Record of Decision
MCA Barracks Site Area (HAA-15)
Hunter Army Airfield, Georgia

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And

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Hunter Army Airfield, Georgia

Acknowledgment and Concurrence for remedial actions to be implemented at HAA-15:

11 MAY 2022

MANUEL F. RAMIREZ
Colonel, MI
Commanding

Date

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Acronyms

Acronym	Definition
µg/L	Micrograms per Liter
AWQC	Ambient Water Quality Criteria
ARAR	Applicable or Relevant and Appropriate Requirement
bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CSM	Conceptual Site Model
cys	Cubic Yards
COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
COPEC	Contaminant of Potential Ecological Concern
CVOC	Chlorinated Volatile Organic Compound
DCE	Dichloroethene
DERP	Defense Environmental Restoration Program
DNAPL	Dense Non-Aqueous Phase Liquid
DPT	Direct Push Technology
ERA	Ecological Risk Assessment
ERD	Enhanced Reductive Dechlorination
EVO	Emulsified Vegetable Oil
ft	Foot or Feet
g/L	Grams per Liter
GAEPD	Georgia Environmental Protection Division
HAAF	Hunter Army Airfield
HBG	Health Based Goal
HHRA	Human Health Risk Assessment
HI	Hazard Index
HQ	Hazard Quotient
ISCO	In Situ Chemical Oxidation
IWQS	Instream Water Quality Standards
IWTP	Industrial Wastewater Treatment Plant
LUC	Land Use Controls
MCA	Military Construction Army
MCL	Maximum Contaminant Level
mg/kg	Milligrams per kilogram
MIP	Membrane Interface Probe
MNA	Monitored Natural Attenuation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
O&M	Operation and Maintenance
OU	Operable Unit
PAH	Polyaromatic Hydrocarbon
PRG	Preliminary Remediation Goals
PVC	Poly Vinyl Chloride
RA	Risk Assessment
RAO	Remedial Action Objective
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Exposure
ROD	Record of Decision
RSLs	Regional Screening Levels
SARA	Superfund Amendments and Reauthorization Act
SOF	Special Operations Forces

Acronym	Definition
SSL	Soil Screening Level
TCE	Trichloroethene
TMV	Toxicity, Mobility, or Volume
TRV	Toxicity Reference Value
USEPA	U.S. Environmental Protection Agency
UU/UE	Unrestricted Use/ Unrestricted Exposure
VC	Vinyl Chloride
VISL	Vapor Intrusion Screening Levels
VOC	Volatile Organic Compound

1 DECLARATION

1.1 Site Name and Location

Site Name: The Military Construction Army (MCA) Barracks Site at Hunter Army Airfield (HAAF), or HAA-15. