IDLH (NIOSH)— Represents the maximum concentration from which, in the event of respirator failure, one could escape within 30 minutes without a respirator and without experiencing any escape-impairing or irreversible health effects.
(e) Exposure limits are based on coal tar pitch.

% – percent
Abs – skin absorption
ACGIH - American Conference of Governmental Industrial Hygiene
C – Ceiling limit value which should not be exceeded at any time.
Ca – Carcinogen
Con – skin and/or eye contact
DCE - dichloroethene
DNT – dinitrotoluene
IDLH - Immediately Dangerous to Life and Health
Inh – inhalation
Ing – ingestion
LEL – lower explosive limit
mg/m^3 – milligrams per cubic meter
NA – Not applicable
ND – Not determined
NIOSH – National Institute for Occupational Safety and Health
NT – Nitrotoluene
PEL – Permissible Exposure Limit
PETN - pentaerythritol tetranitrate
ppm – parts per million
RDX – 1,3,5-trinitro-1,3,5-triazine
REL – NIOSH Reportable Exposure Limit
STEL – Short Term Exposure Limit
TCE – trichloroethene
TLV – Threshold Limit Value
TNT – Trinitrotoluene
TWA – Time-Weighted Average

2.2 Special Medical Monitoring

Employees on this project whose work involves potential exposure to site contaminants will be included in the medical surveillance program.

Personnel will have a current medical exam clearance (physician's written opinion) in accordance with Occupational Safety and Health Administration (OSHA) standards prior to entering regulated work areas in accordance with 29 Code of Federal Regulations (CFR) 1910.120. ECC uses the services of WorkCare, whose principal is Dr. Peter Greaney, a Board-Certified Occupational Physician to review all exams and provide the clearances, which include an assessment of employee ability to wear respiratory protection and Personal Protective Equipment (PPE) safely. Complete results of everyone's medical examination results are maintained by the medical provider and will not to be kept on-site. The SSHO will ensure appropriate subcontractor's medical screenings are completed, documented, and the physician's written opinions are available at the work site.

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3.0 PERSONAL PROTECTIVE EQUIPMENT

Unless otherwise approved by the SSHO, all activities will include at least American National Standards Institute (ANSI)-approved hard hats, safety-toe footwear, safety glasses with side impact protection and high visibility garments. **Table 3-1** summarizes the PPE anticipated during performance field activities.

Table 3-1. Personal Protective Equipment Selection

Activity	Respiratory Protection	Body Protection*	Hand Protection	Eye/Face/Other Protection	Hearing Protection	Fall Protection
Mobilization, Site Inspection and Site Preparation	NA	Level D	Leather palm work gloves; cut resistant gloves if sharp objects, cutting devices, or sharp edges are present	Safety glasses	Plugs or muffs if necessary, based on equipment use, where noise levels exceed 85 dBA	NA
Environmental Sampling		Modified Level D[(a)]	Leather or cut resistant gloves when cutting plastic tubes/ nitrile gloves when sampling	Safety glasses; for splash hazards, face shield with safety glasses or goggles		
Well Installation, Maintenance, and Abandonment			Nitrile or Leather palm work gloves	Safety glasses		
ISEB injection			Nitrile or Leather palm work gloves; adhere to manufacturer requirements for PPE specified in the SDS.			
Equipment Decontamination, Demobilization and Site Restoration[(b)]			Nitrile or Leather palm work gloves	Safety glasses and face shield and apron (if necessary, for equipment decon)		

Notes:

a) A face shield with safety glasses or goggles shall be used during activities where a splash hazard exists. Wear permethrin treated gaiters when in grassy areas.

b) If direct contact with soils, boot covers/ over boots and Tyvek® may be required. Site Safety and Health Officer (SSHO) will determine when boot covers and Tyvek ® are needed

* - Level D body protection includes high visibility Class II garment.

dBA – decibels (adjusted)
NA – Not applicable
ISEB – In-Situ Enhanced Bioremediation
PPE – Personal Protective Equipment
SDS – Safety Data Sheet

3.1 Use and Limitations

Read and follow all manufacturer instructions regarding product use and limitations.

- ***Body protection*** – Wear normal work clothing including high visibility Class II garment. During soil disc and raking and excavation activities, boot covers /over boots and Tyvek ® may be required. The SSHO will determine when these over garments are required.
- ***Hand protection*** – Use gloves described in **Table 3-1**. Chemical protective gloves are meant for incidental contact. Change gloves in the event of immersion unless specifically selected for that purpose. Inspect frequently and change gloves on signs of contamination, and when protection is compromised by wear and tear.
- ***Eye/face protection*** – Wear protection prescribed in **Table 3-1**. Discard when protection is scratched or worn impacting visibility. If face shields are worn for chemical splash, also wear splash goggles underneath. Safety glasses will be worn under face shields for impact protection and under welding helmets. Lens shade will be selected based on hazard, following SOP Environment, Safety and Quality (ESQ)-6.1 (Task Instruction 6.1.02)
- ***Hearing Protection*** – Wear hearing protective devices in accordance with manufacturers' instructions, including fitting and insertion. Use of specific devices will be limited to exposures within the noise reduction ratings.

- ***Fall Protection*** – For the activities covered by this SSHP, fall protection is not anticipated; however, if it becomes necessary, the Safety and Health Manager (SHM) will prepare a site-specific fall protection plan and submit it to the Contracting Officer's Representative (COR) for acceptance before proceeding.

3.2 Work Mission Duration

Work mission durations will be limited to accommodate acceptable service life of the PPE.

Where PPE may cause a hazard, such as heat stress, work mission duration will be determined in the AHA by the SSHO with the assistance of the SHM. Employees must exit the Exclusion Zone (EZ) for rest or monitoring in accordance with the established schedule.

3.3 Personal Protective Equipment Maintenance and Storage

It is important that all PPE be kept clean and properly maintained. Cleaning is particularly important for eye and face protection where dirty or fogged lenses could impair vision. Employees must inspect, clean, and maintain their PPE according to the manufacturers' instructions before and after each use. Supervisors are responsible for ensuring that users properly maintain their PPE in good condition.

Personal protective equipment must not be shared between employees until it has been properly cleaned and sanitized. PPE will be distributed for individual use whenever possible. Where employees provide their own protective equipment, ECC will be responsible for assuring its adequacy, including proper maintenance, and sanitation of such equipment.

3.4 Personal Protective Equipment Decontamination and Disposal

It is anticipated that most of the PPE utilized on the project, beyond the basic PPE elements (hard hat, safety glasses, steel-toed boots, leather gloves), will be of a disposable nature (nitrile or other chemical gloves, ear plugs, boot covers, and Tyvek®). Contaminated PPE will be collected in a dedicated container and disposed of appropriately at a suitable facility. Based on the contaminants present and their concentrations it is anticipated that disposable PPE will be disposed of as non-hazardous waste.

Earmuffs, safety glasses, and other non-disposable forms of PPE will be routinely wiped clean of any visible contamination after each use.

3.5 Personal Protective Equipment Training and Proper Fitting

Users will be trained on the selection, use and limitations of PPE. Each affected employee will demonstrate an understanding of the training specified in this section, and the ability to use PPE properly, before being allowed to perform work requiring the use of PPE.

Should ECC have reason to believe that any affected employee who has already been trained does not have the understanding and skill required of this section, the employer will retrain that employee.

Gloves, head gear, coveralls, and footwear must fit properly to avoid tripping and snagging hazards, or constriction and tearing. Hearing protection will be checked by the user and SSHO for proper fit and must be inserted/worn in accordance with manufacturer instructions.

3.6 Personal Protective Equipment Donning and Doffing Procedures

The SSHO will train on and demonstrate proper donning and doffing procedures for PPE ensembles worn in EZs during site orientation.

3.7 Personal Protective Equipment Inspection Procedures

Each person who is required to wear PPE will inspect their equipment prior to, during, and after each use. Defective or damaged equipment will not be used. Heavily contaminated PPE that cannot be adequately cleaned will be discarded. Stored PPE will be inspected every month to ensure that it has not been damaged and is suitable for use. Workers who wear PPE in the field will take note of the condition of the PPE worn by their co-workers and inform them of any apparent problems, such as missing equipment, tears in protective clothing, excessive contamination, improper use of PPE, inadequate PPE, etc.

3.8 Evaluation of Effectiveness of PPE Program

The SSHO will inspect the jobsite each day and as frequently as necessary to ensure that PPE has been properly selected and is being used as designed. The SSHO will also inspect PPE stored for emergency use every month. Similar PPE inspections will be conducted by ECC's SHM during scheduled visits of the project site.

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4.0 CONTAMINATION CONTROL, SANITATION AND WASTE MANAGEMENT

The following sections describe the contamination control during the field activities.

4.1 Work Zones

Access to the sites are limited to authorized project personnel, approved subcontractors and their employees, and local/State/Federal agency staff escorted by site personnel.

For the purposes of Work Zone Delineation, the site perimeters will encompass an area slightly larger than the portion of the site identified for activities. The perimeter of the sites will be properly delineated (caution tape or high visibility fencing).

4.1.1 Support Zone

The Support Zone (SZ) is located outside the Contamination Reduction Zone (CRZ) and within the site perimeter. The support zone is an uncontaminated (clean) area where personnel will not be exposed to hazardous materials or contaminants.

4.1.2 Contamination Reduction Zone

The CRZ is located in between and serves as a buffer between the SZ and the EZ. The CRZ is intended to prevent the spread of contamination and is utilized for both personnel and equipment decontamination.

4.1.3 Exclusion Zone

The EZ is the work area where, based on planned activities, there is potential for worker exposure to site contaminants. The EZ is bounded by the CRZ and accessed only through the Contamination Reduction Corridor (CRC). The EZ perimeter will be delineated with caution tape or high visibility fencing.

4.2 Access Controls

The SSHO and Site Superintendent will establish the physical boundaries of each zone and instruct all workers and visitors on the limits of the restricted areas. No one will be allowed to enter the restricted area without the required PPE for that area. The Site Superintendent will ensure compliance with all restricted area entry and exit procedures. The Site Superintendent will also designate a decontamination point for personnel to exit the contaminated area and to enter the clean area, which is where personnel may eat and rest.

All site personnel and/or visitors entering and exiting the EZ or the CRZ will be required to log-in/log-out from the site on a daily basis. The log will be maintained at the entrance.

4.3 Hazard Briefing

No person will be allowed on the site during site operations without first participating in a hazard briefing. In general, the briefing will consist of a review of the SSHP and the tailgate safety meeting. All persons on the site, including visitors, must sign the SSHP Acknowledgment Sheet and Daily Safety Meeting Form which is included in **Attachment 1.** Tailgate safety meetings will be held daily before site activities begin.

4.4 Visitor Access

The following section describes how to handle visitors to the site.

4.4.1 Approach

If unannounced visitors arrive at a site, ECC employees should approach them, introduce themselves, and respectfully ask the visitors to identify themselves and state their business. An effort should be made to distinguish between ECC workers and subcontractors and people for whom ECC is not responsible for enforcing health and safety rules on job sites, such as client representatives, agency representatives, and other visitors authorized by the client. For example, hardhats and safety glasses may be a requirement in the SZ or anywhere on the site for workers, but to enforce this requirement on all visitors may not be necessary. A respectful explanation of what areas to avoid may be all that is necessary.

4.4.2 Unauthorized Visitors

If visitors are unauthorized, ECC employees should explain to the visitors that entry to the site is restricted because the site contains hazards. The site boundaries and any other relevant restrictions should be pointed out to the visitors.

4.4.3 Visitors Authorized to View the Site from the Support Zone

If visitors are authorized by the client to see the site from the SZ, ECC employees should do the following:

- Review the tailgate safety meeting form with them and ask them to sign it.
- Provide the visitors with hardhats, safety glasses, and safety vests, if applicable; and,
- Prohibit entry to the EZ.

4.4.4 Visitors Authorized to Enter the Exclusion Zone During Ongoing Work Activities

If the visitors are authorized by the client to enter the EZ, ECC employees should do the following:

- Verify that they have current Hazardous Waste Operations and Emergency Response (HAZWOPER) training.
- Verify that they had a current physical exam authorizing work on hazardous waste sites.
- Review the SSHP and the tailgate safety meeting form and have the visitors sign the acknowledgement forms of all documents.
- Provide the PPE required for the site; and,
- Escort the visitor while in the EZ.

4.4.5 Refusal

If visitors refuse to comply with any one of the requirements listed in the previous sections, and the **client authorizes** the visitor to enter the EZ anyway, ECC will **shut down** any potentially hazardous equipment and take all practicable steps to eliminate other hazards and exposures. The event will be thoroughly documented.

Visitors who refuse to comply and are not authorized by the client should be asked to leave. Contact the local police if problems occur with visitors who refuse to leave.

4.5 Emergency Entry and Exit

People who will enter the site on an emergency basis will be briefed by the Site Superintendent regarding the hazards. All hazardous activities will cease in the event of an emergency. **Attachment 2A** provides more information for emergency procedures.

4.6 Personal Hygiene and Decontamination Procedures

The importance of good hygiene practices will be emphasized with all site workers. Upon exiting the EZ and CRZ, workers and/or site visitors will enter the CRZ and carefully remove all designated PPE, wash their hands, face, and forearms prior to eating, drinking, or smoking. Smoking, eating and drinking will only be allowed in clean work areas (i.e., SZ).

4.7 Equipment Decontamination Procedures

Heavy equipment will be decontaminated using dry methods, a pressure washer, and/or equivalent. Hand tools and smaller equipment will be decontaminated using a non-phosphate detergent scrub, followed by fresh water, and distilled or deionized water rinses. Prior to removal from site, decontaminated equipment and material will be inspected and accepted by the SSHO and the Site Superintendent.

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5.0 EMERGENCY PLANNING

Prior to the commencement of work, the Site Safety and Health Supervisor (SSHS) will contact potential emergency response personnel and will serve as the main point of contact of any on-site emergency. Additionally, field staff will be familiar with emergency condition identification, notification, and response procedures. Emergency response training shall be a part of the initial SSHP pre-work training required of all employees. Additional discussions or refreshers shall take place periodically throughout the project as part of the daily tailgate safety meetings.

The emergency telephone numbers for local emergency response and reporting organizations are provided in **Table 5-1**. Key personnel will have a copy of this table readily available at all times. The Emergency Action Plan and The Fire Protection and Prevention Plan are provided in **Attachments 2A and 2B, respectively)**. Directions to the nearest hospital from the site are provided below and a map is provided in **Attachment 3.** The SSHS will review emergency procedures and/or applicable site contingencies during the initial tailgate safety meeting with site personnel. Off-site emergency personnel will ultimately handle on-site emergencies. Initial response and first aid treatment, however, will be provided on-site. First aid kits, portable eyewash units, and fire extinguishers will be maintained on-site in accordance with ANSI.

The following lists the emergency call list and the project organization. This table must be available to the crew at all time. In case of an emergency, the crew must be transported to the designated medical center.

Table 5-1. Emergency Call List

Name/Organization	Phone Number
Fire Department (ask for Redstone Arsenal [RSA] Fire Department)	911
Fire Department (from cellular phone)	256-876-2117
Ambulance (Huntsville Emergency Medical Services Inc.[HEMSI])	911
Installation Emergency Operations Center (non-911 emergencies)	256-313-1043
Military Police	256-876-2222
Huntsville Hospital (Emergency Room)	256-265-8144
Huntsville Hospital (Trauma Center)	256-265-8137
Chemical Agent Emergencies (state that you are at Redstone)	911
Unexploded Ordnance (UXO) Emergencies (state that you are at Redstone)	911
Installation Operations Center (IOC)	256-313-1043
Garrison Safety Office • Michael Moore, Safety Manger • Michael Moore, Safety Manager (DSN) • Keith Coates, Safety & Occupational Health Specialist • Bobby Taylor, Safety & Occupational Health Specialist • Jonathan Niedergeses (Munitions and Explosives of Concern [MEC] Support)	256-876-2944 256-313-3297 256-897-3297 256-876-3383 256-313-3294 256-876-6027
Primary Site Emergency Contact, Matt Berry, Site Manager, RSA	601-278-4390
Clint Howard, U.S. Army Garrison, Chief Installation Restoration Branch	256-758-7084 (cellular) 256-842-3702 (office)
National Response Center	80-424-8802
Poison Control Center	800-222-1222
United States Environmental Protection Agency (USEPA) Region IV	404-347-3931
Pam Foti, ECC Project Manager	508-274-3084 (cellular) 865-288-0357 (office)
Kym Edelmen, ECC Corporate Safety Director	757-435-5384 (cellular)
Aaron Glad, Site Manager and ECC Site Safety and Health Officer (SSHO)	256-452-986
ECC Hot Line (ECC incident reporting)	650-347-7512 Ext 111

Note: KEY PROJECT/FIELD PERSONNEL ARE TO HAVE A COPY OF THIS LIST READILY AVAILABLE AT ALL TIMES.

5.1 Emergency Conditions

Fire, a medical emergency, a spill, severe weather, criminal or terrorist activity, incidents, accidents, injuries, and mishaps are the conditions that may lead to an emergency situation.

5.2 Evacuation and Rally Points

The SSHS will review procedures during the first tailgate safety meeting. Topics will include conditions leading to an emergency, location of rally point, contact numbers, and head counts. At least two of the Contractor's employees on-site will be trained/certified in First Aid/Cardio-Pulmonary Resuscitation/Bloodborne Pathogen Program.

5.3 Spill or Release Potential

In case of release or spill (i.e., fuel from associated with motorized equipment, the following is needed to prevent the release or spill of spreading:

- Non-combustible absorbent pillows or pads or speedi-dri;
- U.S. Department of Transportation (DOT)-approved 55-gallon drums
- Shovels; and
- Appropriate Personal Protective Equipment (PPE).

Water and/or sludge generated from spills will be transferred to DOT-approved 55-gallon drums.

5.4 Directions to Hospital

In case of a medical emergency, the closet hospital is Huntsville Hospital located at 101 Sivley Road SW, Huntsville, Alabama 35801 Driving directions from Main Gate No. 9 – Visitors Center, are given below:

Leaving from Main Gate N0. 9 – Visitors Center – Redstone Arsenal

Instructions: 6.2 miles – 11 minutes

1. Take Redstone Gateway SW to Rideout Road 2 min (0.2 miles)
2. Use the left 3 lanes to turn left onto Rideout Road (0.3 miles)
3. Use the right lane to take the ramp onto I-565 E (2.8 miles)
4. Use the right 2 lanes to take exit 17B for AL-53 S toward Governors Dr (0.5 miles)
5. Continue onto AL-53 S/Governors Dr SW - *Continue to follow Governors Dr SW, pass by AutoZone Auto Parts (on the right in 0.2 miles)* (2.2 miles)
6. Turn left 85 feet
7. Turn right 315 feet
8. 11. Turn left 420 feet
9. Huntsville Hospital will be on the left.

A hospital map with directions from each site is included in **Attachment 3**.

5.5 Heat Stress/Cold Stress

See **Attachments 4A** and **4B**.

5.6 Rescue Plan(s)

The SSHS will prepare a Rescue Plan(s) and present the Rescue Plan(s) to the crew, if the field crew will be working under any of the following situations:

- Geographically remote sites;
- Elevated positions;
- Using personal fall arrest systems;
- Confined spaces; and/or
- Atmospheres considered potentially Immediately Dangerous to Life and Health (IDLH).

None of these conditions are anticipated for the field activities at the site.

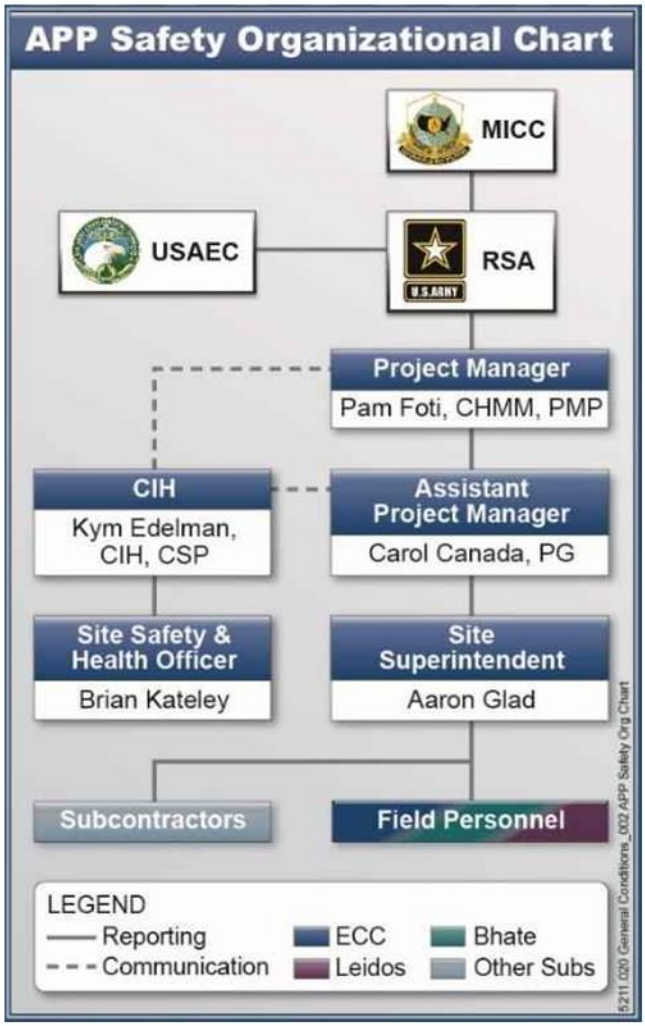
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6.0 ORGANIZATION, RESPONSIBILITIES, AND LINES OF AUTHORITY

ECC and its subcontractors are responsible for implementing this SSHP. Personnel responsibilities for project safety and the lines of authority of these safety personnel are described below. Refer to **Figure 6-1** for the project safety organization. Resumes of the SHM and SSHO are provided in **Attachment 5.**

ECC, as the prime contractor, is the "controlling authority" for all work site safety and health of the subcontractors. ECC is responsible for informing their subcontractors of the safety provisions under the terms of the contract and the penalties for noncompliance, coordinating the work to prevent one craft from interfering with or creating hazardous working conditions for other crafts, and inspecting subcontractor operations to ensure that accident prevention responsibilities are being carried out.

Figure 6-1: Safety Organization



6.1 Health and Safety Responsibilities

The following sections describe the key personnel involved in this project and their responsibilities. To achieve the goals of the SSHP, each individual must fulfill their responsibilities and comply with the health and safety requirements. Failure to do so could result in removal from the site.

No work will be conducted on the site without the presence of the Site Safety and Health Officer (SSHO) or designated CP. Pre-task analysis (AHA, daily tailgate, Job Safety Analysis) will be conducted prior to doing work.

6.1.1 ECC Project Manager

Reports through Program Director to the Chief Operating Officer.

The PM, Ms. Pam Foti, Certified Hazardous Material Manager (CHMM), Project Management Professional (PMP), represents ECC in all aspects of work under the contract and is responsible for the following:

- Providing leadership by setting an example for all site personnel through actions and words regarding the importance of proper health and safety practices and holding project staff accountable for safety performance.
- Ensuring adequate resources are available to implement the SSHP.
- Ensuring that subcontractor Statements of Work include appropriate safety provisions and expectations.
- Ensuring that mishaps are properly reported to the Army and ECC's ESQ reporting network.
- Notifying the SHM of any changes in the SOW or site conditions.
- Ensuring that the SSHP is updated to address new hazards.

6.1.2 ECC Safety and Health manager

Reports to the Vice President of Operations.

The SHM, Ms. Kym Edelman, Certified Industrial Hygienist (CIH), Certified Safety Professional (CSP) will oversee the overall project health and safety structure and implementation and is responsible for the following:

- Reviewing and signing the SSHP prior to submittal and approving any modifications.
- Developing and/or reviewing AHAs prepared for the project.
- Approving the appointment of the SSHO and ensuring that the SSHO has the appropriate training and competencies to perform all expected duties.
- Being available on a 24-hour basis for consultation with the SSHO during on-site emergencies or as needed.
- Providing on-site consultation as needed to ensure the SSHP is fully implemented.
- Conducting general safety inspections during site visits and at least once per quarter.
- Participating in the investigation of mishaps.
- Evaluating air monitoring data and recommending changes to engineering controls, work practices, and PPE.
- Assisting in development of on-site training, which will be provided by the SSHO.

6.1.3 Site Safety and Health Officer

Reports to the PM and SHM.

The SSHO, Mr. Brian Kateley, implements the task-specific SSHP. In accordance with United States Armh Corps of Engineers (USACE) EM 385-1-1, the SSHO must have completed the 30-hour OSHA Construction Safety course, the 30-hour General Industry Safety course, or an equivalent course meeting

the 30-hour training objectives; eight hours of safety and health coursework every year; and at least five years of experience in construction or general industry safety or four years of experience plus a third party, nationally accredited Safety and Occupational Health (SOH) certification.

The SSHO will be responsible for:

- Serving as the general site Competent Person (CP) for safety and health (EM 385-1-1 01.A.17 and 29 CFR 1926.20(b) (2)). No work will be done unless the SSHO or a suitable CP is on site.
- Overseeing compliance with the SSHP procedures and OSHA regulations through informal daily inspections.
- Developing (or assisting subcontractors with the development of) project-specific AHAs before work begins.
- Reporting to the site on a full-time basis for the duration of field activities.
- Serving as a member of the Quality Control (QC) staff on matters relating to safety and health.
- Stopping work if unacceptable safety and health conditions exist and taking necessary action to re-establish and maintain safe working conditions.
- Consulting and coordinating modifications to the SSHP with the SHM, ECC PM, and designated U.S. Army representative.
- Ensuring all site personnel and visitors are properly trained in site hazards.
- Ensuring all employees and subcontractors are properly trained on the SSHP /AHAs and implement the SSHP.
- Conducting air monitoring and preparing air monitoring reports.
- Conducting site safety surveys and maintaining deficiency logs.
- Ensuring accidents are reported, investigated, and corrective actions are implemented.
- Monitoring decontamination methods to determine effectiveness.
- Ensuring proper training on PPE usage and monitoring the effectiveness of the PPE program.
- Maintaining all required safety and health records (e.g., OSHA 300 Logs, incident/accident reports, training certificates and qualifications, equipment checklists, safety plans, air monitoring data and reports) throughout the life of the project.

6.1.4 Site Superintendent

Reports to the PM.

The Site Superintendent, Mr. Aaron Glad**,** is responsible for:

- Setting an example for all site personnel through actions and words regarding the importance of proper health and safety practices on the job.
- Assisting in the development of AHAs before beginning work.
- Communicating daily work plans and schedules with the SSHO.
- Monitoring overall safety performance of field personnel.
- Conducting a weekly general safety inspection of the site, when needed.
- Enforcing safety rules and correcting work practices or conditions that may result in injury or hazard exposure.
- Immediately stopping site operations in emergencies or serious hazard exposure.

- Participating in mishap investigations.
- Ensuring proper equipment is provided, utilized, and maintained in accordance with manufacturer recommendations.

6.1.5 Field Personnel

Reports to the SSHO, Site Superintendent, or CP.

Field personnel are responsible for understanding and abiding by the SSHP and performing work in a safe and responsible manner. Specific responsibilities include the following:

- Acting in a responsible manner at all times in order to prevent incidents, injury, and exposure to themselves and co-workers.
- Reporting all incidents, including near misses, and hazards to the SSHO.
- Attending and participating in all health and safety tailgate meetings.
- Following the instructions and directions of the SSHO, Site Superintendent, and/or CP.
- Utilizing the PPE provided.
- Following all field safety procedures for safe work practices.
- Performing tasks as instructed (unless the individual feels unqualified to perform the tasks safely).
- Conducting work in a manner compliant with the SSHP and AHAs.
- Reporting any personal condition that could affect their safety and/or the safety of coworkers (e.g., fatigue, drowsiness, illness, impairment by medications, influence by drugs or alcohol, emotional stress).

6.1.6 Subcontractors

Report to the SSHO or CP.

Subcontractors who perform work for ECC under this SSHP are responsible for the health and safety of their employees. The presence of an SSHO and the implementation of the SSHP do not relieve subcontractors of their responsibilities as employers. Specific responsibilities of subcontractors include:

- Complying with the requirements of their SOW.
- Development of AHAs for their work activities.
- Maintaining a safe and healthy work environment.
- Complying with contract requirements, laws, regulations, and EM 385-1-1.
- Reviewing the SSHP to ensure that the health and safety requirements of their specific tasks are satisfied.
- Performing all work in accordance with the SSHP requirements.
- Providing trained and experienced workers for the specific work activities.
- Participating in the Safety Tailgate Meetings.
- Identifying additional training needs for unique tasks.
- Reporting all incidents and participating in the investigations.
- Participating in routine site inspection activities.

- Ensuring all equipment brought to the site is in a "new or like new" condition, routinely inspected, and maintained in safe working order.
- Setting a positive safety example for all project staff.

6.1.7 Site Visitors

Site visitors will be responsible for the following:

- Participating in a site briefing before leaving the administrative office or site entry point.
- Following all site rules and instructions.
- Being escorted at all times unless otherwise approved by the SSHO.
- Wearing appropriate PPE.

6.2 Lines of Authority

ECC as the prime contractor is responsible for the implementation of the SOH Program as described in this SSHP and attachments. ECC will enforce compliance with the program requirements among our own employees, subcontractors and all others on the worksite.

The SSHO has a technical and administrative reporting relationship to the SHM who reports directly to ECC's President and Chief and Executive Officer. The reporting relationship provides for access to safety and health expertise as well as an independent reporting and line of communication. The SSHO has a functional reporting relationship to the PM, providing the PM and team with a resource for safety and health support for the project.

During field event, an SSHO or CP will perform daily and weekly health and safety inspections and provide general support to the PM for health and safety issues.

6.3 Competent Persons

The SSHO serves as the general CP, per EM 385-1-1 01.A.17 and 29 CFR 1926.20(b)(2). The qualifications of the SSHOs are included in **Attachment 5**.

CPs for specific activities will be designated in the AHAs for those activities, and their qualifications will be submitted and accepted with the AHA at the Preparatory Meeting.

No work will be performed unless a designated CP/SSHO is present at the job site.

6.4 Disciplinary Procedures

All employees are required to comply with APP and SSHP policies and procedures. Discipline will be in accordance with the Disciplinary Procedure described in the ECC Employee Handbook, which allows for immediate termination for serious infractions. ECC expects that all subcontractors will exercise proper discipline or terminate its employees at its sole discretion when justified. ECC retains the right to deny access to the site to any individual not compliant with safety requirements, in accordance with our subcontract agreement.

6.5 Manager and Supervisor Accountability

ECC managers and supervisors are accountable for providing a safe work environment through proper staffing, training, equipment availability, and by setting a leadership example for safety. Annual performance reviews for managers and supervisors include assessments of project safety performance as well as the individual's demonstrated attitude toward safety.

7.0 TRAINING

All ECC and subcontractor project personnel will have the training and certifications required to complete environmental remediation at RSA.

7.1 Project Meetings and Training Requirements

The training listed in **Table 7-1** will be provided to project personnel as noted. In addition to the topics listed below, the SSHO (in cooperation with the assistant SSHO), may identify additional topics and work tasks to be included in the training requirements. These special requirements may be noted on Project AHAs requiring additional training. All required training will be documented, and this documentation will be maintained on site.

Table 7-1: Project Meetings and Training Requirements

Topic	Description	Trainer	When Conducted	Personnel
General Training				
New Employee Indoctrination	Responsibilities for accident prevention; general SOH policies and procedures; reporting of mishaps; medical facilities and emergency response procedures; reporting of unsafe conditions and practices; job hazards and controls; other specific training as required.	SHM, SSHO, or other authorized by SHM	Before beginning field work	All new hires, and employees new to the project site.
APP/ SSHP	Review of APP/ SSHP requirements during site orientation.	SSHO	Before beginning field work	All project personnel
AHAs	Activity-specific hazards, controls, and training requirements for a specific phase or activity.	SSHO or designated CP	Before beginning specific tasks	Workers, supervisors, and oversight personnel engaged in the activity
HAZWOPER – General Training	40-Hour OSHA HAZWOPER initial training for general site employees, and three days of supervised on-the-job training for site workers.	HAZWOPER sites	Before beginning field work	Workers, supervisors, and oversight personnel working on-site who must enter the EZ or whose work exposes them to health or safety hazards related to hazardous waste or contaminated media.
HAZWOPER Supervisor Training	Eight-Hours of training for supervising activities on hazardous waste sites.	HAZWOPER sites	Before beginning field work	Supervisors at HAZWOPER sites
Respiratory Protection	In accordance with 29 CFR 1910.134	SHM, SSHO, or other authorized by SHM; by Subcontractor CP	Before use of respiratory protection	Employees engaged in operations requiring use of respirators
HAZWOPER Refresher	Eight-Hours of annual refresher training for workers on hazardous waste sites.	HAZWOPER sites or SHM	Before beginning field work	Workers, supervisors, and oversight personnel working on-site who must enter the EZ or whose work exposes them to health or safety hazards related to hazardous waste or contaminated media.
Emergency Action Plan	Roles, responsibilities, recognition of emergency conditions, reporting and notification, evacuation, and other procedures.	SSHO	Before beginning field work	All project personnel, with detailed information on procedures for workers with special responsibilities
Hazard Communication	Requirements for SDSs and labels; hazards of site materials and controls; signs and symptoms of exposure; location of and access to Hazardous Materials and their SDSs.	SSHO	Before beginning field work	All project personnel potentially exposed to hazardous materials

Topic	Description	Trainer	When Conducted	Personnel
Fire Protection and Prevention	Requirements of the Fire Protection and Prevention Plan, general education on selection, distribution, and proper use of fire extinguishers.	SSHO	Before beginning field work as necessary to document training	All project personnel. Fire extinguisher use for personnel designated as Fire Watch (other personnel as deemed necessary)
OSHA 30-hour construction or equivalent	Common hazards, controls, and OSHA requirements for construction activities.	Authorized OSHA Trainer	Prior to beginning field work	SSHO
Daily Safety Briefing	Review of Plan-of-the-Day and daily hazards; presentation of a specific topic; refresher training on various issues; and changes in hazards, controls, or procedures.	SSHO, Site Superintendent, CP	Daily, prior to work	All field workers, and field oversight personnel
Weekly safety Meeting	Incidents, modification to SSHP , upcoming work, new hazards, etc.	SSHO, CP	Weekly	All field personnel and field oversight personnel
Special Training				
First Aid/CPR	Principles and techniques for First Aid and CPR.	Red Cross, American Heart Association, or other authorized provider	Prior to beginning field work	At least two project personnel (SSHO, and other field personnel)
Fall protection	Fall (from elevation) hazards, fall protection techniques, proper use of personal fall arrest systems and rescue procedures.	SSHO, other qualified instructors	Prior to work at elevation	Task-specific, workers exposed to fall hazards
Lockout/tagout	Site-specific energy control and verification procedures.	SSHO, other qualified instructors	Prior to utilization of Lockout/tagout procedures	Authorized personnel engaged in lockout/ tagout, and affected employees whose work may be impacted by a lockout/ tagout situation
Forklifts	Hazards and operation procedures, including machine-specific safe operating procedures.	SSHO	Prior to operation of forklift; every three years	Forklift/powered industrial truck operators
Other heavy equipment operations	Qualified by SSHO, Site Superintendent or Equipment Supervisor as documented on ECC Equipment Operator Qualifications Form.	SSHO, Equipment Supervisor	Prior to heavy equipment operations on site	Equipment operators
Power tools (e.g., chain saws, chippers, powder-actuated tools, compressed air systems)	Hazards: proper use and maintenance of tools as described in operations manual. Powder-operated tool users certified by manufacturer.	SSHO, or trainer authorized by manufacturer (explosive-actuated tools)	As part of general site orientation; prior to use of specific tools	Project personnel using power tools
UXO Awareness Training	Recognition of munitions and explosives of concern that may be encountered during site activities	UXO Qualified Personnel	Prior to beginning site operations	All site personnel

Notes:
AHA – Activity Hazard Analysis
APP – Accident Prevention Plan
CFR – Code of Federal Regulations
CP – Competent Person
CPR – Cardiopulmonary Resuscitation
EZ – Exclusion Zone
HAZWOPER – Hazardous Waste Operations and Emergency Response
OSHA – Occupational Safety and Health Administration
SDS – Safety Data Sheet
SHM – Safety and Health Manager
SOH – Safety and Occupational Health
SSHO – Site Safety and Health Office
SSHP – Site Safety and Health Plan
UXO – Unexploded Ordnance

7.2 Safety Indoctrination Training for New Employees

New employees to ECC receive indoctrination training before they are allowed to participate in field work. The indoctrination training consists of the following:

- ECC COVID-19 Prevention Program (**Attachment 6)**
- Review requirements and responsibilities for accident prevention and maintaining a safe and healthy workplace.
- Review ECC's general safety and health policies and procedures.
- Review ECC's incident reporting system and procedures.
- Identify employees' responsibilities for reporting incidents (safety, health, and quality).
- Review medical treatment facilities of the employee's assigned office.
- Review safety, emergency, and evacuation procedures for the employee's assigned office.

7.3 Periodic Safety and Health Training for Supervisors and Employees

All project personnel will participate in training/refresher topics throughout the project. These topics may be presented as part of the daily tailgate meetings, or as separate classes established for specific project work activities and procedures. All supervisors, managers, and employees are encouraged to participate in other seminars or courses provided by outside vendors as necessary to increase knowledge and to maintain currency with construction topics, hazards, and controls.

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8.0 EXPOSURE MONITORING AND AIR SAMPLING

Based on historical sampling analysis data (low-level concentrations of VOCs), elevated levels of VOCs in the breathing zone are not anticipated, air monitoring is required during intrusive activities. Air monitoring will be performed in the general work area and the breathing zone prior to starting and during intrusive activities. Personnel performing testing and monitoring will be trained in testing and monitoring procedures and hazards. Monitoring equipment will be used, inspected, maintained, and properly calibrated in accordance with the manufactures' instructions and standard industrial hygiene practice.

Table 8-1 below lists the monitoring requirements and response actions for this project. All direct and integrated air monitoring equipment will be properly calibrated before and after each period of use in accordance with the manufactures' instructions and standard industrial hygiene practice.

Table 8-1. Exposure Monitoring

Instrument / Contaminant	Frequency	Action Levels	Actions/Upgrade and Rationale
Real Time (air, noise, heat, radiation, light)			
Multi-RAE Plus or equivalent / VOCs	During any intrusive activities	Work Area: Sustained readings of 5 ppm VOC, 20.8% O_2 < 10% LEL 15 ppm CO < 5 ppm H_2S in the breathing zone.	Stop activities, suspend work activities for 15 to 30 minutes; if readings are sustained then contact SHM[(a).]
OSHA/NIOSH HEAT Index App + Body Temp / Heart Rate Monitoring	Daily during work in hot conditions (> 85°F Level D, > 70°F when impervious coveralls worn)	Variable depending on the individual and work activity	Follow Precautions recommended by the HEAT Index app. Implement physiological monitoring when Heat Index indicates Moderate Risk for employees in protective clothing working in sunlight; and for other workers when Heat Index indicates High Risk; and for any workers indicating signs and symptoms of heat stress.

Notes:

a. Contact with the SHM must be made prior to continuance of work. The SHM may then initiate perimeter/integrated air sampling along with additional engineering controls

% – percent
°F – degrees Fahrenheit
> – greater than
< - less than
CO – carbon monoxide
H_2S – hydrogen sulfide
LEL – lower explosive limit
NIOSH – National Institute for Occupational Safety and Heath
O_2 – oxygen
PID – Photoionization detector
ppm – parts per million
OSHA – Occupational Safety and Health Administration
SHM – Safety and Health Manager
VOC – Volatile organic compounds

Records will include the date, time, substances or hazards monitored, person conducting monitoring, calibration date and method, operations and location of monitoring, and results. Records are available to employees, their representatives, and to the Army.

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9.0 EFFECTIVENESS OF PLAN

The effectiveness of this SSHP will be determined by the inspections listed below, as well as from incident investigations and input by site personnel including reports of hazards, safety observations, and suggestions for improvement.

9.1 Safety and Health Inspections

ECC and its subcontractors will perform periodic health and safety inspections throughout the duration of the environmental remediation field activities at RSA. Results of all health and safety compliance review audits or inspections will become part of the project file.

9.2 General Inspection Procedures

Table 9-1 lists the general inspection requirements for this project.

Daily site-wide inspections will be conducted by the SSHO. Other CPs identified in specific AHAs will also conduct daily inspections of the work activities within their responsibility, as deemed necessary. Findings that represent deficiencies in the implementation of the SSHP or EM 385-1-1 will be added to the Tracking Log. Actions, timetable, and responsibility for correcting the deficiencies shall be recorded in the Deficiency Tracking Log. Follow-up inspections to ensure correction of any identified deficiencies will also be conducted and documented in the Deficiency Tracking Log. The Deficiency Tracking Log will be posted in the administrative area and updated daily. A monthly evaluation of the data should be discussed in the QC or SOH meeting with everyone on the project.

Table 9-1: General Inspection Requirements

What	Who	When	Documentation
General site conditions	SSHO	Daily	Mobile safety app
	CM/QC	Bi-Weekly	Site Health and Safety Inspection Checklist and Action Item Report, cc: SSHO, PM, Program/SHM
	PM	Monthly (as travel permits)	
	Program SHM	Monthly (as travel permits)	
Mobile construction equipment	Operators	Initial and Daily	Inspection checklist, cc: Construction/Equipment Supervisor (Note: Notify Army before initial to coordinate joint inspection)
Construction tools and equipment	Users	Daily	None. Tag defective items "out of service"
Lock out/Tag Out	SSHO	Prior to working on machinery, equipment, or process units where employees may be exposed to hazardous energy sources.	Lockout/Tagout Permit
Rigging	CP	Daily	None. Rigging items must be tagged with load capacities.
Ladders	SSHO	Weekly	Logbook, tag or inspection log form
Emergency supplies and equipment (fire extinguishers, spill response, PPE, First Aid, etc.)	SSHO	Weekly	Logbook, tag or inspection log form

What	Who	When	Documentation
PPE	SSHO	Initial, Periodic	None
	Users	Daily	None
Hazardous energy sources and processes (electrical systems, pneumatic equipment, etc.)	CP or QP	Initial	Per operating instructions, QCP, O&M procedures
	User/Operator	Daily	TBD

Notes:
CM – Construction Manager
CP – Competent Person
O&M – Operations and Maintenance
PPE – Personal Protective Equipment
PM –Project Manager
QC – Quality Control
QCP – Quality Control Plan
QP – Qualified Person
SHM – Safety and Health Manager
SSHO – Site Safety and Health Officer
TBD – To be Determined

9.3 External Inspections and Certifications

If regulatory agency personnel arrive on site to conduct an inspection, the ECC PM and the following individuals will be contacted immediately:

- COR
- Subcontractor's site representative
- ECC SHM
- ECC General Counsel

If a citation is issued to ECC or its subcontractors, a copy of the citation will be submitted to the COR along with a Corrective Action Plan.

9.4 Follow-up Procedures for Inspection Deficiencies

All deficiencies identified during project or equipment inspections are noted and tracked through closure. Deficiencies identified by operators during equipment inspections are noted on the equipment inspection form. Any deficiency noted must be reviewed by the SSHO or site supervisor/foreman prior to the equipment being allowed to operate. Any deficiency that affects safe work performance must be corrected before the equipment is put back into operation. Minor deficiencies that do not affect safe performance will be corrected as soon as practical. Following correction of the deficiency, the noted item is initialed by the SSHO on the inspection form as corrected.

Deficiencies identified during the weekly formal site inspections are noted on the inspection form (with a due date and responsible individual) as well as on the SOH Deficiency Tracking Log posted on the project Safety and Health Bulletin Board. These deficiencies are also tracked to closure and verified upon completion. Deficiencies corrected immediately will be noted on the weekly inspection form.

10.0 REFERENCES

APTIM. 2020a. *RCRA Facility Investigation Report, RSA-115, Inactive East Side Blowdown Lagoon at Test Area 5, Operable Unit 13, Revision 3, U.S. Army Garrison* – Redstone, Madison County, Alabama. August.

APTIM. 2020b. *RCRA Facility Investigation Report, RSA-116, South Side Blowdown Lagoon at Test Area 5, Operable Unit 13, Revision 4, U.S. Army Garrison* – Redstone, Madison County, Alabama. November.

Occupational Safety and Health Administration (OSHA). 1999. *Occupational Safety and Health Standards, 29 Code of Federal Regulations 1910*. 1 July.

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ATTACHMENTS

ATTACHMENT 1

ACTIVITY HAZARD ANALYSIS

Environmental Chemical Corporation
Activity Hazard Analysis (AHA)

Activity/Work Task: **Mobilization, Site Inspection, and Site Preparation Activities**	Overall Risk Assessment Code (RAC) (Use highest code)	**L**
Project Location: **Redstone Arsenal (RSA), Alabama (AL)**		
Contract Number: **W9124J-18-D-0004/ W9124J-22-F045**		
Date Prepared / Revised: **01 June 2023**		
Prepared by (Name/Title): **Courtney Bigelow, Associate Scientist**		
Reviewed by (Name/Title): **Kym Edelman, CIH, CSP / Site and Health Manager**		
Competent Person (Name/Title): **Aaron Glad, Site Superintendent**		
Notes: (Field Notes, Review Comments, etc.)		

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

- **E = Extremely High Risk**
- **H = High Risk**
- **M = Moderate Risk**
- **L = Low Risk**

JOB STEPS	POTENTIAL SAFETY / HEALTH HAZARDS	RECOMMENDED CONTROLS **Consider People, Equipment, Materials and Environment** *(Note: Standard PPE required for this activity includes Hard Hat, Safety glasses with side protection, and safety-toe footwear. Additional PPE requirements are listed in this column depending on the hazard. This constitutes the Workplace Hazard Assessment per 29 CFR 1910.132. Additional assessments and PPE selection when needed will be documented on a daily briefing sign-in form and signed by the SSHO in accordance with WE SOP ESQ 6.1. Hazard assessment and respirator selection for inhalation hazards are documented in the site Respiratory Protection Plan if respirators are part of PPE.)*	RAC
Underground utility survey Identify all overhead utilities	Contact with Overhead Utility Lines – Electrocution, Fires/underground utilities	General Safety - To minimize potential hazards all personnel shall attend site orientation prior to start of work activities in addition to daily Safety Tailgate meetings to familiarize themselves to hazards, emergency procedures, operational aspects & heavy equipment use, and change(s) in site work conditions. Daily housekeeping will be implemented during and at the ends of each workday. Equipment vehicles must be set up with a fire extinguisher (min 10:BC & a FA Kit). Drinking water must be stored in a cooler clearly marked "Food & Drink Only – No Samples". • Before work begins, survey the site for overhead power lines. LOOK UP! Equipment will not be used that is able to reach overhead power lines. • If work must be conducted closer to utilities than guidelines allow, the utility company must be contacted. • An observer/spotter shall be designated to observe clearance of the equipment and give timely warning for all operations where it is difficult for the operator to maintain the desired clearance by visual means. This shall be the ONLY job the observer is performing when an observer is required.	L

Environmental Chemical Corporation
Activity Hazard Analysis (AHA)

Underground utility survey Identify all overhead utilities (Continued)	Contact with Overhead Utility Lines – Electrocution, Fires/underground utilities (Continued)	• Keep all personnel well away from the equipment whenever it is close to power lines. • If intrusive activities, Louisiana 811 shall be notified prior to with sufficient time allowed for white-lining and utility marking. — Excavation Permit Procedure: Mark the area for the requested clearance and then submit an excavation permit with RSA. Alabama 811 is contacted 48 hours prior to activity start. • ECC personnel will "white-line" or otherwise mark the area where the wells are to be installed, prior to utility marking. • Intrusive soil activities conducted within a five foot "Buffer Zone" (horizontal or vertical, as measured from the outside edge of the utility) of any utility (electric, gas, high pressure, chemical storage tanks, pipelines, sewers, etc.) may require the use of non-aggressive excavation methods such as hand excavation using non-conductive hand tools, use of an air spade, hydro-excavation, or similar means (some jurisdictions require more stringent buffer zones). Spotter will assist the operator/workers to identify unknown conditions during drilling. • If a previously unknown utility line is identified, uncovered, or disturbed during intrusive activities, stop immediately and project management notified. Intrusive operations shall not recommence until the line has been evaluated, identified, and the appropriate utility notified. • Most utilities and marking services utilize the American Public Works Association Uniform Color Code for marking out utilities. All personnel involved in excavation projects will be familiar with this code.	L
	Back Strain or Sprain	• Use proper lifting techniques, move heavy objects with wheelbarrow/carts, seek assistance if items weigh over 50 pounds.	L
Receipt and placement of equipment vehicle: Spotting of equipment vehicle	Struck-by moving truck	• Always ensure a spotter for delivery truck stays in line-of-sight of driver at all times.	L
	Caught in or under equipment vehicle	• Use a spotter to coordinate activities of driver and person setting cribbing, tie-downs, chains. • Keep hands out of pinch points. • Wear leather work gloves.	L
	Contact with Overhead Utility Lines – Electrocution, Fires	• Before work begins, survey the site for overhead power lines. LOOK UP! Equipment will not be used that is able to reach overhead power lines. An observer/spotter shall be designated to observe clearance of the equipment and give timely warning for all operations where it is difficult for the operator to maintain the desired clearance by visual means. This shall be the ONLY job the observer is performing when an observer is required. • Keep all personnel well away from the equipment whenever it is close to power lines.	L
Installation of temporary work zones construction fencing	Struck-by hand tools	• Wear leather gloves, safety-glasses, hard hats, safety-toe footwear. Keep hands out of pinch points. • Use post driver, not sledgehammer, for placing fence posts. Tape top of fence post or install mushroom caps to reduce potential for scrapes.	L

Environmental Chemical Corporation
Activity Hazard Analysis (AHA)

Installation of erosion controls	Sprains/strains Struck-By (hand tools)	• Use two people to carry heavy loads of fencing/posts. Do not lift and carry more than comfortable weight for individual; 50 lbs. maximum.	L
Establishment of work zones, decontamination stations for personnel and equipment	Slips/trips/falls	• Wear high traction safety-toe footwear. • Keep loads manageable to not obstruct vision.	L
	Scrapes and cuts	• Wear safety glasses, gloves and long sleeves.	L
	Contact with poisonous plants (e.g. poison ivy)	• Inspect area before starting. • Wear long sleeve shirts, tuck sleeves and pant legs. If there is heavy growth, wear disposable coveralls and use barrier cream (e.g. Ivy Block). • Have Tecnu or other poison ivy cleanser on-hand, and wash immediately after contact.	L
	Stung by bees/hornets, bit by ticks or snakes	• Inspect areas for hives. • Ensure allergic individuals have emergency medical kit and are committed to using it. • Use insect repellant containing DEET on exposed skin and Permethrin on clothing. • Do not approach snakes. If bitten, seek medical attention.	L
	Struck by moving equipment	• Personnel will stay out of equipment swing areas and pinch-points.	L
	Fire/explosion of gasoline	• Allow equipment to cool before refueling and eliminate other sources of ignition. • Use only approved NFPA safety cans for gasoline. • Cleanup spills immediately.	L
	Heat Stress/Cold Stress (applies to all job steps)	• Monitor weather conditions and implement controls in accordance with Heat/Cold Stress Prevention Plan in APP. • Stay hydrated. • Stop and rest in cool shaded area if heat strain symptoms occur and when instructed by SSHO. • Report all signs and symptoms of heat strain immediately to SSHO.	L
	Severe Weather (applies to all job steps)	• Shut down operations during severe electrical storms, heavy rain, high wind and evacuate site/take cover. • Train personnel on Emergencies Response. • Monitor weather systems.	L
	Eye injuries	• Safety glasses with side shields (impact resistant).	L

Environmental Chemical Corporation
Activity Hazard Analysis (AHA)

Stop work and notify the Team Leader if you are not sure how to perform your task safely!	*Stop work and notify the Team Leader if you are not sure how to perform your task safely!*	*Stop work and notify the Team Leader if you are not sure how to perform your task safely!*
Equipment to be Used	**Training Requirements**	**Inspection Requirements**
1. Support Vehicles 2. Skid steer/forklift <u>Support Zone</u> • Cell phone or Radio communication • Eyewash station • Fire extinguishers • First aid kit • Drinking water • 911 Air horn • Spill containment supplies • Air Monitoring equipment, if needed • Emergency decontamination supplies **PPE: Level D (hardhat, steel toe boots, work gloves, orange safety vest, safety glasses, and hearing protection, as needed)**	• Only qualified operators permitted to operate mobile equipment • Operators of forklifts will have recent certification / training in safe forklift operation (20 CFR 1910, Subpart N – Powered Industrial Trucks) • First Aid/Cardiopulmonary Resuscitation training (at least two individuals onsite) • Initial Safety Orientation • Daily Safety Tailgate Meetings • Emergency Response Plan/Procedures • Fire extinguishers. **Competent Person: Site Superintendent and/or SSHO**	• SSHO daily site inspection • Equipment - Receipt and inspected by SSHO • Competent person will inspect equipment daily prior to each use. No equipment will be placed in service until all deficiencies are corrected • Complete ECC daily equipment inspection form • Weekly inspection of first aid kits • Monthly inspection of fire extinguishers • GFCIs (at least monthly).

Environmental Chemical Corporation
Activity Hazard Analysis (AHA)

Activity/Work Task: **Environmental Sampling**	Overall Risk Assessment Code (RAC) (Use highest code) **L**
Project Location: **Redstone Arsenal (RSA), Alabama (AL)**	
Contract Number: **W9124J-18-D-0004/ W9124J-22-F045**	
Date Prepared / Revised: **01 June 2023**	
Prepared by (Name/Title): **Courtney Bigelow, Associate Scientist**	
Reviewed by (Name/Title): **Kym Edelman, CIH, CSP / Site and Health Manager**	
Competent Person (Name/Title): **Aaron Glad, Site Superintendent**	
Notes: (Field Notes, Review Comments, etc.)	

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

- **E = Extremely High Risk**
- **H = High Risk**
- **M = Moderate Risk**
- **L = Low Risk**

JOB STEPS	POTENTIAL SAFETY / HEALTH HAZARDS	RECOMMENDED CONTROLS **Consider People, Equipment, Materials and Environment** *(Note: Standard PPE required for this activity includes Hard Hat, Safety glasses with side protection, and safety-toe footwear. Additional PPE requirements are listed in this column depending on the hazard. This constitutes the Workplace Hazard Assessment per 29 CFR 1910.132. Additional assessments and PPE selection when needed will be documented on a daily briefing sign-in form and signed by the SSHS in accordance with ECC SOP ESQ 6.1. Hazard assessment and respirator selection for inhalation hazards are documented in the site Respiratory Protection Plan if respirators are part of PPE.)*	RAC
Labeling sample containers Handling sample containers w/ preservation / adding preservation to containers Purging monitoring wells Filling sample containers from soil borings or well sample pump Cleaning outer surface of sample containers	• Personal injury • Slips & Trips • Lifting Strains & Sprains • Heat Stress/Cold Stress • Splash hazard • Handling Materials Containing Hazardous Materials • Proper Material Handling • Biohazard and Controls	General Safety - To minimize potential hazards all personnel shall attend site orientation prior to start of work activities in addition to daily Tailgate meeting. Review JSA to familiarize themselves to hazards, emergency procedures and equipment, operational aspects & heavy equipment use, and change(s) in site/work conditions. Daily housekeeping will be implemented at the end of each workday. Equipment/vehicles must be set up with a fire extinguisher (min 10:BC & a FA Kit w/ eye wash. Drinking water must be stored in a cooler clearly marked "Food & Drink Only – No Samples". **Stay on established pathways and ensure tools, cords, other objects are removed from walk areas to prevent trips and falls.** **Be cautious of muddy, wet, icy, or other slippery surfaces. Ensure surfaces are cleared and proper footwear is utilized to prevent slips/falls.**	L

Labeling sample containers Handling sample containers w/ preservation / adding preservation to containers Purging monitoring wells Filling sample containers from soil borings or well sample pump Cleaning outer surface of sample containers (CONTINUED)	• Personal injury • Slips & Trips • Lifting Strains & Sprains • Heat Stress/Cold Stress • Splash hazard • Handling Materials Containing Hazardous Materials • Proper Material Handling • Biohazard and Controls (CONTINUED)	**Hand & Power Tool Use:** Prior to use all tools must be inspected. Any damaged or defective tools will be tagged and removed from service for repair and/or discarded. Ensure all guards are in place on tools. Wear protective gloves based on hazard associated with tool. Cutting devices must have blade protection. Fixed blade utility knives that cannot be retracted are prohibited. Ensure electrical tools are double insulated or properly grounded. Extension cords shall be connected to a GFCI. **Working with Hazardous Materials:** Employees will be provided with an overview of the hazards associated with the chemicals that will be used. A copy of the SDS will be available for review and proper PPE will be provided.	L
		Heat Stress/Cold Stress: • Monitor weather conditions and implement controls in accordance with Heat/Cold Stress Prevention Plan in APP. • Stay hydrated. • Stop and rest in cool shaded area if heat strain symptoms occur and when instructed by SSHO. • Report all signs and symptoms of heat strain immediately to SSHO. **PPE:** Modified Level-D PPE will be worn inside posted areas. Any PPE upgrade will be in accordance with the SSHP action level guidelines. A face shield or goggles shall be used during activities where a splash hazard exists. Use of chemical resistant gloves shall be worn when there is potential skin contact with contaminated fluids. Hearing protection shall be worn if noise survey results above TWA of 85dBA. Wear Permethrin treated gaiters. **Material Handling & Storage:** No individual employee is permitted to lift any object that weights over 50-pounds. Proper lifting techniques shall be used. Multiple employees or the use of mechanical lifting are for lifting objects over the 50-pounds limit. Know the weight of the load and ensure loads are stable and secure before transporting. Ensure stages materials are properly stacked and secured to prevent sliding/falling. **Biohazard Controls:** • Inspect area before starting. • Wear long sleeve shirts, tuck sleeves and pant legs. If there is heavy growth, wear disposable coveralls and use barrier cream (e.g. Ivy Block). Wear Permethrin treated gaiters. • Have Tecnu or other poison ivy cleanser on-hand and wash immediately after contact. • Do not approach any wild animals. If bitten seek medical attention.	L

Environmental Chemical Corporation
Activity Hazard Analysis (AHA)

Use of Generator	• Lift and carrying generator • Fire hazard while refueling	**Back Injury:** • Do not lift awkward sized items use proper lifting techniques • Do not use equipment to lift and move drums, equipment and supplies. Lift with your legs not with your back. • Additional personnel will be used to lift items weighing over 60 pounds. If possible, use mechanical movement aids (i.e., hand truck or wheelbarrow). • A fire extinguisher and spill containment supplies should be readily available. Ensure generator is on the ground while refueling. • Fuel generator only after engine has been shut down and cooled	**L**

Stop work and notify the Team Leader if you are not sure how to perform your task safely!	***Stop work and notify the Team Leader if you are not sure how to perform your task safely!***	***Stop work and notify the Team Leader if you are not sure how to perform your task safely!***
Equipment to be Used	**Training Requirements**	**Inspection Requirements**
• Hand Sampling Tools • Generator <u>Support Zone</u> • Cell phone or Radio communication • Eyewash station • Fire extinguishers • First aid kit • Drinking water • 911 Air horn • Spill containment supplies • Air Monitoring equipment, if needed • Emergency decontamination supplies **PPE: Modified Level D (hardhat, steel toe boots, nitrile gloves when sampling/leather gloves when cutting plastic tubes, gaiters, orange safety vest, safety glasses, and hearing protection, as needed). A face shield or goggles shall be used during activities where a splash hazard exists. Wear Permethrin treated gaiters.**	• Only qualified operators permitted to operate First Aid/Cardiopulmonary Resuscitation training (at least two individuals onsite) • Initial Safety Orientation • Daily Safety Tailgate Meetings • Emergency Response Plan/Procedures • Fire extinguishers **Competent Person: Site Superintendent and/or SSHO**	• Daily inspection of hand and power tools with replacement of damaged items. • Annual and monthly inspection of fire extinguishers • Weekly inspection of first aid kits/eyewash

Environmental Chemical Corporation
Activity Hazard Analysis (AHA)

Activity/Work Task: **Well Installation, Maintenance and Abandonment**	Overall Risk Assessment Code (RAC) (Use highest code): **L**
Project Location: **Redstone Arsenal (RSA), Alabama (AL)**	
Contract Number: **W9124J-18-D-0004/ W9124J-22-F045**	
Date Prepared / Revised: **01 June 2023**	
Prepared by (Name/Title): **Courtney Bigelow, Associate Scientist**	
Reviewed by (Name/Title): **Kym Edelman, CIH, CSP / Site and Health Manager**	
Competent Person (Name/Title): **Aaron Glad, Site Superintendent**	
Notes: (Field Notes, Review Comments, etc.)	

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

- E = Extremely High Risk
- H = High Risk
- M = Moderate Risk
- L = Low Risk

JOB STEPS	POTENTIAL SAFETY / HEALTH HAZARDS	RECOMMENDED CONTROLS Consider People, Equipment, Materials and Environment *(Note: Standard PPE required for this activity includes Hard Hat, Safety glasses with side protection, and safety-toe footwear. Additional PPE requirements are listed in this column depending on the hazard. This constitutes the Workplace Hazard Assessment per 29 CFR 1910.132. Additional assessments and PPE selection when needed will be documented on a daily briefing sign-in form and signed by the SSHS in accordance with ECC SOP ESQ 6.1. Hazard assessment and respirator selection for inhalation hazards are documented in the site Respiratory Protection Plan if respirators are part of PPE.)*	RAC
Mobilization		General Safety - To minimize potential hazards all personnel shall attend site orientation prior to start of work activities in addition to daily Safety Tailgate meetings to familiarize themselves to hazards, emergency procedures, operational aspects & heavy equipment use, and change(s) in site work conditions. Daily housekeeping will be implemented during and at the ends of each workday. Equipment vehicles must be set up with a fire extinguisher (min 10:BC & a FA Kit). Drinking water must be stored in a cooler clearly marked "Food & Drink Only – No Samples". • Level D PPE will be worn inside the designated EZ. Any PPE upgrade will be in accordance with APP guidelines. Hearing protection shall be worn if noise survey results above TWA of 85 dBA	L

Direct Push Technology (DPT), Hollow Stem Auger (HSA), Air Rotary Activities	Contact with Underground and Overhead Utility Lines – Electrocutions, Fires/underground utilities	• Before work begins, survey the site for overhead power lines. LOOK UP! Equipment will not be used that is able to reach overhead power lines. • If work must be conducted closer to utilities than guidelines allow, the utility company must be contacted. • An observer/spotter shall be designated to observe clearance of the equipment and give timely warning for all operations where it is difficult for the operator to maintain the desired clearance by visual means. This shall be the ONLY job the observer is performing when an observer is required. • Keep all personnel well away from the equipment whenever it is close to power lines. • If intrusive activities, Alabama 811 shall be notified prior to with sufficient time allowed for white-lining and utility marking. — Excavation Permit Procedure: Mark the area for the requested clearance and then submit an excavation permit with RSA DPW. Alabama 811 is contacted 48 hours prior to activity start. • ECC personnel will "white-line" or otherwise mark the area where the wells are to be installed, prior to utility marking. • Intrusive soil activities conducted within a five foot "Buffer Zone" (horizontal or vertical, as measured from the outside edge of the utility) of any utility (electric, gas, high pressure, chemical storage tanks, pipelines, sewers, etc.) may require the use of non-aggressive excavation methods such as hand excavation using non-conductive hand tools, use of an air spade, hydro-excavation, or similar means (some jurisdictions require more stringent buffer zones). Spotter will assist the operator/workers to identify unknown conditions during drilling. • If a previously unknown utility line is identified, uncovered, or disturbed during intrusive activities, stop immediately and project management notified. Intrusive operations shall not recommence until the line has been evaluated, identified, and the appropriate utility notified. Most utilities and marking services utilize the American Public Works Association Uniform Color Code for marking out utilities. All personnel involved in excavation projects will be familiar with this code. Before derrick is raised a thorough walkthrough of surrounding area is required to ensure there are no overhead utilities within 100 feet horizontally. If overhead utilities are within 100 ft horizontally of the derrick, consult local utility company and refer to EM 385-1-1 Table 11-1 before commencing operations.	L
	Equipment Malfunction	• Rig operators must be qualified and designated. • All operations must be conducted in accordance with manufacturer's operations manual. Ensure equipment manual is on site at all times and contents of the manual, specifically related to safe operations, have been reviewed will all employees engaged in activities. Ensure this review is documented. • Complete inspections and maintenance of the rig in accordance with the manufacturer's operations manual.	L

DPT, HSA, Air Rotary Activities (CONTINUED)	Cuts/Lacerations	• A cutting device designed for cutting acetate liners (procured through Geoprobe) shall be used. If a safety utility knife is used, snubbed nose blades are required and the user must wear Kevlar gloves under leather gloves. Non-retractable utility knives are prohibited. Blades must be secured when not in use. • Utilize proper cutting technique and ensure cuts are made away from the body, keep hands clear. • Utilize leather work gloves or other cut resistant work gloves at all times when handling equipment. Ensure gloves are appropriate for potential laceration hazard if sharp edges are encountered.	L
	Lifting Strains/Sprains	• No individual employee is permitted to lift any object that weighs over 50 pounds. Proper lifting techniques shall be used. Multiple employees or the use of mechanical lifting are for lifting objects over the 50-pound limit. Materials shall be inspected for sharp edges prior to being handled and avoid pinch point hazards. • While handling direct push rods and filled acetate liners, make sure proper lifting techniques are used.	L

	Struck by or caught in drill rig equipment	• Only qualified personnel shall be permitted to operate equipment. The equipment shall be inspected daily using an ECC inspection form specific for the equipment in use. Equipment must have functioning safety devices as installed by the manufacturer. Deficiencies in equipment shall be corrected prior to operating. Equipment found to be unsafe shall not be used. Fire extinguishers of the appropriate size will be available on the equipment. All equipment shall have back up enunciators.
		• Only personnel essential to drill rig operation will be permitted in area directly surrounding drill rig. All personnel not directly contributing to drill rig operations will be required to stay a minimum of 25' away.
		• Check all safety devices, emergency shut-down switches daily or at the start of drilling shift. Drilling will not be permitted until all emergency shut-down switches and warning systems are working properly.
		• Drill rig operator is required to do a daily equipment checklist to ensure equipment is in safe working condition.
		  ○ Personnel need to be cognizant of surroundings and keep clear of cuttings discharge point. Eye protection will be worn at all times.
		  ○ Personnel need to remain away from air compressor and air hose unless a specific task requires work in close proximity.
		  ○ Do not operate compressed air system with broken or inoperable safety controls.
		  ○ Inspect airline safety cables to verify they are in good working condition.
		• If augers are used during drilling operations, auger guards will be required.
		• All work areas on and around the drill rig operation will be required to be kept clear of unnecessary equipment and materials. Ongoing housekeeping throughout the day will keep work areas free of slip, trip and fall hazards.
			L

	Struck by Traffic	When working adjacent to or on active roadways adequate traffic control devices must be installed to establish a safe work zone. Adequate signage must be established to identify the work zone. All personnel entering and working in an established work zone must wear the classification of reflective vests (appropriate based on speed of vehicles).	L

DPT, HSA, Air Rotary Activities (CONTINUED)	Struck-By / Pinch Points	• All personnel will wear ANSI Type 2 high-visibility traffic safety vests. Operators shall maintain a constant awareness of personnel and equipment in the work areas. • Moving heavy equipment must have properly functioning back-up alarms. • Spotters on the ground will assist operators in manipulating vehicles and equipment into tight or confined spaces. • Getting off or on any equipment while it is in motion is prohibited. • Three points of contact shall be maintained when getting on or off equipment. • Seats will be provided for each occupant of the equipment. • The operator shall use safety belts while equipment is in use. • All original manufacturer-installed safety equipment such as lights, guards, brakes, horn, etc. must be functional at all times. • Whenever equipment is parked, the parking brake shall be set, and wheels chocked when on an incline • Heavy equipment operators shall inform their Supervisor(s) of any prescribed medication that they are taking that would impair their judgment and/or vision • Never walk or work directly in back of or to the side of heavy equipment without the operator's knowledge and approval.	L
		• Personnel will stay out of equipment swing areas and pinch-points. When dumping a load from a bed equipped with a tailgate, a spotter must be positioned a safe distance from the vehicle, such that they can observe the bed to notify the operator if an obstruction occurs	L
	Excessive Noise Exposure	• Wear hearing protective devices (Ear muffs/plugs) when working, when using or near high noise producing equipment, or when directed by ECC SSHO in response to noise monitoring. • Ensure adequate maintenance on equipment. • Conduct periodic sound level surveys.	L
	Inhalation of materials containing crystalline silica	• Review SDS for grout/concrete and other materials utilized to install wells to determine silica content. If silica is present, adhere to controls in APP. Work upwind, avoid dust clouds, keep materials wet, avoid dry sweeping	L
	Heat/Cold Stress (applies to all steps in this AHA)	• Monitor weather conditions and implement controls in accordance with Heat/Cold Stress Prevention Plan in APP. • Stay hydrated. • Stop and rest in cool shaded area if heat strain symptoms occur and when instructed by SSHO. — Report all signs and symptoms of heat strain immediately to SSHO.	L
	Severe weather (applies to all steps in this AHA)	• Shut down operations during severe storms, heavy rain, high wind, and lightning episodes. Evacuate the project site and take shelter at the designated shelter location. • All personnel shall be trained on the project Emergencies Response procedures.	L

Environmental Chemical Corporation
Activity Hazard Analysis (AHA)

Welding/Cutting	Fire	• Personnel that weld or cut will be required to wear proper PPE including flame resistant gloves, aprons, safety shoes, welding helmets, goggles, and shaded glasses. • Fire extinguisher must be present. • Hot work permit must be obtained before any welding or cutting begins. • Verify that no combustible materials are within work area. • Fire watch must continue for 30 minutes after any welding or cutting concludes. • Protective caps must be used when moving cylinders. • Cylinders must be stored properly.	L
Equipment Decontamination	Chemical Contamination Exposure	• All personnel assigned to drilling operations will operate inside a designated EZ. • All PPE will be removed properly prior to exiting the CRZ. • Air monitoring will be performed. All equipment and hand tools will be decontaminated in accordance with the established procedure. • Air monitoring will be conducted for combustible gas, oxygen levels, and toxic gas exposure during drilling and well abandonment.	L

Stop work and notify the Team Leader if you are not sure how to perform your task safely!	***Stop work and notify the Team Leader if you are not sure how to perform your task safely!***	***Stop work and notify the Team Leader if you are not sure how to perform your task safely!***
Equipment to be Used	**Training Requirements**	**Inspection Requirements**
1. Support Vehicles 2. Drill Rig 3. Hand Tools 4. Air Monitoring Equipment (Multi-RAE Plus or equivalent) <u>Support Zone</u> • Cell phone or radio communication • Eyewash station • Fire extinguishers • First aid kit • Drinking water • 911 air horn • Spill containment supplies • Air monitoring equipment, if needed • Emergency decontamination supplies • GFCI • Hand and power tools. **PPE: Level D (hardhat, steel toe boots, work gloves, Class 2 hi-viz safety garment, safety glasses, and hearing protection as needed), unless noted otherwise in this AHA**	• Only qualified operators permitted to operate mobile equipment • Operators of DPT and HSA rig will be a licensed driller. • Operators of forklifts will have recent certification / training in safe forklift operation (20 CFR 1910, Subpart N – Powered Industrial Trucks) • First Aid/Cardiopulmonary Resuscitation training (at least two individuals onsite) • Initial Safety Orientation • Daily Safety Tailgate Meetings • Emergency Response Plan/Procedures • Fire extinguishers. **Competent Person: Site Superintendent and/or SSHO** **Designated Drill Rig Operator:**	• SSHO daily site inspection • Equipment – Receipt and inspected by SSHO • Competent person will inspect equipment daily prior to each use. No equipment will be placed in service until all deficiencies are corrected • Complete daily equipment inspection form will be completed by the operator • Weekly inspection of first aid kits • Monthly inspection of fire extinguishers • GFCIs (at least monthly) • Air monitoring equipment will be calibrated at least monthly and bump tested daily before each shift and as often as necessary. Equipment that cannot pass bump test criteria will be recalibrated or replaced. • Drill rig and associated equipment in accordance with manufacturer's requirements.

Environmental Chemical Corporation
Activity Hazard Analysis (AHA)

Activity/Work Task: **Land Use Control (LUC) Inspection and Geophysical Survey**	Overall Risk Assessment Code (RAC) (Use highest code) **L**
Project Location: **Redstone Arsenal (RSA), Alabama (AL)**	
Contract Number: **W9124J-18-D-0004/ W9124J-20-F-0020**	
Date Prepared: **4 February 2021**	
Prepared by (Name/Title): **Lauren Sparkman/ Environmental Engineer**	
Reviewed by (Name/Title): **Kym Edelman, CIH, CSP / Site and Health Manager**	
Competent Person (Name/Title): **Aaron Glad, Site Superintendent**	
Notes: (Field Notes, Review Comments, etc.)	

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

- **E = Extremely High Risk**
- **H = High Risk**
- **M = Moderate Risk**
- **L = Low Risk**

JOB STEPS	POTENTIAL SAFETY / HEALTH HAZARDS	RECOMMENDED CONTROLS **Consider People, Equipment, Materials and Environment** *(Note: Standard PPE required for this activity includes Hard Hat, Safety glasses with side protection, and safety-toe footwear. Additional PPE requirements are listed in this column depending on the hazard. This constitutes the Workplace Hazard Assessment per 29 CFR 1910.132. Additional assessments and PPE selection when needed will be documented on a daily briefing sign-in form and signed by the SSHS in accordance with ECC SOP ESQ 6.1. Hazard assessment and respirator selection for inhalation hazards are documented in the site Respiratory Protection Plan if respirators are part of PPE.)*	RAC
LUC Inspection	Slips & Trips	General Safety - To minimize potential hazards all personnel shall attend site orientation prior to start of work activities in addition to daily Safety Tailgate meetings to familiarize themselves to hazards, emergency procedures and equipment, operational aspects & heavy equipment use, and change(s) in site/work conditions. Daily housekeeping will be implemented at the end of each workday. Equipment vehicles must be set up with a fire extinguisher (min 10:BC & a FA Kit). Drinking water must be stored in a cooler clearly marked "Food & Drink Only – No Samples". • Wear high traction safety-toe footwear. • Keep loads manageable to not obstruct vision.	L

Environmental Chemical Corporation
Activity Hazard Analysis (AHA)

LUC Inspection (CONTINUED)	Lifting Strains & Sprains	• No individual employee is permitted to lift any object that weighs over 50 pounds. Proper lifting techniques shall be used. Multiple employees or the use of mechanical lifting are for lifting objects over the 50-pound limit. Materials shall be inspected for sharp edges prior to being handled, and avoid pinch point hazards.	L
	Exposure to excessive Noise levels	• Hearing protection shall be worn around heavy equipment of other noise generating equipment or when noise levels exceed TWA of 85 dBA.	L
	Using damaged / malfunctioning power tools	• Prior to use all tools must be inspected. Any damaged or defective tools will tagged and removed from service for repair and/or discarded. • Proper PPE shall be worn when operating power tools. At a minimum, Level "D" will be required.	L
	Caught in or between equipment	• Only qualified personnel shall be permitted to operate equipment. Operators will have constant communication with ground support crews and will be aware of activities around their piece of equipment during operation. • Mobile equipment shall be inspected daily. Deficiencies in equipment shall be noted on the inspection form. Equipment found to be unsafe shall not be used. • Fire extinguishers of the appropriate size will be available in the operators of all heavy equipment. • All equipment shall have backing alarms. • All equipment will be properly secured / rigged prior to transportation off site. All rigging equipment shall be inspected prior to use.	L
	Contact with stinging or biting insects	• Personnel shall wear light colored clothing and apply insect repellent (i.e., DEET) to outer pants legs; Body checks should be performed at the end of the workday. • Any individual who has a known or has a potential for allergic reaction to insect stings shall notify the SSHS and an Epi-Pen shall be readily available.	L
	Contact with poisonous plants (e.g. poison ivy)	• Inspect area for known plants before starting field activities • Wear long sleeve shirts, tuck sleeves and pant legs. If there is heavy growth, wear disposable coveralls and use barrier cream, e.g. Ivy Block. • Have TecNu or other poison ivy cleanser on hand and wash immediately after contact.	L
	Scrapes and cuts	• Wear safety glasses, gloves and long sleeves.	L

Environmental Chemical Corporation
Activity Hazard Analysis (AHA)

LUC Inspection (CONTINUED)	Heat/Cold Stress (applies to all steps in this AHA)	• Monitor weather conditions and implement controls in accordance with Heat/Cold Stress Prevention Plan in APP. • Stay hydrated. • Stop and rest in cool shaded area if heat strain symptoms occur and when instructed by SSHO. • Report all signs and symptoms of heat strain immediately to SSHO.	L
	Severe weather (applies to all steps in this AHA)	• Shut down operations during severe storms, heavy rain, high wind, and lightning episodes. Evacuate the project site and take shelter at the designated shelter location. • All personnel shall be trained on the project Emergencies Response procedures.	L
Stop work and notify your supervisor if you are not sure how to perform your task safely!	***Stop work and notify your supervisor if you are not sure how to perform your task safely!***	***Stop work and notify your supervisor if you are not sure how to perform your task safely!***	

Equipment to be Used	Training Requirements/Competent or Qualified Personnel name(s)	Inspection Requirements
• Hand and Portable power tools <u>Support Zone</u> • Cell phone or Radio communication • Eyewash station • Fire extinguishers • First aid kit • drinking water • 911 Air horn • Spill containment supplies • PDR and PID air monitors • Emergency decontamination supplies • Hand tools **PPE: Level D (hardhat, steel toe boots, work gloves, orange safety vest, safety glasses, and hearing protection as needed)**	• Initial Safety Orientation • Daily Safety Tailgate Meetings • Emergency Response Plan • First Aid/Cardiopulmonary Resuscitation training (at least two individuals onsite) **Competent Person: Site Superintendent and/or SSHO**	• Documented daily equipment inspections by operator are to be conducted and recorded on ECC inspection checklist form. • Competent person will inspect equipment daily prior to each use. No equipment will be placed in service until all deficiencies are corrected • Weekly inspection of first aid kits • Monthly inspection of fire extinguishers

Environmental Chemical Corporation
Activity Hazard Analysis (AHA)

Activity/Work Task: **Equipment Decontamination, Demobilization, and Site Restoration**	Overall Risk Assessment Code (RAC) (Use highest code)	**L**
Project Location: **Redstone Arsenal (RSA), Alabama (AL)**		
Contract Number: **W9124J-18-D-0004/ W9124J-22-F045**		
Date Prepared / Revised: **01 June 2023**		
Prepared by (Name/Title): **Courtney Bigelow, Associate Scientist**		
Reviewed by (Name/Title): **Kym Edelman, CIH, CSP / Site and Health Manager**		
Competent Person (Name/Title): **Aaron Glad, Site Superintendent**		
Notes: (Field Notes, Review Comments, etc.)		

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

- **E = Extremely High Risk**
- **H = High Risk**
- **M = Moderate Risk**
- **L = Low Risk**

JOB STEPS	POTENTIAL SAFETY / HEALTH HAZARDS	RECOMMENDED CONTROLS **Consider People, Equipment, Materials and Environment** *(Note: Standard PPE required for this activity includes Hard Hat, Safety glasses with side protection, and safety-toe footwear. Additional PPE requirements are listed in this column depending on the hazard. This constitutes the Workplace Hazard Assessment per 29 CFR 1910.132. Additional assessments and PPE selection when needed will be documented on a daily briefing sign-in form and signed by the SSHO in accordance with WE SOP ESQ 6.1. Hazard assessment and respirator selection for inhalation hazards are documented in the site Respiratory Protection Plan if respirators are part of PPE.)*	RAC
Decontamination of equipment Dry Decontamination with hand tools • Use hand tools to remove excess soil or debris from equipment Site Restoration/Demob	Slip and Trip Hazards	General Safety - To minimize potential hazards all personnel shall attend site orientation prior to start of work activities in addition to daily Safety Tailgate meetings to familiarize themselves to hazards, emergency procedures and equipment, operational aspects & equipment use, and change(s) in site/work conditions. Daily housekeeping will be implemented at the end of each workday. Equipment vehicles must be set up with a fire extinguisher (min 10:BC & a FA Kit w/ eye wash). Drinking water must be stored in a cooler clearly marked "Food & Drink Only – No Samples". • Practice good housekeeping. • Use care when walking on surface tarp, especially when wet. • Clean all spills immediately. • Proper PPE to include shoes which allow for good footing. • Be aware of physical hazards – watch for uneven ground, rocks, dirt clods, etc.	L
	Overhead Hazards	• Before work begins, survey the site for overhead power lines. LOOK UP! Equipment will not be used that is able to reach overhead power lines.	L

Decontamination of equipment Dry Decontamination with hand tools • Use hand tools to remove excess soil or debris from equipment Site Restoration/Demob (CONTINUED)	Manual Lifting/Backs/Ergonomic	• Train/Utilize correct lift techniques. • Personnel will not lift more than 50 lb. • Use Buddy System. • Position equipment as to eliminate over stretching/ergonomic concerns.	L
	Splash hazards (skin/eyes / face)	• Avoid direct exposure to potential eye hazards. • Wear ANSI approved safety glasses at all times. • Utilize face shield/goggles if potential for flying debris/splash hazards. • Wear rain suit or poly coated Tyvek, waterproof boots or boot covers	L
	Severe Weather	• Shut down operations during severe electrical storms, heavy rain, high wind and evacuate site/take cover. • Train employees on Emergencies Response. • Monitor weather systems.	L
	Noise	• Wear hearing protective devices (earmuffs/plugs) inside the exclusion zone, when using or near high noise producing equipment, or when directed by ECC's SSHS in response to noise monitoring. • Ensure adequate maintenance on thermal/heavy equipment.	L
	Struck By/Against Heavy Equipment	• Maintain radio/verbal communication. • Eye contact with operators will be made before approaching trucks. • Equipment will not be approached on blind sides. • Personnel will understand and review hand signals. • All machines will be equipped with backup alarms and lighting. • Always set emergency brake on equipment. • Equipment will properly Locked Out prior to decontamination (i.e., key removed from ignition) • Engage all equipment-supplied safety equipment (i.e., locking arms, chocks) on equipment parts that are suspended. DO NOT place yourself between unprotected/unsecured parts of the equipment.	L
	Chemical Exposure	• Protective clothing/PPE (steel toe boots, ANSI approved safety glasses, chemical gloves). • Decontaminate equipment away from intrusive activities and upwind.	L
	Scrapes and cuts	• Wear safety glasses, gloves and long sleeves.	L
	Heat/Cold Stress	• Monitor weather conditions and implement controls in accordance with Heat/Cold Stress Prevention Plan in APP. • Stay hydrated. • Stop and rest in cool shaded area if heat strain symptoms occur, when instructed by SSHO. • Report all signs and symptoms of heat strain immediately to SSHO.	L
Wet Decontamination with use of water • Use hose or pressure washer to remove soil or debris from equipment	High pressure washer operation	• The lance must always be pointed at the work area and away from other site personnel. Non-operators must remain a safe distance from the operator. The distance must be a minimum of 25 feet in every direction • Only trained authorized personnel will be allowed to use the equipment. • The operating pressure should never exceed what is necessary to complete the job. • **The trigger should never be tied down.**	L

Environmental Chemical Corporation
Activity Hazard Analysis (AHA)

Wet Decontamination with use of water • Use hose or pressure washer to remove soil or debris from equipment (CONTINUED)	Equipment malfunction	• No unauthorized attachment may be connected to the unit. • Equipment should be cleaned after every use to avoid oil or dirt build-up especially around the trigger and guard area. • **Do not modify the lance.** The lance barrel, from trigger block to the tip, should not be less than 48 inches as recommended by manufacturers of hydroblasting equipment. • All users and assistants must be trained in emergency shut down procedures and general equipment maintenance.	L
	Slips, trips, and falls	• Proper PPE to include shoes which allow for good footing.	L

Stop work and notify the Team Leader if you are not sure how to perform your task safely!	***Stop work and notify the Team Leader if you are not sure how to perform your task safely!***	***Stop work and notify the Team Leader if you are not sure how to perform your task safely!***
Equipment to be Used	**Training Requirements/Competent or Qualified Personnel name(s)**	**Inspection Requirements**
1. Hand Tools 2. Skid Steer 3. Pressure washer unit and hoses 4. Support Vehicles <u>Support Zone</u> • Cell phone or Radio communication • Eyewash station • Fire extinguishers • First aid kit • Drinking water • 911 Air horn • Spill containment supplies • Air Monitoring equipment, if needed • Emergency decontamination supplies • GFCI • Hand and Power Tools **PPE: Modified Level D (Face shield, hardhat, steel toe boots, chemical gloves, orange safety vest, safety glasses (face shield if needed) and hearing protection, as needed)**	• Only qualified operators permitted to operate mobile equipment • Operators of forklifts will have recent certification / training in safe forklift operation (20 CFR 1910, Subpart N – Powered Industrial Trucks) • First Aid/Cardiopulmonary Resuscitation training (at least two individuals onsite) • Initial Safety Orientation • Daily Safety Tailgate Meetings • Emergency Response Plan/Procedures • Fire extinguishers. **Competent Person: Site Superintendent and/or SSHO**	• SSHO daily site inspection • Equipment – Receipt and inspected by SSHO • Competent person will inspect equipment daily prior to each use. No equipment will be placed in service until all deficiencies are corrected • Complete daily equipment inspection form will be completed by the operator • Weekly inspection of first aid kits • Monthly and annual inspection of fire extinguishers • GFCIs (at least monthly).

Vision Integrity Results	ECC	DAILY SAFETY MEETING SIGN-IN SHEET

Date: _____ Project Name/Location: Redstone Arsenal

Company: ECC Person Conducting Briefing: _____

1. AWARENESS (e.g., Hazards, special EHS concerns, pollution prevention, recent incidents, etc.):

2. OTHER ISSUES (HASP changes, new AHAs, attendee comments, etc.):

3. DISCUSSION OF DAILY ACTIVITIES/TASKS AND SAFETY (PPE) MEASURES TO BE USED:

4. Hospital Information

Name: Huntsville Hospital

Address: 101 Sivley Rd SW

Phone: 256 – 265-1000

Directions: Exit Arsenal via Rideout Road. Merge onto -565 East. Take exit 19C for Jefferson St NW towards downtown (0.3 mi). Continue on Jefferson St. North (0.2 mi). Turn Right onto Monroe St NW(0.5 mi). Turn left onto Church St (0.5 mi). Turn left onto Williams Ave SW (0.2 mi). Turn right onto Madison St SE (0.5 mi), Turn Right into Hospital.

5. ATTENDEES (Print Name):

1.	2.
3.	4.
5.	6.
7.	8.
9.	10.

WORKER ACKNOWLEDGEMENT OF THE SITE SAFETY AND HEALTH PLAN AND SITE ORIENTATION

I have read or been trained to the contents of this Site Safety and Health Plan (SSHP). I understand the contents, and I agree to abide by its requirements. I understand that failure to comply with the provisions of this plan can lead to disciplinary action and possible termination from the project. Documentation of worker acknowledgment will be placed in the Project Records.

APP/Site Safety and Health Plan (SSHP)/Site Orientation Acknowledgment Form

Printed Name	Signature	Date

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ATTACHMENT 2A
EMERGENCY ACTION PLAN
AND
ATTACHMENT 2B
FIRE PREVENTION AND PROTECTION PLAN

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ATTACHMENT 2A
EMERGENCY ACTION PLAN

1.0 PROJECT

Contract Number: W9124J-18-D-0004
Delivery Order W9124J-22-F-045
Project Name: Environmental Remediation Services
Location: Redstone Arsenal (RSA), Alabama

2.0 PRE-EMERGENCY PLANNING

This section includes information needed for pre-planning for emergencies.

2.1 Emergency Contact List

Table A2A-1 EMERGENCY CALL LIST AND PROJECT ORGANIZATION

Name or Organization	Title	Phone number(s)
Fire/Ambulance/Police/ Emergency Redstone Arsenal (RSA)		For all emergencies: 911 For non-emergency RSA police/fire: (256) 876-2222
Hospital	Huntsville Hospital	(256) 265-1000
Clinic	Huntsville Hospital Urgent Care	(256) 539-0781
Occupational Medicine	Peter Greaney, MD / WorkCare, or US HealthWorks	(800) 455-6155 (714) 288-8303
Poison Control	Poison Control	(800) 256-9822
Jennifer Graham	Contracting Officer's Representative (COR)	Office: (210) 466-1406
Clint Howard	Army – RSA Branch Chief-Environmental Restoration	Office (256) 8423702
Pam Foti, Certified Hazardous Materials Manager (CHMM) Project Management Professional (PMP)	Project Manager (PM)	Mobile: (508) 274-3084
Carol Canada, Professional Geologist (PG)	Assistant PM	Mobile: (615) 693-9915
Kym Edelman, Certified Safety Professional (CSP), Certified Industrial Hygienist (CIH)	Safety and Health Manager (SHM)	Mobile: (757) 496-5622
Brian Kateley	Site Safety and Health Officer (SSHO) (Primary) (first aid/ Cardiopulmonary Resuscitation [CPR] provider)	Mobile: (410) 671-2970
Aaron Glad	Site Superintendent – alternate (first aid/ CPR provider)	Mobile: (508) 229-2270
First Aid/CPR providers	SSHOs	See above
ECC HOTLINE	ECC	650-347-7512 Ext 111

KEY PROJECT PERSONNEL ARE TO HAVE A COPY OF THIS LIST READILY AVAILABLE AT ALL TIMES

2.2 Coordination with Local Emergency Agencies

Local authorities and emergency services will be contacted prior to initiation of work. The work objectives and on-site capabilities will be explained, as well as the most likely emergencies. Preferred contact procedures will be established and the response capabilities of local responders will be determined. Environmental Chemical Corporation (ECC) will ensure there is good coordination between our emergency plan and local requirements. The Site Safety and Health Officer (SSHO) will document this meeting in the project files.

3.0 PERSONNEL ROLES AND LINES OF AUTHORITY

During all emergencies, the SSHO will serve as the SSHO. He will work to abate and/or contain the emergency.

4.0 EMERGENCY RECOGNITION AND PREVENTION

Conditions that may lead to an emergency situation during field activities will be addressed in specific Activity Hazard Analyses (AHAs) as tasks are identified or the **Attachment 1**. These conditions include:

- Incident involving a serious injury
- Fire
- Environmental release
- Severe weather

Before daily work assignments, regular "tailgate/toolbox" safety meetings should be held. Discussions should include, but not limited to:

- Specific task to be performed (Plan of the Day)
- Weather conditions (if severe weather is anticipated, evacuation routes/rally points will be discussed)
- Time Constraints (e.g. rest breaks, tide restrictions, 24-hour operations)
- Hazards that may be encountered, including their effects, how to recognize symptoms or monitor them, concentration limits, or other danger signals
- Near misses from the previous day's work
- Emergency Procedures

5.0 SAFE DISTANCES AND SAFE ZONES

If severe weather is anticipated, places of refuge and rally points will be discussed at the daily tailgate meeting.

For releases of hazardous material, the SSHO will monitor the rally point to ensure exposure to hazardous materials is not likely to occur. The evacuation routes and rally points during a fire or environmental release may be modified during the response due to wind direction and potential exposure situations. Personnel must remain alert for changes to alternate routes and rally locations.

6.0 SITE SECURITY AND CONTROL

Site control procedures for this project will include the establishment of Work Zones in order to provide site security by avoiding unauthorized access and to secure work locations between shifts. On this project, work zones may be established by using appropriate work area signage in combination with warning or danger tape, barricades, or other measures selected for the sites, if deemed necessary.

The SSHO, as well as employees, will stay alert for any unauthorized entry and take necessary actions to control the work area.

Authorized site visitors may visit the site upon meeting the following conditions:

- Receiving site hazard and safety instructions from the SSHO; to include Emergency Response procedures briefing
- Reviewing and complying with the essential elements of the Accident Prevention Plan (APP)

- Using their own, or provided Personal Protective Equipment (PPE), to enter regulated work areas per the APP
- Reporting any observed unsafe act and/or condition at, or affecting, the work site

Visitors will be evacuated from the incident location, or from the site, during emergency activities.

7.0 EVACUATION ROUTES AND PROCEDURES

Evacuation routes and procedures will be reviewed and discussed regularly during tailgate meetings.

8.0 EMERGENCY MEDICAL TREATMENT (FIRST AID/CPR/AED)

At least two employees certified in both First Aid, Cardiopulmonary Resuscitation (CPR), and Automated External Defibrillator (AED) use be on the project at all times. A First Aid kit must be maintained on site and checked weekly (EM 385-1-1 section 03.B.02). First aid kit will be maintained by the SSHO. A log of First Aid treatment and materials used will also be maintained by SSHO.

If an injury or illness requires more than First Aid, but is not an emergency, the employee will be taken to Huntsville Hospital Urgent Care for examination or observation, after contacting the ECC Corporate Medical Provider, Dr. Greaney, or his alternate at WorkCare (1-800-455-6155). The Huntsville Hospital Urgent Care route can be found in **Figure A2A-1**.

If the injury or illness is considered an emergency, call 911 and an installation ambulance service will be contacted to transport the victim to the Huntsville Hospital. The route can be found in **Figure A2A-2**.

9.0 RESCUE OPERATIONS

Where employees are engaged in one of the following activities or environments, a rescue plan will be incorporated into the AHA or appropriate site-specific plan:

- Working at elevations – not anticipated
- Using personal fall arrest systems – not anticipated
- Working alone – not anticipated
- Confined spaces, or potentially immediately dangerous to life and health atmospheres – not anticipated

10.0 EMERGENCY ALERTING AND RESPONSE NOTIFICATION

An employee alarm system will consist of the use of verbal instructions, either directly or via radio.

Cellphone of telephones will be used to contact emergency responders. **Table A2A-1** of this Plan will be kept in site vehicles. The following information will be communicated:

- Name of the person reporting the emergency
- Telephone number at the location of the person making the call
- Name of the injured person, if known
- Description of the emergency
- Exact location of the emergency
- Actions already taken
- What assistance is needed

Although not anticipated, if an employee is working alone in remote area, he/she will have either two-way radios or cell phones. The employee will be required to check in/check out with the SSHO with an agreed upon frequency before employee leaves for the remote work.

11.0 PERSONAL PROTECTIVE EQUIPMENT AND EMERGENCY EQUIPMENT

Each field team will have quick access to a First Aid kit, cell phone, bloodborne pathogen prevention PPE, and fire extinguisher.

12.0 SITE LAYOUT AND PREVAILING WEATHER CONDITIONS

See **Attachment 3** for hospital and clinic routes; due to the numerous sites for this project, the rally points and procedures will be discussed regularly during the daily tailgate meetings.

13.0 REPORTING PROCEDURES

All emergencies will be immediately communicated to the SSHO who will initiate emergency response procedures and notify the Contracting Officer's Representative (COR) and appropriate response personnel.

After the response, ECC will prepare an Incident Report. It will include such things as a chronological history of the emergency facts, actions taken, personnel present, sample results (if taken), summary of injuries, and possible exposures. For spills and releases it will also include:

- Description of material spilled, including identity, quantity, and a copy of the Safety Data Sheet (SDS) or waste disposal manifest
- Exact time and location of the spill, and the description of the area involved
- Containment procedures utilized
- Description of the cleanup procedure employed at the site, including disposal of spill residue
- Summary of the communications ECC had with other agencies.

This report will be given to the Army within 24 hours of the incident along with immediate verbal notification.

The report will also contain a critique of the response and modifications to this plan will be made if necessary, to adequately address subsequent emergencies.

14.0 TRAINING

The Emergency Response Plan will be discussed during initial site training and discussed regularly during the Daily Tailgate Safety Meetings. Due to the short timeframes of field events drill test will not be necessary.

15.0 PROCEDURES

Emergency Action Procedures - Injury and Medical Emergency

Prevention:

Wear proper PPE at all times. Implement precautions in AHA. Follow standard operating procedures (SOPs). Avoid pinch points, struck by hazards and exposures to falls from elevation. Report all hazards, injuries and illnesses to your supervisor SSHO immediately. Follow instructions on all prescription medications. Stay hydrated.

Recognition and Reporting:

If an injury, illness or medical condition arises, notify your nearest co-worker immediately. Have them call the SSHO or your supervisor.

All First Aid Providers will be contacted immediately and will report to location of the injured person. See **Table 2A1-1** contact list.

Actions:

1. First Aid Providers will do an immediate area and victim assessment in accordance with their training.
2. Call 911 or local emergency notification number immediately if any of the following situations exist:
    a. Unconscious
    b. Severe bleeding
    c. Head or spine injury is suspected
    d. Seizures
    e. No pulse
    f. No breathing
    g. Overdose situation possible
    h. Situation requires rescue/medical evacuation (fire, airborne release, workplace violence, trapped)
    i. Any other situation where the condition of the patient is in question. If in doubt contact 911.
3. Establish clear area or have ambulatory patient move to a safe location.
4. Apply Universal Precautions per Bloodborne Pathogens Exposure Control Plan (Attachment 6 of APP) and training, and don PPE (disposable gloves, CPR mask, etc.).
5. Provide appropriate First Aid/CPR/AED consistent with training and certification.
6. Provide complete information to emergency medical technicians, if necessary.
7. Clean area and contain potentially contaminated materials and articles in labeled bag per Bloodborne Pathogens Exposure Control Plan (Attachment 6 of APP).
8. Participate in incident investigation, provide for and monitor medical follow up if necessary.

Emergency Action Procedures - Fire

Prevention:

See Fire Prevention and Protection Plan, **Attachment 2B**.

Recognition and Reporting:

Call designated base emergency services number upon observation of any uncontrolled fire or smoke.

Actions:

1. Always alert the emergency management system first, regardless of the size of the fire
2. Use fire extinguisher if:
    a. You have been trained
    b. You have an escape route behind you
    c. The fire is small (incipient stage) and can likely be put out with one extinguisher in about 10 seconds.

3. If the fire cannot be controlled with a fire extinguisher:
    a. Notify Site Superintendent or SSHO and initiate evacuation procedure immediately.
    b. The SSHO will notify site personnel and client representatives of evacuation order.
    c. The SSHO will ensure evacuation alarms are sounded, and evacuation proceeds in accordance with Evacuation Plan.
4. If the fire is controlled by a fire extinguisher:
    a. Call for another fire extinguisher for stand by
    b. Remove potential sources of fuel and ignition
    c. Stay at the location until relieved by the SSHO or Fire Department to watch for re-ignition.
5. Participate in incident investigation.

Emergency Action Procedures - Evacuation

Prevention:

Most emergency evacuations can be prevented by following the APP and by practicing safe behaviors. Report all hazards and suspicious activities immediately.

Recognition and Reporting:

Emergency evacuation of the site may be prompted by various situations, including but not limited to the following:

- Fires
- Hazardous material releases
- Sudden severe weather events
- Workplace violence or terrorism
- Utility damage
- Off-site emergency that may impact site operations.

Report potential emergency conditions immediately to your Supervisor or the SSHO. Call 911. See **Table A2A-1** contact list.

Actions:

1. In the event of an emergency, the SSHO may initiate evacuation of the site by sounding the evacuation alert - one long blast on the air horn or make verbal contact
2. Call local 911 or emergency notification number
3. The SSHO will notify and coordinate with client representatives, RSA personnel, and emergency responders
4. Upon arrival of emergency response personnel, the SSHO will report to and assist the Incident Commander (lead from local emergency response team)
5. The SSHO will retrieve the daily sign in logs and proceed to the rally point
6. All personnel, upon hearing the evacuation alert, or receiving verbal instructions to evacuate will immediately proceed along the designated route to the rally point which will be discussed at each daily tailgate meeting
7. In the event of a fire or release of airborne toxic chemical, check local wind indicators. Evacuate in a direction perpendicular to the wind direction if possible
8. Be attentive for instructions on changes in rally location based on site conditions

9. In some cases, a shelter-in-place order may be given. In that case, close doors and windows and shut off ventilation system
10. Report to your Supervisor at the rally point
11. Supervisors will report on the presence of crew members to SSHO for accountability purposes.
12. Look around for friends and co-workers. Report anyone missing to the SSHO
13. Critical plant operations – there are no critical plant operations on this project. Upon hearing the evacuation alert, all personnel will shut off power tools and equipment and proceed immediately to the rally point
14. Rescue procedures are included in the Fall Prevention and Protection Plan or Confined Space Entry Plan, if applicable. Once an evacuation order is given, rescue activities will be turned over to off-site emergency responders
15. Site First Aid Providers will render First Aid and support to injured personnel at the rally point. In an evacuation, the local Emergency Medical Service will be notified and will take charge of medical support
16. The SSHO will report the status of evacuated personnel to the Incident Commander, including the name, description and last known location of any unaccounted for individuals
17. Site(s) may be re-entered when the SSHO gives the "all clear" order. An incident investigation will begin immediately, led by the SSHO.

Emergency Action Procedures - Severe Weather

Prevention:

The SSHO will monitor the weather at least twice daily. Weather monitoring will become continuous when the National Weather Service issues a severe weather Watch or Warning.

Recognition and Reporting:

A Watch means that a weather emergency is possible. It means Be Prepared. On issuance of a Watch, the SSHO will determine what site preparations will be made to secure the site, shut down, evacuate or call off a scheduled work shift.

A Warning means that a weather emergency is in the area. It means Take Action. Upon issuance of a Warning, the SSHO will implement emergency shut down procedures.

Actions:

1. Thunderstorm, Lightning, Tornado
    a. Remove loose or stacked materials from roofs, or open floor decks
    b. Remove from site or secure stacks of materials at ground level
    c. Lightning - Stop outdoor activities involving load handling equipment, roofing, working on elevating platforms and scaffolds, tree trimming, or work in open areas upon hearing thunder or seeing lightning. Seek indoor shelter. Stay indoors for 30 minutes after the last audible thunder or visible flash of light
    d. Proceed to pre-determined tornado shelter upon issuance of a Warning. The SSHO will work with RSA personnel or local emergency agencies to identify shelters during mobilization.

Emergency Action Procedures - Spills and Releases of Hazardous Materials

Prevention:

Supervisors will review the hazards of chemicals with their work crews, and SDS and labels will be maintained in accordance with the Hazard Communication Program.

- **Avoid mixing chemicals**, even common household products. Some combinations, such as ammonia and bleach, can create toxic gases. When in doubt, consult the SDS or the SSHO.
- **Always read and follow the directions** when using a new product. Some products should not be used in small, confined spaces to avoid inhaling dangerous vapors. Other products should not be used without gloves and eye protection to help prevent the chemical from touching your body.
- **Store chemical products properly.** Non-food products should be stored tightly closed in their original containers so you can always identify the contents of each container and how to properly use the product. Containers of flammable and combustible liquids will be stored in flammable liquid storage cabinets or removed from the site at the end of the day. Bulk storage of fuels or other hazardous materials will have secondary containment, and containment around transfer valves, spigots and hoses.
- **Report and Clean up any spills immediately** with some rags, being careful to protect your eyes and skin.
- **Follow operating procedures**. Implement procedures designed to limit open containers, excess pressure, surface area of contaminated environmental media, drum and container handling, etc.
- **Implement the Storm Water Pollution Prevention Plan** if one is required on the site, or general good chemical handling practices to keep materials from flowing off-site with stormwater.

Recognition and Reporting:

Notify your Supervisor or the SSHO of any spill or airborne release of hazardous materials. The SSHO will investigate and determine if an emergency should be declared and will issue an alert to evacuate or shelter-in-place if necessary. The SSHO will call the RSA emergency services if an emergency is declared.

The SSHO will notify the client representative immediately of any spill or release. Where reporting to installation and regulatory agencies is required, the reporting will be done in accordance with the communications plan approved by the Contracting Officer. See Contact List **Table A2A-1**.

Actions:

The actions to be taken will depend on the nature and extent of the release. Only personnel trained in the procedures and PPE required to handle the spill or release should be involved in containing, stabilizing, and cleaning up the material.

1. If a release from an on-site or off-site source results in a shelter-in-place order:
    a. Proceed to the nearest designated shelter
    b. Shut doors and windows
    c. Turn off ventilation system.
    d. If possible, seal gaps around doors and window with tape, wet towels or other items
2. Take immediate measures to control and contain the release (e.g. shut off pumps, close valves).
3. Contact local emergency service providers.
4. Don protective equipment as specified by the SSHO.
5. If exposure to individuals causes injury/health effects, make sure the area is safe before attempting rescue or First Aid. If safe to do so, move them to fresh air and apply appropriate First Aid. Notify the Emergency Medical Service of the nature of injury.
6. Isolate and contain hazardous release areas.
7. Deny entry to the spill area to unauthorized personnel.
8. Do not allow anyone to touch spilled material.
9. Stay upwind, keep out of low areas.

10. Keep combustible materials away from the spilled material.
11. Use water spray or foam to reduce dust or vapors as needed.
12. Collect samples for analysis to determine that cleanup is adequate.
13. If the release is from tanks, prevent the discharge from traveling beyond site boundaries.
14. Containerize materials and arrange for proper disposal.
15. Take caution when handling drums and containers (opening, sampling, and over packing).

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ATTACHMENT 2B
FIRE PREVENTION AND PROTECTION PLAN

1.0 PROJECT

Contract Number: W9124J-18-D-0004
Delivery Order W9124J-22-F-045
Project Name: Environmental Remediation Services
Location: Redstone Arsenal (RSA), Alabama

2.0 SCOPE

This Plan applies to all activities, including subcontractor activities for the project identified above.

3.0 LIST OF MAJOR WORKPLACE FIRE HAZARDS

On this project, the major workplace fire hazards will include:

- Normal combustibles including transmitter building, trash, construction materials, vegetation and waste piles. Good housekeeping will be maintained. Trash will be collected daily and placed in a designated receptacle.
- Combustible and flammable liquids used as fuels in site vehicles, mobile construction equipment and power tools.
    - Gasoline will be kept in labeled five-gallon metal safety cans with flame arrestor and spring-loaded lid, or in Underwriters Laboratories (UL) approved one to two-gallon plastic cans.
    - Diesel fuel will be kept in labeled UL approved containers.
    - A temporary Diesel fuel tank will be protected with barriers and secondary containment.
    - The refueling area is shown on the Site Layout.

4.0 CONTROL OF IGNITION SOURCES

- Smoking is prohibited inside vehicles and buildings. A designated smoking area will be established during mobilization and supplied with a self-extinguishing ash tray stand.
- Temporary fuel storage tanks will be protected from accidental impact by vehicles and equipment.
- Storage tanks will be double-walled or have other secondary containment measures which will have a capacity of at least the tank volume +10 percent (%). Secondary containment will be inspected regularly and kept free of accumulation of liquids, including rainwater to ensure sufficient free board at all times.
- Tanks, pumps and hoses will be rated/approved and listed for the service and will include appropriate bonding to control static sparks.
- Hose nozzles used to fill equipment from the temporary tank will be automatic closing and will not be equipped with a latch-open device. All filling and transfer operations will be attended.
- Normal combustibles, including high vegetation will be kept at least 25 feet from the refueling area.
- Sources of ignition will be prohibited within 25 feet of the refueling area.
- Equipment with small engines will not be fueled while hot.
- The refueling area will be posted with signs, including “No Smoking”, “No Hot Work”, and “Do not fuel hot equipment.”
- A Fire Extinguisher rated at least 40 B:C will be placed in a fixed and visibly labeled location within 100 feet of the refueling area.
- Tanks will have appropriate hazard warning labels.
- A spill kit suitable for minor spills and leaks of petroleum products will be stationed at the refueling area.

- The refueling area, equipment, and emergency supplies will be inspected as needed.
- Small portable containers of flammable liquids will be stored out of direct sunlight and in a designated location. A Flammable liquid storage cabinet will be used if more than two containers of flammable liquids are stored on site. The cabinet will include a "No Smoking" label.

See **Section 9.0** below for Hot Work requirements.

5.0 TYPES OF FIRE SUPPRESSION EQUIPMENT

Portable fire extinguishers will be selected and distributed as follows:

- Fire extinguishers rated to 1-A:10-B:C or higher, will be in all work vehicles, mobile construction equipment, and in the immediate vicinity of stored flammable materials.
- 40-B:C extinguisher in the refueling area.
- 4-A: 60-B:C (10-pound agent minimum) at each hot work location.
- Not anticipated, but if in buildings under construction, alteration or demolition, at least one 4-A:6-0B:C extinguisher will be located per every 6,000 square feet of floor space, on each floor. Extinguishers shall not require a travel distance of more than 75 feet, and one extinguisher on each floor should be placed close to the stairways. Note: If unusual fire hazards exist, consult National Fire Protection Association (NFPA) 10 for additional selection and distribution information.
- The equipment will not be removed except for inspection and/or use in an emergency.
- The Site Safety and Health Officer (SSHO) will provide training on the use of the fire extinguisher during the pre-entry briefing.
- Fire extinguishers will be visually inspected monthly.

6.0 RESPONSIBILITIES FOR MAINTAINING EQUIPMENT AND SYSTEMS

The SSHO will be responsible for inspection of work areas on a daily basis, and inspection of fire extinguishers on a monthly basis.

Fixed systems in buildings under construction, alteration or demolition will be inspected by, or under the direction of the Authority Having Jurisdiction.

7.0 PERSONNEL RESPONSIBLE FOR CONTROLLING FUEL SOURCE HAZARDS

The SSHO is responsible for controlling fuel source hazards, in accordance with this Plan. This includes regular inspections of areas and equipment, maintaining adequate freeboard in secondary containment, limiting combustibles around fuel storage and dispensing operations, and ensuring control of ignition sources in these areas.

8.0 HOUSEKEEPING PROCEDURES

Trash will not be permitted to accumulate. Receptacles with lids or roll off boxes will be used to contain trash. Work areas will be cleaned up each day, as often as necessary to maintain a safe job site.

Waste piles will be limited in size, segregated and removed from site as soon as possible.

Spills of flammable and combustible materials will be contained and cleaned up as soon as possible. See Emergency Action Plan, **Attachment 2A** of the Site Safety and Health Plan (SSHP).

9.0 HOT WORK PERMITS

Hot work is defined as any process that produces open flames, heat or sparks, including, but not limited to: burning, cutting, welding, soldering, brazing, torch applied roofing, and the use of temporary heating devices involving an open flame or exposed heating elements.

Before any hot work is performed, ECC personnel shall obtain a Hot Work Permit from the U.S. Army local authority. A hot work site will have a designated fire watch. This person's sole responsibility shall be to monitor the hot work and have immediate access to the fire extinguisher located at each hot work site (a portable fire extinguisher [A:B:C] will be readily available). The fire watch shall remain at his/her designated watch for 30 minutes from the conclusion of hot work activities.

It is the responsibility of the SSHO to work with the Army or local authority/permit issuing group to establish the requirements, definitions, and regulations. In general, a hot work permit is required from the local hosting facility when the hot work is being performed on a pre-existing building/structure or new attachment to an existing structure. If the hot work is solely on a new building/structure not connected to a preexisting structure and has not been handed over to client or end user, then an ECC Hot Work permit can be used. This should be communicated prior to the start of any hot work activities.

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ATTACHMENT 3

MEDICAL SUPPORT PLAN

ATTACHMENT 3
MEDICAL SUPPORT PLAN

1.0 PROJECT

Contract Number: W9124J-18-D-0004
Delivery Order W9124J-22-F-045
Project Name: Environmental Remediation Services
Location: Redstone Arsenal (RSA), Alabama

2.0 SCOPE

This plan provides information for medical support for all operations at the project identified above.

3.0 COMMUNICATION

The site will have ready communications to medical support facilities via cell phone. Phone numbers are listed on the Emergency Contact List (Emergency Action Plan, **Attachment 2A**, **Table A2A1-1**) and the list will be kept in all site vehicles.

4.0 FIRST AID AND MEDICAL FACILITIES

Minor injuries will be treated on-site by certified First Aid Providers (see Emergency Contact List). If additional care is needed, the local facility, Huntsville Hospital Urgent Care**,** will be used. **Figure A3-1** shows the route map to the facility.

If an incident results in a major injury, call 911 for ambulance. Environmental Chemical Corporation (ECC) will not transport non-ambulatory, unconscious or shock risk patients. **Figure A3-2** is the route map to Huntsville Hospital. Copies of the route maps will be kept in all site vehicles.

Medical consultation can be obtained from ECC's occupational medical consultant, Dr. Greaney or his associates at WorkCare, Inc. WorkCare should be called before transporting any minor injury to the local clinic or emergency room.

At least one First Aid kit for every 25 employees will be kept on-site. The First Aid kits will comply with American National Standards Institute (ANSI) Z308.1. All kits will contain bloodborne pathogen prevention personal protective equipment (PPE) including surgical gloves and resuscitator mask or shield.

At least two individuals with current certification in First Aid and Cardiopulmonary Resuscitation (CPR) will available on each shift.

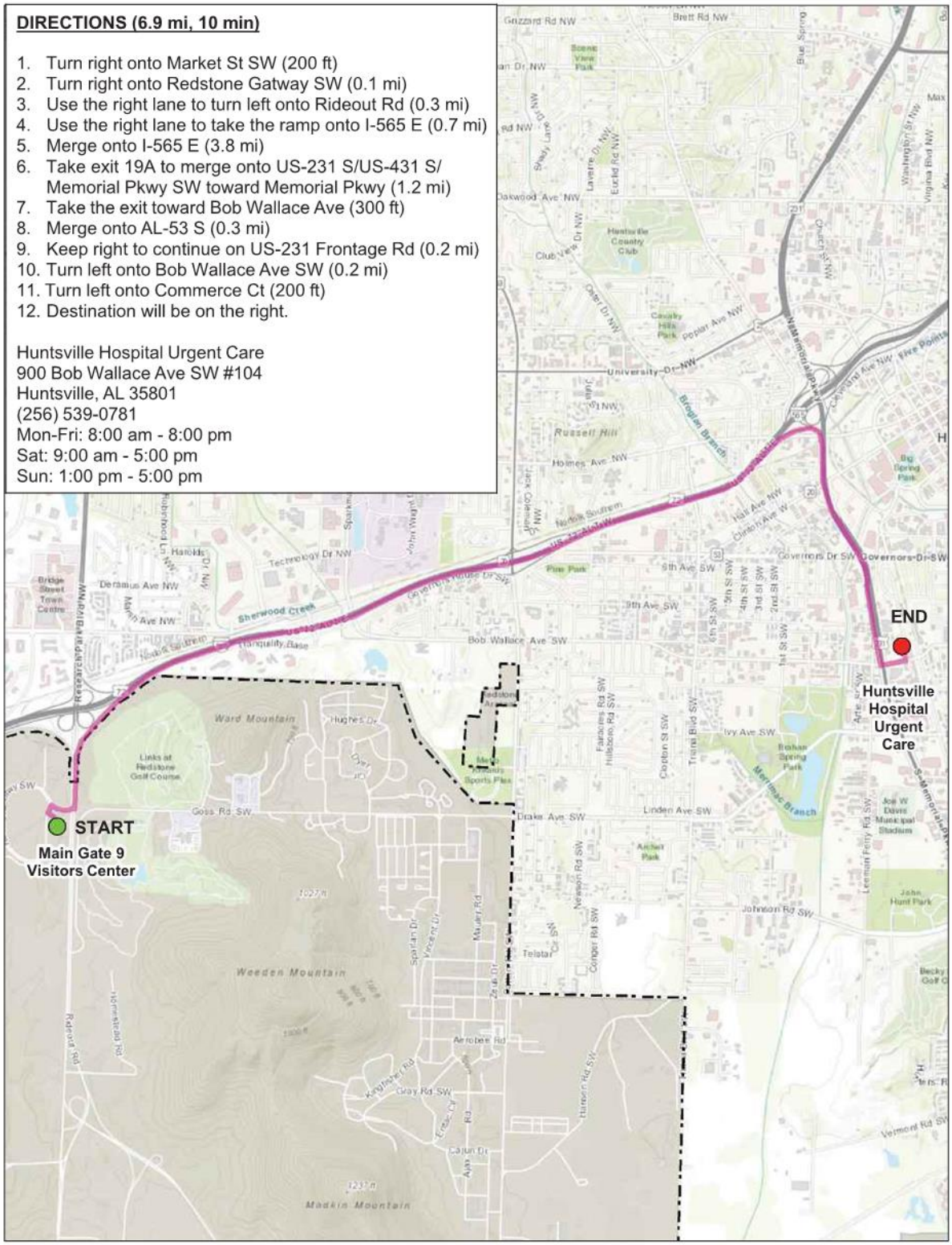
Each will have current certification in First Aid and CPR from the American Red Cross, the American Heart Association, or from an organization whose training adheres to the standards of the International Liaison Committee on Resuscitation (as stated in writing), or from a Licensed Physician. Certification courses will have hands-on component that cannot be taken on-line. Retraining will occur every two years.

First Aid Providers on this project include the Site Safety and Health Officers (SSHOs) Mr. Brian Kateley and Mr. Aaron Glad. They are First Aid and CPR trained; are qualified to administer First Aid and CPR; and have completed Bloodborne Pathogen training in accordance with 29 Code of Federal Regulations (CFR) 1910.1030. Their duties are to provide First Aid/CPR in accordance with their training.

DIRECTIONS (6.9 mi, 10 min)

1. Turn right onto Market St SW (200 ft)
2. Turn right onto Redstone Gatway SW (0.1 mi)
3. Use the right lane to turn left onto Rideout Rd (0.3 mi)
4. Use the right lane to take the ramp onto I-565 E (0.7 mi)
5. Merge onto I-565 E (3.8 mi)
6. Take exit 19A to merge onto US-231 S/US-431 S/ Memorial Pkwy SW toward Memorial Pkwy (1.2 mi)
7. Take the exit toward Bob Wallace Ave (300 ft)
8. Merge onto AL-53 S (0.3 mi)
9. Keep right to continue on US-231 Frontage Rd (0.2 mi)
10. Turn left onto Bob Wallace Ave SW (0.2 mi)
11. Turn left onto Commerce Ct (200 ft)
12. Destination will be on the right.

Huntsville Hospital Urgent Care
900 Bob Wallace Ave SW #104
Huntsville, AL 35801
(256) 539-0781
Mon-Fri: 8:00 am - 8:00 pm
Sat: 9:00 am - 5:00 pm
Sun: 1:00 pm - 5:00 pm



LEGEND

- Clinic Route
- Redstone Arsenal



NOTES
1. Coordinate System: NAD83 State Plane Alabama East, US Feet (FIPS 0101)
2. Basemap data from IGI&S Office at Redstone Arsenal
3. Map Size: B-size (17" x11")
4. Revision Date: 2/8/2021

Figure A3-1

Clinic Route Map
Redstone Arsenal
Madison County, Alabama

0 3,500 7,000 Feet

1 inch = 2,778 feet

Mission & Installation Contracting Command (MICC)
U.S. Army Garrison-Redstone

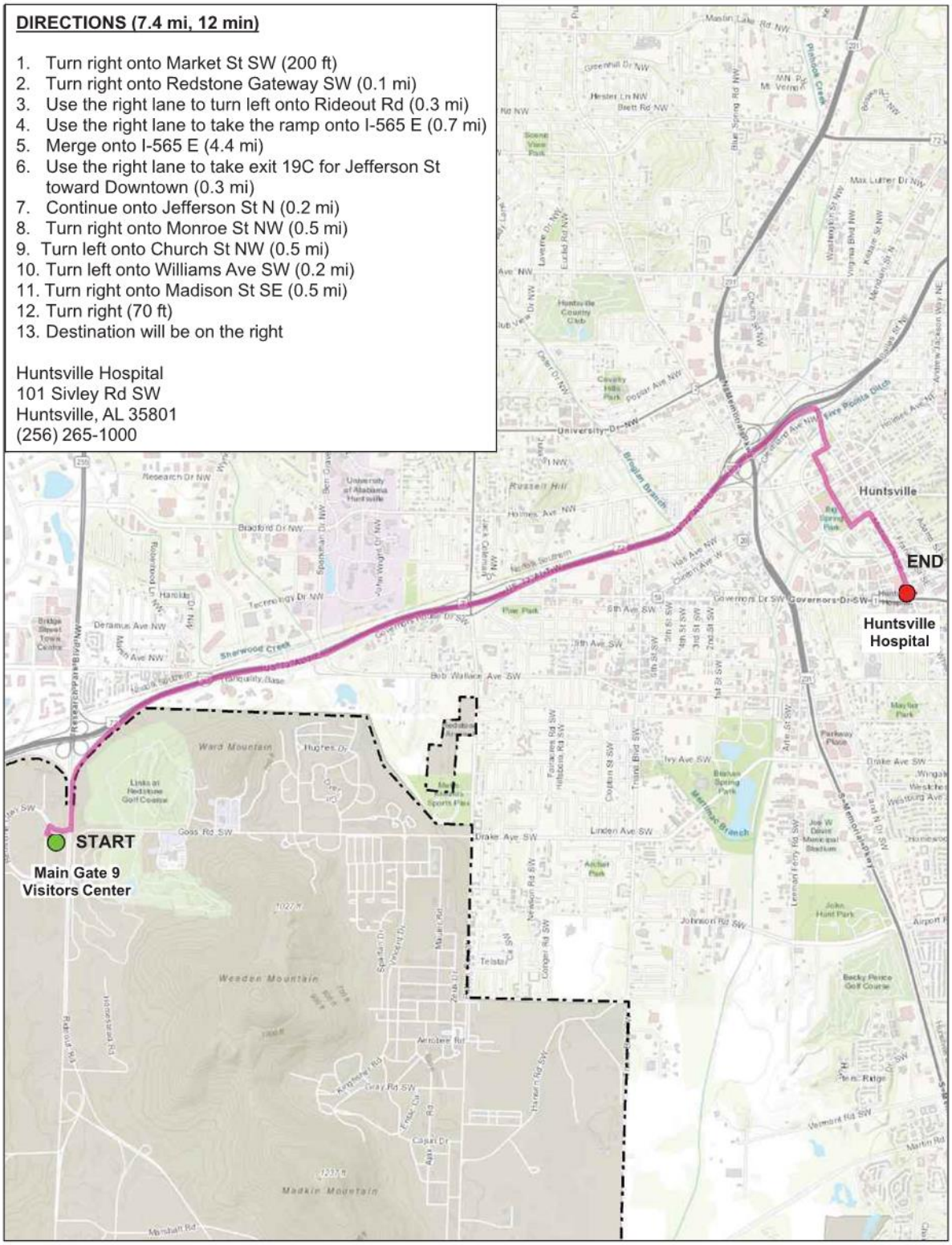
DISCLAIMER: The data represent the results of data collection/processing for a specific Redstone Arsenal activity and indicates the general existing conditions. As such, it is only valid for its intended use, content, time, and accuracy specifications. The user is responsible for the results of any application of the data for other than its intended purpose.

ECC GIS Server: E:\Projects\Redstone\MapDocument\APP\Fig3-1_RSA_APP_ClinicMap.mxd

DIRECTIONS (7.4 mi, 12 min)

1. Turn right onto Market St SW (200 ft)
2. Turn right onto Redstone Gateway SW (0.1 mi)
3. Use the right lane to turn left onto Rideout Rd (0.3 mi)
4. Use the right lane to take the ramp onto I-565 E (0.7 mi)
5. Merge onto I-565 E (4.4 mi)
6. Use the right lane to take exit 19C for Jefferson St toward Downtown (0.3 mi)
7. Continue onto Jefferson St N (0.2 mi)
8. Turn right onto Monroe St NW (0.5 mi)
9. Turn left onto Church St NW (0.5 mi)
10. Turn left onto Williams Ave SW (0.2 mi)
11. Turn right onto Madison St SE (0.5 mi)
12. Turn right (70 ft)
13. Destination will be on the right

Huntsville Hospital
101 Sivley Rd SW
Huntsville, AL 35801
(256) 265-1000



LEGEND

- Hospital Route
- Redstone Arsenal



NOTES
1. Coordinate System: NAD83 State Plane Alabama East, US Feet (FIPS 0101)
2. Basemap data from IGI&S Office at Redstone Arsenal
3. Map Size: B-size (17" x11")
4. Revision Date: 2/8/2021

Figure A3-2

Hospital Route Map
Redstone Arsenal
Madison County, Alabama

0 4,000 8,000 Feet

1 inch = 3,045 feet

Mission & Installation Contracting Command (MICC)
U.S. Army Garrison-Redstone

DISCLAIMER: The data represent the results of data collection/processing for a specific Redstone Arsenal activity and indicates the general existing conditions. As such, it is only valid for its intended use, content, time, and accuracy specifications. The user is responsible for the results of any application of the data for other than its intended purpose.

ECC GIS Server: E:\Projects\Redstone\MapDocument\APP\Fig\A3-2_RSA_APP_HospitalMap.mxd

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ATTACHMENT 4A
HEAT STRESS MONITORING PLAN
AND
ATTACHMENT 4B
COLD STRESS MONITORING PLAN

ATTACHMENT 4A
HEAT STRESS MONITORING PLAN

1.0 PROJECT

Contract Number: W9124J-18-D-0004
Delivery Order W9124J-22-F-045
Project Name: Environmental Remediation Services
Location: Redstone Arsenal (RSA), Alabama

2.0 SCOPE

This Plan applies to the project identified above and will be incorporated into the Site Safety and Health Plan (SSHP). Subcontractors are required to comply with this program by virtual of their coverage under the Accident Prevention Plan (APP).

3.0 PROCEDURES

3.1 Heat Stress And Heat Strain

Heat stress is the net heat load to which a worker may be exposed from the combined contributions of metabolic cost of work, environmental factors and clothing requirements. Heat stress is a hazard during warm weather or when personnel are wearing Personal Protective Equipment (PPE) that aggravates the heat stress hazard. Heat stress can occur even when temperatures are moderate if the body's physiological processes fail to maintain a normal body temperature.

Heat strain is the overall physiological response resulting from heat stress. The resulting physical reactions that occur are fatigue, irritability, anxiety, and a decrease in concentration, dexterity, and/or movement. Onset of signs and symptoms of exposure can occur rapidly, and may progress to a medical emergency (i.e., heat stroke) without intervention. In extreme cases, death can result if the patient is not given immediate treatment.

3.1.1 Symptoms of Heat Exhaustion

Heat exhaustion occurs when your body cannot sweat enough to cool you off. It generally happens when you are working or exercising in hot weather. Symptoms include:

- Fatigue, weakness, dizziness, or nausea
- Cool, clammy, pale, red, or flushed skin
- Heavy sweating

First Aid for Heat Exhaustion

- Get the person out of the sun and into a shady or air-conditioned location
- Lay the person down and elevate the legs and feet slightly
- Loosen or remove the person's clothing
- Have the person drink cool water, not iced, or a sports drink containing electrolytes
- Cool the person by spraying or sponging him or her with cool water and fanning
- Monitor the person carefully. Heat exhaustion can quickly become heatstroke. If fever greater than 102 degrees Fahrenheit (ºF), fainting, confusion or seizures occur, call for emergency medical assistance.

3.1.2 Symptoms of Heat Stoke

Heat exhaustion can sometimes lead to a heat stroke. Heat stoke requires emergency treatment. It happens when your body stops sweating but the body temperature continues to rise, often to 105°F or higher. Symptoms include the following:

- Cessation of sweating
- Confusion, delirium, or unconsciousness
- Hot, dry, red or flushed skin, even under the arm pits
- Rapid and shallow breathing
- Chills
- Irritability
- Malaise
- Disorientation or confusion

First Aid for Heat Stroke

- It is vital to lower a heat stroke victim's body temperature. Seconds count.
- Call emergency medical assistance and get an ambulance on the way as soon as possible.
- Move the person out of the sun and into a shady or air-conditioned space.
- Pour water on them, fan them, apply cold packs.

3.2 CONTROL MEASURES

Where monitoring indicates a possible heat stress hazard the following safety procedures shall be implemented:

General Controls

- Review signs and symptoms of heat strain, as well as controls and First Aid measures with site personnel.
- Encourage employees to eat a normal diet and get proper rest.
- Encourage employees to refrain from consuming diuretics, including caffeine from coffee and tea beverages, or any form of alcohol. (*Note: Consumption of alcohol is prohibited during working hours*). Counsel and monitor workers on medications that may affect blood pressure, sweating, body temperature regulation, or kidney function.
- Adjust expectations of those returning to work after absence from heat exposure situations and encourage them to eat salty foods (with approval of physician for those on salt-restricted diets).
- Provide potable drinking water and encourage workers to about one cup every 20 minutes.
- Permit self-limitation of exposures and plan frequent rest breaks.
- Encourage workers to report signs and symptoms of heat strain and not to try to work through it.
- Encourage the buddy system to detect signs and symptoms in co-workers.
- Provide shade (i.e., fixed or portable canopy) and/or cool rest areas.

Job-Specific Controls

Where the screening or physiological monitoring discussed below exceed the criteria, the job-specific controls for this project will include the following:

- Engineering controls to reduce workload, (e.g., mechanical vs. manual material handling where possible).
- Mobile construction equipment will have functioning air conditions and be operated with the doors/windows closed.
- Office trailer and vehicles will have functional air conditioning to provide cool rest locations during breaks.
- Wear breathable polypropylene disposable coveralls over modesty clothing for activities requiring Modified Level C.
- Use heat reducing PPE, such as cool vests, head bands, wrist bands, etc.
- Modify work schedule to take advantage of the cooler parts of the day.
- Establish work/rest regimens to reduce exposure times, when physiological monitoring indicates heat strain conditions.

3.3 Heat Stress and Heat Strain Monitoring

Heat stress and heat strain monitoring shall begin when ambient conditions exceed 85°F when working in Level D and 70°F when working in Modified Level C and above. For clear weather conditions (i.e., 100 percent [%] sunshine) ambient temperatures shall be decreased by 5°F (i.e., 65°F and 80°F, respectively) to determine when to begin monitoring. Ambient conditions shall be determined by maintaining a properly calibrated outdoor thermometer in the shade at each workstation, or by monitoring local weather reports throughout each work shift.

3.3.1 Environmental Monitoring

Use a Wet Bulb – Globe Temperature (WBGT) monitor to perform heat stress screening in accordance with the **Tables A4A-1** (Acclimatized Workers) and **Table A4A2-2** (Unacclimatized Workers) below. Clothing adjustment factors are included in **Table A4A-3**.

If the WBGT levels (corrected for clothing ensemble) for the particular workload and work/rest cycle are exceeded, then implement the General Controls and either perform physiological monitoring as described below or implement Job Specific Controls such as those listed in **Section 3.2**.

Table A4A-1 - WBGT Screening Criteria for Acclimatized Workers

Allocation of Work in a Cycle of Work and Recovery	Light	Moderate	Heavy	Very Heavy
75% - 100%	88°F 31°C	82.5°F 28°C	-	-
50% - 75%	88°F 31°C	84°F 29°C	81.5°F 27.5°C	-
25% - 50%	89.5°F 32°C	86°F 30°C	84°F 29°C	82.5°F 28°C
0%-25%	90.5°F 32.5°C	88.5°F 31.5°C	87°F 30.5°C	86°F 30°C

From ACGIH Threshold Limit Values (TLVs)® and BEIs® 2014.
Note: Light moderate work includes operating heavy equipment. Heavy work includes hand shoveling or other manual labor activities.
°C – degrees Celsius °F – degrees Fahrenheit

Table A4A-2 - WBGT Screening Criteria for Unacclimatized Workers

Allocation of Work in a Cycle of Work and Recovery	Light	Moderate	Heavy	Very Heavy
75% - 100%	86°F 28°C	77°F 25°C	-	-
50% - 75%	83.5°F 28.5°C	79°F 26°C	75°F 24°C	-
25% - 50%	85°F 29.5°C	80.5°F 27°C	78°F 25.5°C	76.1°F 24.5°C
0%-25%	86°F 30°C	84°F 29°C	82°F 28°C	80.5°F 27°C

From ACGIH TLVs® and BEIs® 2015.
°C – degrees Celsius °F – degrees Fahrenheit

Table A4A-3 – Clothing-Adjustment Factors for Some Clothing Ensembles*

Clothing Type	Addition to WBGT (°C)
Work clothes (long sleeve shirt and pants)	0
Cloth (woven material) coveralls	0
Double-layer woven clothing	3
SMS polypropylene coveralls	0.5
Polyolefin coveralls	1
Limited-use vapor barrier coveralls	11

*These values must not be used for completely encapsulating suits, often called Level A. Clothing Adjustment Factors cannot be added for multiple layers. The coveralls assume that only modesty clothing is worn underneath, not a second layer of clothing.
From ACGIH TLVs® and BEIs® 2014.
°C – degrees Celsius

3.3.2 Alternate Environmental Monitoring Procedures

Where permitted by the client, ECC may use the Occupational Safety and Health Administration (OSHA) Heat Tool mobile app for monitoring environmental conditions based on the HEAT INDEX. Precautions recommended for the different Heat Index levels should be followed and are consistent with the General Controls and Job Specific Controls listed above. Where the HEAT INDEX level falls in the High or Very High to Extreme categories, implement physiological monitoring in addition to Job Specific Controls. The Heat Tool app can be accessed in OSHA's Heat Stress prevention topic section at https://www.osha.gov/SLTC/heatillness/heat_index/heat_app.html

3.3.3 Physiological Monitoring

For site personnel wearing vapor barrier clothing and for site personnel where Job-Specific Controls may not be sufficient to control heat strain, physiological monitoring will be performed. Physiological monitoring will also be performed when workers report signs and symptoms of heat strain.

Select workers whose exposure is most extreme or who are probably the least heat tolerant. Heat tolerance may be affected by acclimatization, body size, general health and physical fitness, medications, and age.

Heat strain should be evaluated by monitoring the heart rate and temperature.

Where an individual's pulse rate or temperature exceeds the criteria below, action should be taken to limit the individual's heat exposure. However, where a pattern develops among workers of exceeding the criteria, then additional Job-Specific Controls shall be implemented for the work group.

Pulse Rate

The radial pulse should be taken for 30 seconds one minute after beginning to rest (i.e., at the beginning of a rest break). This rate is multiplied by two to determine the heart rate at initial rest. This rest should not exceed 110 beats per minute (bpm). If the resting heart rate exceeds 110 bpm, then modify the work rest schedule for the individual by decreasing the work period and increasing the rest period.

Heart rate monitoring should be recorded on an Exposure Monitoring Log. Monitoring should begin at the first break. The first rest break should be taken within the first hour of work when ambient conditions exceed the screening criteria of **Table A4A-1**if working in Level D, and within the first 30 minutes if ambient conditions exceed 70°F if working in Modified Level C.

Oral Temperature

Use a digital oral thermometer with disposal plastic sleeves or similar device (e.g. aural thermometer) to measure the oral temperature at the end of the work period (before drinking).

If an individual's temperature exceeds 99.6°F (or 37.6 degrees Celsius [°C]), adjust the work rest cycle.

Do not permit a worker to wear semipermeable or impermeable clothing when his/her oral temperature exceeds 100.6 °F (or 38.1 °C).

- Never ignore signs and symptoms of heat-related disorders -

4.0 TRAINING

Workers on project sites will be trained by the SSHO at site orientation, or during special tailgate meetings. The training will include the elements of this program, and in particular:

- Heat related disorders and First Aid measures
- Environmental factors and workload impacts on heat strain
- Personal factors impacting heat strain including health status, caffeine, alcohol and drugs
- Reporting Signs and Symptoms of exposure
- Monitoring measures to be employed on the project
- General and Job-Specific Controls to reduce exposure
- Emergency Response

5.0 DOCUMENTATION

The SSHO will record periodic environmental monitoring results in the Logbook, if needed. Physiological monitoring will be recorded on the Physiological Monitoring Form, if needed. Records will be maintained on the job site and will be archived with the project files at the end of the job.

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ATTACHMENT 4B
COLD STRESS MONITORING PLAN

1.0 PROJECT

Contract Number: W9124J-18-D-0004
Delivery Order W9124J-22-F-045
Project Name: Environmental Remediation Services
Location: Redstone Arsenal (RSA), Alabama

2.0 COLD STRESS

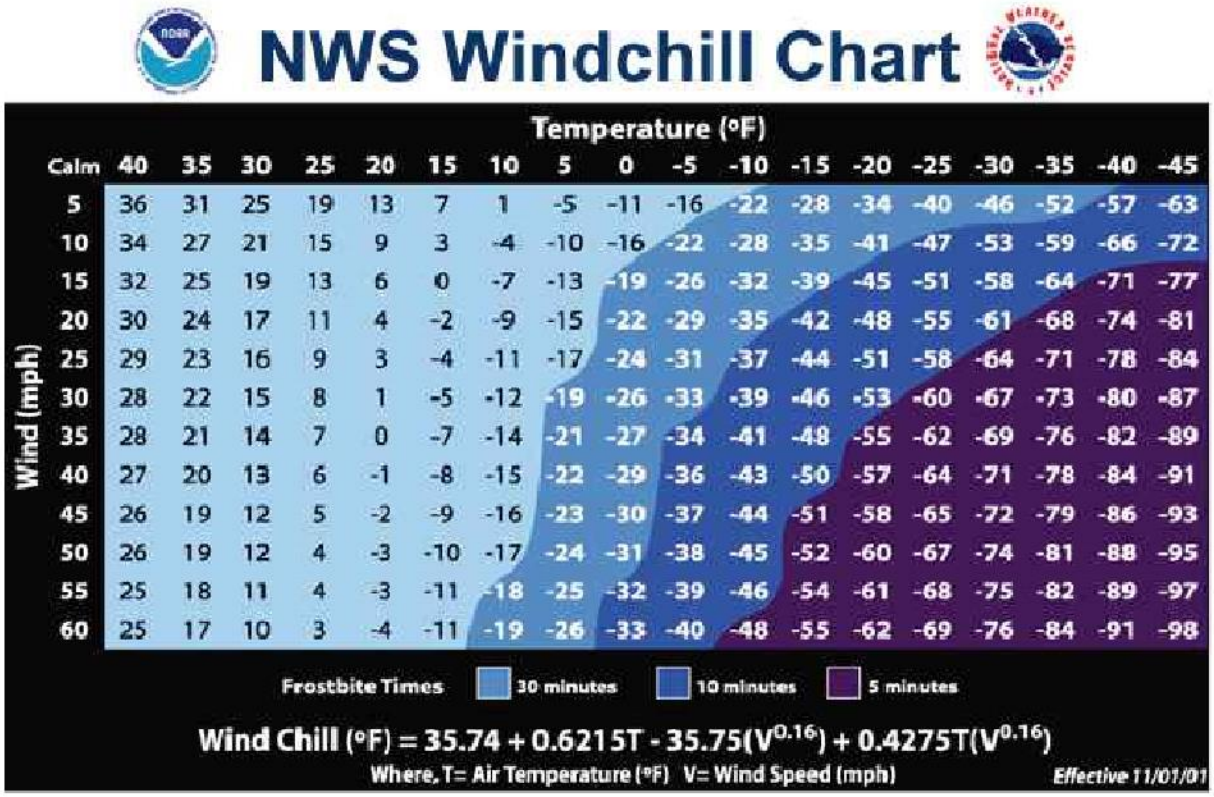
Cold stress hazards are most likely to occur at low temperatures or low wind chill factors, with wet, windy conditions contributing to risk. Where cold stress is a potential hazard (temperatures less than 40 degrees Fahrenheit [ºF]) workers will be trained on the information in the attached Cold Weather Fact Sheet.

As a precautionary measure, employees will wear layers of loose-fitting clothing including insulated coveralls, head cover (perhaps a liner beneath a hard hat), and boots when temperatures fall below 40°F, including wind chill. Protection of the hands, feet, and head is particularly important because these are likely to be injured first by cold. However, actual injury to hands, feet, and head is not likely to occur without prior development of early signs of hypothermia, such as numbing and shivering. Bare skin contact with cold surfaces (below 32°F) will be avoided.

The wind chill factor is the cooling effect of any combination of temperature and wind velocity or air movement. An anemometer can be used to measure wind velocity. The wind chill index (below) should be consulted when planning for exposure to low temperatures and wind. The Site Safety and Health Officer (SSHO) will monitor weather forecasts and determine wind chills at least every four hours when the temperature drops below 20ºF. The wind chill index does not take into account the specific part of the body exposed to cold, the level of activity that affects body heat production, or the amount of clothing being worn.

Like with heat strain, employees are permitted and encouraged to self-limit outdoor work activities when symptoms of cold stress are experienced. The buddy system is also encouraged to ensure that employees frequently check on co-workers in temperature extremes. A temperature-dependent work regimen limiting lengthy periods of outdoor activity may be necessary. If required, this will be developed by the SSHO in coordination with the Project Safety and Health Manager (SHM).

Wind Chill Index



3.0 REFERENCES

National Weather Service http://www.nws.noaa.gov/om/winter/windchill.shtml

OSHA's Campaign to Prevent Heat Illness in Outdoor Workers.
https://www.osha.gov/SLTC/heatillness/index.html

USAPHC

Injury Prevention: Fact vs Fiction

Cold Weather Injuries

FACT SHEET 12-004-0415

What causes Cold Weather Injuries?

Cold weather injuries (CWIs) can occur due to an imbalance of body temperature regulation, where heat loss is greater in an area of the body (or the body core) than heat production. There are 4 primary types of cold injuries: hypothermia, frostbite, non-freezing cold injuries, and injuries related to cold exposure. **Tables 1-4** provide details on these injuries.[1]

Why are CWIs a concern to the Army?



CWIs are preventable, yet if early signs and symptoms go unrecognized or preventive measures are not taken, these injuries may result in permanent injury and even death. A typical CWI casualty is a 20 year-old male at the rank of E-4 and below and often from a warm climate. However, anyone can become a CWI casualty.[2]

How can Soldiers protect themselves from a CWI?

Soldiers should be aware of risk factors and increase resilience by consuming a healthy diet with plenty of fluids, maintaining fitness levels according to Army standards, and getting quality sleep each night. Dressing properly for the weather conditions in a way to easily adjust (layers), and balancing the time and amount of activity spent in cold weather conditions will reduce risks.[1,3,4,5]

Prevention of Cold Weather Injuries

Clothing
- ❖ Wear uniform properly (layers worn loosely).
- ❖ Keep socks & clothes dry (use sock liners and foot powder).
- ❖ Remember the acronym C-O-L-D
  - Keep it CLEAN
  - Avoid OVERHEATING
  - Wear clothing LOOSE and in LAYERS
  - Keep clothing DRY

Eyes
- ❖ Wear dark UV protective glasses
- ❖ If no sun glasses – improvise with cut slits in cardboard/cloth; or use tape over regular eyeglasses

Skin
- ❖ Keep your skin clean, covered, & dry
- ❖ Use sunscreen and lip balm
- ❖ Use gloves to handle all equipment and fuel products

Hydration
- ❖ Drink warm liquids
- ❖ Monitor urine color for dehydration

Environment
- ❖ Use warming tents when needed
- ❖ Monitor conditions, especially the wind chill index
- ❖ Use anti-slip shoe gear if outside extensively

Other
- Conduct NCO checks and look after your battle buddy

What factors increase the risk of having a CWI?

All Soldiers regardless of rank are susceptible to a CWI in the right conditions. However, surveillance data from the Army and other Services indicate that rates of cold injuries appear higher among African Americans, women, Service members under 20 years old, and enlisted personnel.[2] Additional risk factors are discussed below[1-7]:

✚ *Prior cold injury or medical conditions*

Soldiers who have had a cold injury in the past are much more likely to develop a new cold injury sooner or one of more severe nature in the future. Existing medical conditions may predispose an individual to a CWI. For example, Raynaud's Disease is a disorder that causes blood vessel constriction in cold temperatures or during emotional distress, resulting in reduced blood flow to the extremities (e.g., fingers & toes).[6] Other conditions, such as anemia, diabetes, sickle cell disease, hypotension, and atherosclerosis, may also increase susceptibility to frostbite and injuries related to cold exposure.[1]

✚ *Dehydration*

Inadequate fluid intake affects the body's ability to sustain physical activity, which in turn affects thermoregulation (i.e., the balance between heat production and loss). In cold environments sensitivity to thirst declines, which can increase the risk of dehydration during strenuous activity, where fluid loss often exceeds intake.[1, 4, 5]

✚ *Over- and Under- Activity*

Vigorous exercise/activity induces sweating, which leads to wet clothing and subsequent increased heat loss. Conversely, under-activity results in low heat production, which may lower the body's core temperature.[1, 4, 5]

✚ *Tight clothing*

Close-fitting clothing reduces insulation and may restrict movement, resulting in heat loss. Clothing should be worn loosely and layered to allow adjustments as physical activity levels and environmental conditions change.[1, 4, 5]

✚ *Inadequate nutrition*

Underfeeding can cause low blood sugar (hypoglycemia) which impairs shivering, thereby making it difficult to generate body heat. Low carbohydrates stores also limit the ability to maintain physical activity.

✚ *Alcohol & nicotine*

Alcohol imparts a sense of warmth and causes dilation of skin blood vessels which increases heat loss to the environment. It may also impair the senses and judgment, making it difficult for a Soldier to detect signs and symptoms of a CWI. Tobacco use (smoking or chewing) causes increased constriction of skin blood vessels, which increases the risk for frostbite.[1, 4, 5]

✚ *Medications*

Some medications may affect thermoregulation by impairing vasoconstriction. These include benzodiazepines, tricyclic antidepressants, barbiturates, and general anesthetics.[1, 4, 5]

U.S. Army Public Health Command - Injury Prevention Program
usarmy.apg.medcom-phc.mbx.injuryprevention@mail.mil ***410-436-4655/DSN 584-4655***
5158 Blackhawk Road, APG, MD 21010-5403
Approved for Public Release, Distribution Unlimited

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ATTACHMENT 5

RESUMES

Kym Edelman, CIH, CSP *757-435-5384*
EHS Manager

Experience Summary

Highly accomplished Certified Industrial Hygienist and Certified Safety Professional with over 27 years of on-site and project management expertise to provide oversight, review, reporting, training, and control of employee H&S processes on multiple construction/environmental sites.
Comprehensive knowledge of regulatory compliance requirements under OSHA, DOE, CERCLA, RCRA, USACE, EPA, and other federal/state regulatory programs.
Hands-on experience in compliance monitoring, development and implementation of policies and procedures, accident investigation, and worker's compensation issues.
Proven record of retaining minute detail with excellent recall regarding safety regulations and contractual language to make on-the-spot independent decisions.
Well respected with reputation for using excellent interpersonal communication skills to collaborate with staff, all levels of management, and clients.
Consistently commended for outstanding leadership skills, producing quality work product, developing proactive initiatives, and commitment to achieving optimum project safety expectations to ensure client satisfaction while adhering to corporate policy and procedures.

Education

BS (Bachelor of Science), Environmental Health, Industrial Hygiene Concentration, Old Dominion University, Norfolk, VA

Registrations/Certifications

Certified Industrial Hygienist
Certified Safety Professional

Training

40-Hour OSHA Hazardous Waste Health and Safety Training – 1989
40-Hour EM 385 1-1 Awareness Course- 2018
30-Hour OSHA Construction Safety Course- 2004
Shipyard Competent Person- 2019

Experience

Program Health and Safety Manager, April 2020-Present
ECC, Jacksonville, NC

Responsible for assisting in overall management of the safety programs for ECC.

- Monitor overall safety compliance, assistance, and oversight of multiple task orders for Federal as well as commercial client project sites:
- Assist in preparation and review of project work plans in relation to site specific safety program documents.
- Assist in implementation of safety processes on active project sites.
- Provided technical guidance to project and program employees as well as clients.
- Revise and develop programs and procedures

EHS Manager, September 2018-April 2020
APTIM, Norfolk, VA
Responsible for assisting the EHS Lead in overall management of safety programs for APTIM's Government operations.

- Monitor overall safety compliance, assistance, and oversight of multiple task orders for Federal as well as commercial client project sites:
- Assist in preparation and review of project work plans in relation to site specific safety program documents.
- Assist in implementation of safety processes and manage safety staffing on active project sites.
- Provided technical guidance to project and program employees as well as clients.
- Manage injuries and illnesses, and related worker's compensation claims.
- Assist in safety council, award programs, and employee involvement initiatives.
- Conduct periodic reviews and audits of project sites to determine compliance with applicable regulations, standards, and internal procedures.

Director, EHS June 2018-September 2018
Tetra Tech EC, Inc., Virginia Beach, VA
Responsible for overall management of environmental health and safety programs and employees for Tt EC operations.

- Serves as program Certified Industrial Hygienist for the Atlantic Division Remedial Activities Contract, Naval Facilities Engineering Command.
- Provides technical support for programs and projects, including proposal review and support.
- Manages site safety and health professionals on projects and ensures safety staff assignments to meet project and client needs.
- Injury case management and worker's compensation claim management.
- Writes or reviews and approves site-specific health and safety plans.
- Conduct program reviews and audits for compliance and continual improvement.

EHS Manager of Eastern Operations, September 2015-June 2018
Tetra Tech EC, Inc., Virginia Beach, Virginia
Responsible for assisting the Tetra Tech EC Director in overall management of safety programs for Tt EC's operations.

- Monitor overall safety compliance, assistance, and oversight of multiple task orders for Federal as well as commercial client project sites:
- Assist in preparation and review of project work plans in relation to site specific safety program documents.
- Assist in implementation of safety processes and manage safety staffing on active project sites.
- Provided technical guidance to project and program employees as well as clients.
- Manage injuries and illnesses, and related worker's compensation claims.
- Facilitated implementation of LANT RAC program safety council, award programs, and employee involvement initiatives.
- Conduct periodic reviews and audits of project sites to determine compliance with applicable regulations, standards, and internal procedures.

- Program CIH for LANT RAC VI Navy contract.

ES&H Manager, August 2012 – September 2015
CB&I AREVA MOX Project, DOE, CB&I (formerly Shaw) Project Services Group, Aiken, SC
Manage all safety aspects of the project, including sub-contractors. The project has exceeded 21 million man-hours without a lost work day case.
Responsible for management of the on-site medical clinic, fitness center, production facility safety staff, and all field safety engineers.
Interface between high level construction management, client, and filed construction employees, to ensure clear communication of expectations to continue to promote a positive safety environment that has yielded exemplary employee safety performance.
Technical resource for all project staff, as well as client.

August 2002 – August 2012, SHAW E&I, Norfolk, VA
Ten years of progressive experience and achievement as safety project management/ site safety coordinator

Program Safety Manger, May 2008 – August 2011
IHNC, USACE, New Orleans,
Accountable for establishment and initial/continued implementation of project safety programs for this high profile $1.1B project involving design and construction of the New Orleans Hurricane and Storm Damage Risk Reduction System.
Successfully managed the safety program for the largest civil works design-build project ever undertaken by the USACE. The project, during this timeframe, concluded with "no lost work days" for Shaw. Staffed project, developed project safety initiatives, organized the Accident Prevention and Hurricane Preparedness Plans, coordinated training, conducted subcontractor reviews, and acted as overall technical consultant regarding project safety issues, and compliance monitoring of the safety process.

Program Safety Manager, November 2007 – August 2012
Global Contingency and Construction Contract (GCCC), NAVFAC (Naval Facilities) Worldwide
Serves as Health and Safety Manager for this $335M US Navy contract. Directed safety programs for all construction projects under the GCCC contract. Implemented safety processes, managed staffing, developed H&S and Accident Prevention Plans, managed worker's compensation claims, and provided technical oversight to staff and management on all projects.Developed documents and programs to ensure training, programs, and procedures were translated into local languages and worked with third country nationals to establish safety cultures where previously non-existent.Monitored and ensured the implementation of corporate policies and procedures, conducted incident investigations, and maintained proactive safety programs.Ensured compliance with applicable laws/regulations, and provided safety support/consultation to Shaw management, as well as client companies and governmental entities.

Program Safety Manager, May 2008 – 2012
LANTDIV RAC V Program, NAVFAC Atlantic Division, Norfolk, VA
Directed overall program safety on this $150M Navy contract, including safety program implementation and oversight of multiple task orders under the contract.

- Instrumental in team accomplishing 4,000 days with a record of "no lost work days."
- Implemented safety processes, managed staffing, developed health and safety, and accident prevention plans.
- Provided technical guidance to project and program employees as well as clients.
- Managed injuries and illnesses, and related worker's compensation claims.
- Facilitated program safety council, award programs, and employee involvement initiatives.

Program Safety Manager, December 2002 – August 2012
Served as Program Safety Manager leading a staff of field safety professionals in the development and implementation of safe work practices on multiple individual task orders. Also, functioned as Site Safety Coordinator for several individual projects at multiple locations conducted under the LANTDIV RAC IV program.

These projects included UXO demilling activities, active range clearance activities, "Clean" site closures, installation of treatment systems, storage tank removals, bio-remediation, landfill excavation/repairs/capping, soils excavation and removal of hazardous materials.

- 2000 Day President's Award for no lost work days on one project.
- Target Zero achieved for 2 Project Sites.
- RAC Program achieved Zero Lost Work Days, Recordable Incidents or Chargeable Vehicle Incidents within Fiscal Year 2008.
- Successfully adapted to EHS organizational changes, and positioned to advance within group.

Environmental Health and Safety Manager, October 2000 – April 2002
Flextronics Enclosures, Kingston, PA
Responsible for the development, implementation, and monitoring of Flextronics Enclosures, Inc. Environmental Health and Safety program.

- Conducted initial audits, assessments, and industrial hygiene sampling, to determine environmental, safety, and industrial hygiene compliance issues.
- Developed plans and procedures necessary to attain compliance with water permitting, waste disposal, safety and industrial hygiene issues.
- Developed programs to decrease employee injuries as well as reduce incident rates and worker's compensation costs.
- Worked with local occupational health clinic to better manage accidents and injuries, to keep employees at work, and ensure best care possible.
- Responsible for maintaining OSHA 200 logs.
- Conducted and facilitated training sessions for managers and technicians to ensure understand and compliance with new company safety programs.
- Monitored effectiveness of new EHS Program and continually improved upon programs implemented.
- Developed and implemented an Environmental Management System to be compliant with ISO-14001.

Environmental Scientist, January 1996 – April 1997
Maxim Technologies (formerly Huntingdon Chen-Northern), Denver, CO
Assigned to USEPA Superfund Technical Assistance and Response Team, sub-contracted to the primary USEPA contractor.

- Conducted hazardous waste and emergency response operations, including delineation of contamination, site control, and contamination monitoring and reporting.
- Provided on-site technical support to EPA and oversight of contractors for EPA.
- Provided assistance to EPA regarding sampling, management, and disposal of hazardous and mixed wastes.
- Conducted preliminary site investigations to determine presence and extent of contamination on sites.

- Assisted in development of work plans and provided assistance to EPA for subsequent remediation of contaminated sites and abandoned industrial facilities.
- Conducted hazardous materials training as required by OSHA for hazardous waste site work and emergency response, as well as the hazard communication standard.
- Assisted EPA in conducting public information meetings pertaining to remedial sites.

Health and Safety Manager, August 1994 – January 1996
Maxim Technologies (formerly Huntingdon Chen-Northern), Denver, CO
Responsible for the overall management of Maxim's regional health and safety program.

- Developed and implemented corporate health and safety procedures throughout the Northwest Region.
- Managed accidents and injuries as well as required documentation on OSHA 200 logs.
- Responsible for compliance, documentation, and disposal of hazardous materials generated by the regional offices.
- Assisted environmental groups in conducting Phase I site assessments.
- Conducted training for Hazardous Waste Site Work, Hazard Communication, Asbestos Awareness, Instrumentation, and Air Monitoring.
- Conducted accident investigations and management of workers' compensation claims.
- Developed site specific health and safety plans for hazardous waste site work.
- Provided technical support in the areas of industrial hygiene and health and safety.

Site Safety Supervisor, October 1992 – June 1994
OHM Corporation, Findlay, OH
Responsible for the implementation, and management of site specific environmental, industrial hygiene, health, and safety programs, in accordance with site specific health and safety plans.

- Conducted initial site hazard assessments.
- Assisted in completing and maintaining documentation related to hazardous waste storage and disposal.
- Monitored compliance of site operations with respect to OSHA, EPA, and state regulations, such as, RCRA, TSCA, AHERA, HAZWOPER, and HAZCOM.
- Implemented appropriate means to control hazardous materials exposure.
- Monitored the effectiveness of on-site industrial hygiene and safety programs.
- Initiated safety awareness programs.
- Conducted training as required by 29 CFR 1910.120 and the Hazard Communication Standard.
- Liaison between client representatives and OHM in regard to environmental, industrial hygiene, and health and safety issues.

Division Safety Coordinator, October 1989 – October 1992
MAECORP Inc., Columbus, OH
Responsible for the implementation and compliance monitoring of company safety policies in addition to Federal and State OSHA and EPA regulations, on hazardous waste project sites in USEPA Region V.

- Conducted site safety audits and prepared appropriate reports.
- Conducted air monitoring for personal exposures in addition to environmental air sampling.
- Conducted annual refresher training for hazardous waste site operation.
- Developed site specific health and safety plans in accordance with the requirements 29 CFR 1910.120.

- Conducted building inspections for asbestos.
- Maintained appropriate documentation in regard to medical monitoring requirements, training certificates, and hazard communication.
- Conducted accident investigations.
- Managed work related injuries.

References available upon request



HST

CERTIFICATE OF TRAINING

THIS CERTIFIES THAT

Kym Mohrman

has successfully completed 40 hours of instruction in

WASTE SITE WORKER PROTECTION

Prepared and conducted by
Hygiene, Safety and Training Inc.
to comply with OSHA 1910.120(e)(2)

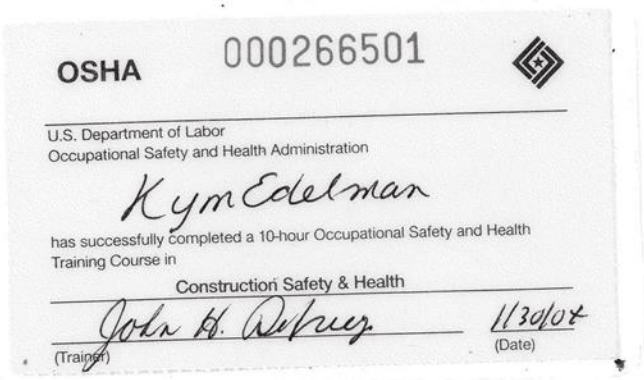
Jack M. Peterson
CSP, CIH

November 10, 1989
Date of Completion

GOES 467-1/2

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OSHA 000266501

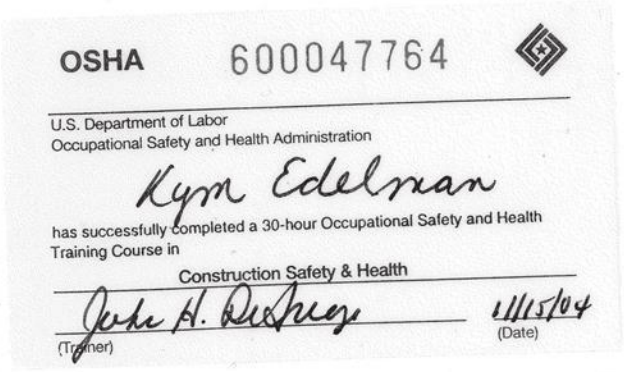
U.S. Department of Labor
Occupational Safety and Health Administration

Kym Edelman

has successfully completed a 10-hour Occupational Safety and Health Training Course in

Construction Safety & Health

John H. DeFrees 11/30/04
(Trainer) (Date)



OSHA 600047764

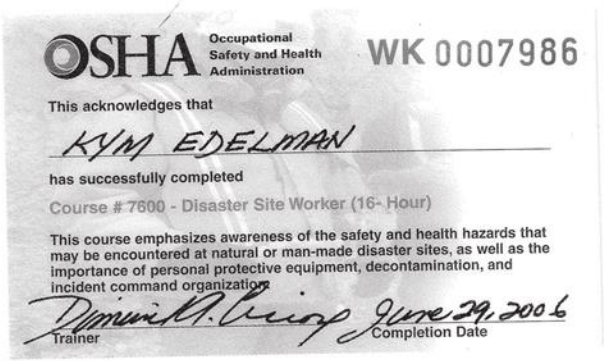
U.S. Department of Labor
Occupational Safety and Health Administration

Kym Edelman

has successfully completed a 30-hour Occupational Safety and Health Training Course in

Construction Safety & Health

John H. DeFrees 11/15/04
(Trainer) (Date)



OSHA Occupational Safety and Health Administration WK 0007986

This acknowledges that

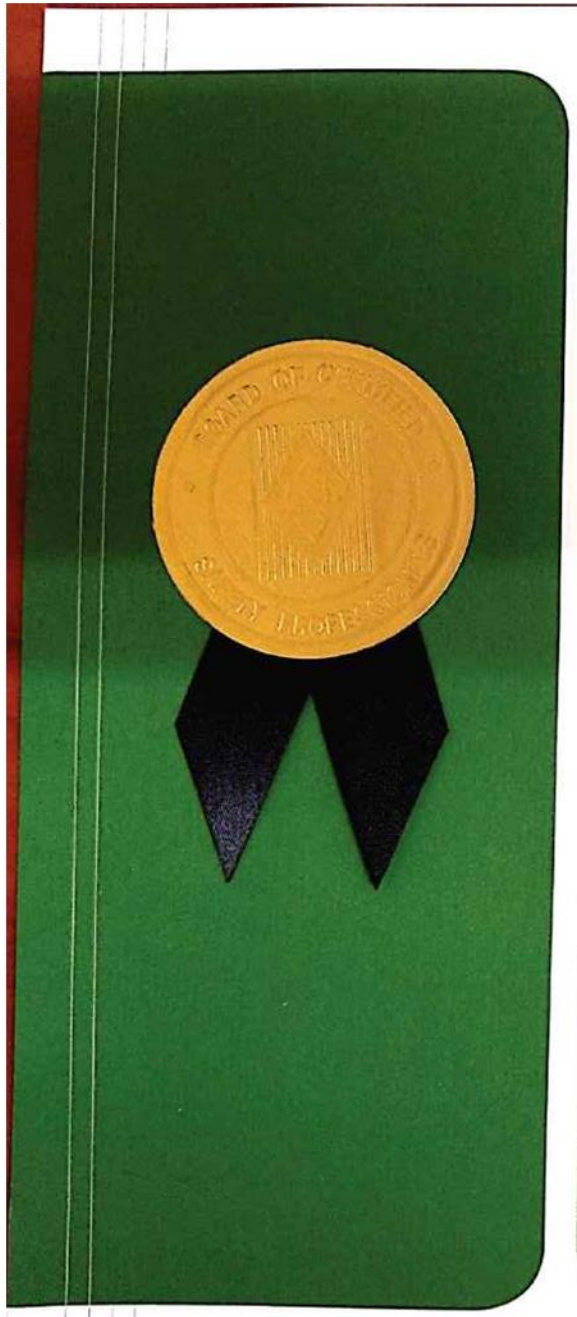
KYM EDELMAN

has successfully completed

Course # 7600 - Disaster Site Worker (16- Hour)

This course emphasizes awareness of the safety and health hazards that may be encountered at natural or man-made disaster sites, as well as the importance of personal protective equipment, decontamination, and incident command organization.

Dominick A. Cuiffo June 29, 2006
Trainer Completion Date



BOARD OF CERTIFIED SAFETY PROFESSIONALS

affirms that

Kym Y Edelman

Has applied for, met qualifications, and passed required examination(s) and is hereby authorized to use the designation

Certified Safety Professional®

in Comprehensive Practice

So long as this certificate is not suspended or revoked and the certificant renews this authorization annually and meets Continuance of Certification requirements.

Board of Examiners in witness whereof we have here unto set our hands and affixed the Seal of the Board this 21st Day of December, 2006

President

Secretary

19423 CSP No.

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american board of industrial hygiene®

6015 West St. Joseph, Suite 102 Lansing, Michigan 48917 **P:** (517) 321-2638 **F:** (517) 321-4624 **E:** abih@abih.org

November 02, 2016

Kym Y. Edelman, CIH
4900 Fennell Lane
Suffolk VA 23435

Dear Ms. Edelman,

It is my pleasure to congratulate you. With the combination of education, experience and your performance on the CIH® examination, the American Board of Industrial Hygiene® finds you qualified for professional certification in the Comprehensive Practice of Industrial Hygiene. You may now use the designation "Certified Industrial Hygienist®" and the corresponding "CIH®".

This is a significant career milestone. Many industrial hygienists strive for the CIH® certification but it's attained by only a few. Your certification says a lot about you as a professional. It is a mark of distinction that indicates not only your knowledge and skills but also your personal motivation to successfully undertake the challenge. This is recognized by peers, employers and clients.

We will be publishing your name on the ABIH® website so that everyone may see this great accomplishment.

Now that you've attained the CIH®, you'll want to make every effort to retain it. The best place to start is with the CM Primer which is available in the Documents Library section of the ABIH website. It provides an easy-to-read summary of the basic program along with some useful tips. As you review the CM Primer, note that you are on a 60 month CM Cycle that runs from January 1, 2017 to December 31, 2021.

Please use the ID Number listed below to access the My Account section of the ABIH website where you can update your contact information, pay fees and locate other CIHs in the private roster.

ID Number: **11689**

On behalf of ABIH®, I personally congratulate you on your achievement. Welcome to an elite group of professionals!

Ron Drafta

Ron Drafta, CIH
Certification Program Manager, ABIH
rdrafta@abih.org

Enclosure

ANSI Accredited Program
PERSONNEL CERTIFICATION

IOHA
International Occupational Hygiene Association
Recognized Certification Board

NCCA ACCREDITED PROGRAM

The Mark of Professionalism

www.abih.org



Certificate Of Completion

American Safety Council

KYM EDELMAN

Has diligently and with merit completed the

40-Hour EM 385-1-1 on 7/6/2018

Director: Jeff Pairan

ABIH®

american board of industrial hygiene®

organized to improve the practice of industrial hygiene
proclaims that

Kym Y. Edelman

having met all requirements of
education, experience and examination,
is hereby certified in the

COMPREHENSIVE PRACTICE
of
INDUSTRIAL HYGIENE

and has the right to use the designations

CERTIFIED INDUSTRIAL HYGIENIST

CIH

Certificate Number	**11090 CP**
Awarded:	**October 26, 2016**
Expiration Date:	**June 1, 2022**

Chair, ABIH

Chief Executive Officer, ABIH

The Compliance Edge Online Institute

Certificate of Completion

Kym Edelman

has met the online course completion requirements for

HAZWOPER 8-Hour Refresher

in accordance with 29 CFR 1910.120 and 1926.65

Certificate ID 1724619-328
Continuing Education Units 0.8
AdvanceOnline Solutions, Inc. offers 0.8 CEUs for this program.

AdvanceOnline, Inc. is authorized to issue the ICSR CEU.

ICSR CEU

Date 7/28/2020 8:09:00 AM
Time Online 08:38:52
AdvanceOnline Solutions, Inc.
1811 Bering Drive, Suite 430
Houston, Texas 77057
www.advanceonline.com
(713) 621-1100

AdvanceOnline SOLUTIONS

BRIAN KATELEY

Years' Experience: 17

With Current Firm: 9.5

Current Professional Registration:

Security Clearance:

Aberdeen Proving Ground

Education:

- BS, Environmental Science & Policy Program, University of Maryland, 2003
- Environmental Technology Certificate, Harford Community College, 1999

Other Professional Qualifications/Training:

- OSHA 40-hour HAZWOPER, 1999 and 2006; 8-hr HAZWOPER Refresher, 2021
- OSHA 8-hour Excavation Safety; 2006
- OSHA 8-hr Supervisor, 2008
- OSHA 30-hour Construction Safety and Health, 2011 – renewal in progress
- First Aid/CPR/AED/BBP, 2017 – renewal in progress

Summary of Experience:

Mr. Kateley is experienced in environmental characterization techniques such as groundwater sampling, soil sampling, lithologic characterization, surface media sampling, direct-push technology, investigations, and monitoring well installation. He is also skilled in groundwater remediation system implementation and operation and maintenance, including monitored natural attenuation, pump and treat systems, in situ bioremediation, and product recovery systems.

Mr. Kateley has been in a Site Supervisor and SSHO role since March of 2014. His responsibilities have included assisting with managing project safety and health programs. Providing safety consultation to the project management team in the planning and execution of project tasks. Providing site orientation for new employees, subcontractors, vendors, and visitors. Performing multi-media sampling to determine appropriate levels of PPE and assigning PPE to team members. Conducting daily safety and workplan tailgate meetings. Conducting daily, weekly, monthly, and annual site inspections. Ensured all employees, including subcontractors, performed daily activities safely and assured compliance with APP/SSHP, AHAs, and workplans while enforcing all site safety and health procedures.

Roles & Responsibilities: Environmental Scientist, Site Supervisor and SSHO since 03/14.

ECC Project Experience

Project Title and Location: Aberdeen Proving Ground Remedial Action (Optimization), Maryland

Dates on Project Start/End: 11/11 to present

Project Start/End Dates: 06/11 to present

Roles & Responsibilities: Environmental Scientist, Site Supervisor and SSHO

Mr. Kateley currently serves as the Site Supervisor and SSHO for the operations, maintenance, and performance monitoring of enhanced in-situ bioremediation systems for the remediation of chlorinated solvents in groundwater at six sites within the Aberdeen Area of APG, Buildings 3327, 525, M600, 361, 507 and Defense Reutilization and Marketing Office Metal Scrap Yard. Systems include active groundwater recirculation systems for the addition of groundwater amendments and passive biobarriers for the treatment of downgradient areas. He is responsible for operations and technical support, including:

tracking weekly groundwater elevation data to determine the status of hydraulic containment; scheduling and overseeing long-term monitoring (LTM) groundwater sampling on a semi-annual schedule; maintaining the project groundwater analytical database; managing and interpreting all of the groundwater elevation and chemical sampling data; and, preparation of quarterly performance and annual operations and performance monitoring technical reports. Mr. Kateley also assists the Project Manager in the oversight of field lab pack technicians and the inventory, tracking, and disposal of solid and liquids wastes generated from the project activities.

Mr. Kateley also supports operations at the Canal Creek and O-Field Groundwater Treatment Facilities under this project and has held an Operator in Training Industrial Wastewater License with the Maryland Department of the Environment (MDE).

Project Title and Location: Site Delineation and Characterization of Phillips Landfill, Western Boundary OU2, Ecological Soil Removal at Fire Training Area, and Achieve Site Closure at CCAPG04031, Aberdeen Proving Ground, Maryland

Dates on Project Start/End: 09/14 to 09/19

Project Start/End Dates: 09/14 to 09/19

Roles & Responsibilities: Environmental Scientist, Site Supervisor and SSHO

Mr. Kateley directed environmental sampling in support of a data-gap investigation at six landfill areas identified within the Phillips Army Airfield Landfill (PAALF) to evaluate potential Feasibility Study response actions for the areas under CERCLA. Specific tasks included the delineation of the presence/absence and horizontal extent of fill material within each landfill area through the use of 171 test pits; existing soil cover thickness assessments of each area, soil and solid waste sampling to characterization of contaminates and waste streams; groundwater sampling of the entire PAALF monitoring well network. Mr. Kateley assisted the Project Manager in the implementation of a non-time-critical removal action (NTCRA) at the Aberdeen Fire Training Area (AFTA), located in the Western Boundary Study Area (WBSA) of the Aberdeen Area of APG involving shallow soil excavation/removal of polycyclic aromatic hydrocarbons (PAHs) and metals-contaminated soil; achieving negotiated cleanup levels. He also supported the implementation of the Closure Plan for the former Aberdeen Area Building 4031 Underground Storage Tank (UST) Site regulated under the State of Maryland's Oil Control Program. Mr. Kateley was responsible for the oversight of well abandonments, decommissioning of the in-active SVE system, construction and operation of an on-site treatment cell for DRO/GRO contaminated soils, excavation and treatment of DRO/GRO contaminated soil from the footprint of the former 4031 Building, liquid phase hydrocarbons (LPH) recovery and groundwater treatment, confirmation sampling and analysis, excavation backfilling, and site restoration. He also supervised lab pack technicians in the performance of post-closure monthly gauging of water levels and removal of free-product from two wells, as well as quarterly groundwater sampling of the well field at the former Building 4031 UST site. Supported preparation of the site project workplans, health safety plans, and closure documentation and coordinated with the DPW Environmental Division Hazardous Waste Branch to provide all documentation necessary to remove waste and IDW from APG. Responsibilities for all project work included oversight of the field sampling teams; inventory and tracking of chemical data and waste generated from investigation and remediation activities; data reporting; and maintaining strict adherence to the health and safety plans and compliance with associated federal, state, local, and APG regulations and guidance governing all CERCLA and RCRA work at APG.

Project Title and Location: Canal Creek Study Area Sites RI/FS PBA, Aberdeen Proving Ground, Maryland

Dates on Project Start/End: 03/14 to 09/17

Project Start/End Dates: 03/14 to 09/19

Role & Responsibilities: Environmental Scientist, Site Supervisor and SSHO

Mr. Kateley supported the environmental sampling tasks associated with the RI work at the Canal Creek Study Area (CCSA) at APG as part of the Installation Restoration Program under CERCLA. This contract covered the completion of the remedial investigations (RIs) (including risk assessments and final RI Reports) for 10 East and 12 West CCSA sites, plus an investigation of the Buried Legacy Chemical Sewer Lines throughout the CCSA. The remedial investigations include site inspections, test digs, and media sampling (i.e., soil, sediment, sludge, and groundwater). Responsibilities included development and production of RI Work Plans, field activity reports, and final RI Reports, overseeing team subcontractors, field sampling events, evaluation of analytical data, inventory and tracking of waste generated from RI activities, and maintaining strict adherence to the health and safety plans and standard operating procedures (SOPs) governing all CERCLA work at APG.

Project Title and Location: Other Miscellaneous DoD and Former DoD Sites in the United States Mid-Atlantic area.

Dates on Project Start/End: 01/12 to present

Role & Responsibilities: Environmental Scientist, Site Supervisor and SSHO

Mr. Kateley has supported other similar projects in the Mid-Atlantic on shorter terms including:

- Joint Base McGuire-Dix-Lakehurst – Burlington County, NJ
- Atlantic City Air National Guard Site – Atlantic County, NJ
- Fort Meade – Anne Arundel County, MD
- Picatinny Arsenal – Morris County, NJ
- Former Griffiss Air Force Base – Oneida County, NY

Work Prior to ECC

Scientist II, EA Engineering, Science, and Technology, Inc. (01/06-10/11).
Project Manager, Aberdeen Proving Ground Edgewood Area Munitions Response Site Remedial Investigation, Aberdeen Proving Ground; Army Environmental Command (2011). Fixed price remedial investigation assessment for munitions and explosives of concern and munitions constituents for 12 Munitions Response Sites at Aberdeen Proving Ground, which total 3,500 acres. Responsible for Technical Project Planning and Restoration Advisory Board support, munitions constituents assessments, providing Unexploded Ordnance Quality Control Officer and Unexploded Ordnance Safety Officer support, Geographic Information System database management, DGM support to include brush clearing, ERIS uploads, and document support. Project includes the re-acquirement and evaluation of over 20 years of Installation Restoration Program data (including geophysics and Installation Restoration Program chemical sampling) to support the Military Munitions Response Site remedial investigation efforts.

Environmental Scientist, Suburban Propane, Reisterstown, Maryland (2010). Responsible for field activities during DPT chemical-oxidation injections including assurance of proper injection depths, volumes, and geochemical sampling from surrounding monitoring wells.

Environmental Scientist, Department of Public Works Parcel B, C, D Remedial Action Plan, National Aquarium of Baltimore, Baltimore, Maryland (2010). Responsible for construction quality assurance and air monitoring of perimeter and work zone at site utilizing dust and mercury vapor meters. Also responsible for the creation of an environmental monitoring plan for environmental hazards during the voluntary cleanup program remedial action plan implementation.

Environmental Scientist, New O-Field Groundwater Remediation; Aberdeen Proving Ground (2009-2010). Performed field activities required to determine contaminant distribution and hydraulic properties for the remedial system design. Responsible for design, installation, and implementation of a bio-barrier injection and monitoring well network to treat chlorinated solvents and metals in groundwater at the site.

Environmental Scientist, Constellation Power Generation Oil Control Program Compliance Support, Perryman and C. P. Crane Generating Stations (2008). Responsible for coordination and performance of field activities including site wide groundwater gauging and sampling events and light non-aqueous phase liquid recovery.

Environmental Scientist, Site 2 Old Dump at Swan Creek Soil, Aberdeen Proving Ground, Aberdeen, Maryland (2009). Conducted site clearing activities and the installation of geotextile for the reestablishment of landfill cap.

Environmental Scientist, Compliance Cleanup of 13 Sites, Aberdeen, Maryland; Aberdeen Proving Ground; Environmental Scientist (2008). Tasks include operation and maintenance of product recovery systems, groundwater monitoring, and reporting.

Environmental Scientist, Enhanced In Situ Bioremediation Systems, Buildings 3327, 525, M600, 361, 507 and Defense Reutilization and Marketing Office Metal Scrap Yard, Aberdeen Proving Ground, Maryland, Aberdeen Proving Ground (2006). Involved in the installation and responsible for the operation, maintenance, and performance monitoring for enhanced bioremediation systems for the remediation of chlorinated solvents in groundwater at six sites in the Aberdeen Area. Systems include active groundwater recirculation systems for the addition of groundwater amendments and passive biobarriers for the treatment of down gradient areas.

Environmental Scientist, Operations and Maintenance Soil Vapor Extraction/Free Product Recovery System, Building 4025, Aberdeen Proving Ground, Maryland (2006-2007). Responsible for operations and maintenance of the Building 4025 soil vapor extraction remediation system, which consists of a soil vapor extraction system that is designed to enhance the recovery of light non-aqueous phase liquids and biodegrade residual hydrocarbons. Also responsible for collection of monthly air sample for submission to laboratory for benzene, toluene, ethylbenzene, and xylene analysis, to ensure that air emissions for the system are in compliance with the Maryland Department of the Environment regulations. Additional responsibilities include preparation of comprehensive monthly progress reports for the system.

Environmental Scientist, Operation and Maintenance Soil Vapor Extraction System, Building 4031, Aberdeen Proving Ground, Maryland (2006-2007). Responsible for operations and maintenance of the Building 4031 soil vapor extraction/free product recovery system. Also responsible for collection of monthly air sample, for submission to laboratory for benzene, toluene, ethylbenzene, and xylene analysis, to ensure that air emissions for the system are in compliance with the Maryland Department of the

Environment regulations. Additional responsibilities include preparation of comprehensive monthly progress reports for the system.

Inspector/Technician, Monitoring and Maintenance 5 Installation Restoration Program Sites; Edgewood Area, Aberdeen Proving Ground, Maryland (2006). Responsible for quarterly inspections and subsequent maintenance of 5 Installation Restoration Program sites; Nike SW landfill, Cluster 5 test area, Old Bush River Road Dump, Graces Quarters, and Carroll Island. Monitoring tasks include sampling of monitoring wells and surface media (soil and sediment), maintenance inspection of landfill sites to ensure site stability and inspection of shoreline stabilization measures with unexploded ordnance sweeps at Grace's Quarters and Carroll Island. Maintenance tasks involve removal of unwanted vegetation, fence repair, and carbon filter replacements.

Environmental Scientist, Millsboro Groundwater Investigation (Trichloroethene); Millsboro, Delaware; Department of Natural Resources and Environmental Control (2006). Collected groundwater samples using direct-push technology in order to delineate the plume size of known trichloroethene contamination. Also collected soil, soil gas vapor, and air samples to define possible volatile organic compound occurrences outside of the groundwater.

Environmental Scientist, Uncle Ted's Trading Post, Millsboro, Delaware, Department of Natural Resources and Environmental Control (2006). Performed operations and maintenance on soil vapor extraction system. Installed upgraded aquifer air sparge and soil vapor extraction system. Sampled monitoring wells and potable wells surrounding the site.

Scientist, Absecon Island Shore Protection Project, Atlantic City, New Jersey; US Army Corps of Engineers (01/04-11/04). Employed on the dune restoration phase of the US Army Corp of Engineers Absecon Island Shore Protection Project. Project focus included sand fence and dune grass installation from Atlantic City to Ventnor City, New Jersey. Responsibilities included fence and planting layout, material storage, equipment maintenance, and communication with contractors. Gained experience in coastal ecology, winter field conditions and operating light machinery. Other projects with this firm included native species reforestation jobs for the Maryland State Highway Administration.

Carpenter's Assistant, Potts & Callahan Inc., Baltimore, Maryland (06/99-09/00). Assisted carpenters in the layout, building, and setting of concrete forms for stormwater management structures. Gained experience in reading blueprints and using instrument levels for grading and excavation. Learned heavy equipment safety procedures and the use of industrial power tools.

Intern/Scientist, Radford Army Ammunition Plant, Radford, Virginia (07/98-04/99). Worked on the environmental remedial investigation. Responsibilities included air, soil, surface water, and sediment sampling along with sampling documentation and transportation. Assisted in the compilation of the collective measures study by processing sampling results, preparing data spreadsheets and producing sampling maps from Global Positioning System data. Team involvement included site management during remediation phases.



ALL AMERICAN ENVIRONMENTAL SERVICES, INC.

This is to certify that

BRIAN D. KATELEY

has successfully completed

"HAZARDOUS WASTE SITE WORKER" 40-HOUR COURSE
SATISFYING OSHA 29 CFR 1910.120 (e) (3) (i)

at

ALL AMERICAN SCHOOL OF OCCUPATIONAL SAFETY AND HEALTH
COLUMBIA, MARYLAND

January 9-13, 2006
40S-0601A

School Director

EA Engineering, Science, And Technology, Inc.

Certificate of Training

PRESENTED TO

Brian Kateley

FOR COMPLETION OF

8-Hour HAZWOPER
Supervisor Training
Per 29 CFR 1910.120

25 April 2008

Peter Garger, CIH

OSHA Occupational Safety and Health Administration

14-600541403

This card acknowledges that the recipient has successfully completed a 30-hour Occupational Safety and Health Training Course in

Construction Safety and Health

Brian Kateley

Peter Garger CIH, CSP (Trainer name – print or type)

5/24/2011 (Course end date)

OSHA recommends Outreach Training Courses as an orientation to occupational safety and health for workers. Participation is voluntary. Workers must receive additional training on specific hazards of their job. This course completion card does not expire.

Use or distribution of this card for fraudulent purposes, including false claims of having received training, may result in prosecution under 18 U.S.C. 1001. Potential penalties include substantial criminal fines, imprisonment up to five years, or both.

For OSHA Outreach Training Program go to "Training" at www.osha.gov

Rev. 12/2009

CLICKSAFETY®

certifies that

BRIAN KATELEY

has successfully completed ClickSafety's web-based training course:

HAZWOPER 2021 Refresher (8-Hour)

In accordance with the requirements of 29 CFR 1910.120(e)
This course was developed and presented by ClickSafety.com, Inc.

CLICKSAFETY
www.ClickSafety.com

I confirm that I **personally took** the course **listed above.**

31533408	1/27/2021	8 HOURS	
SERIAL NUMBER	COMPLETION DATE	COURSE DURATION	STUDENT SIGNATURE

APPENDIX I

NOTICE OF ENVIRONMENTAL USE RESTRICTION

NOTICE OF ENVIRONMENTAL USE RESTRICTIONS

(TO BE PROVIDED ONCE ARMY AND ADEM HAVE REACHED AGREEMENT ON WORDING OF DOCUMENT)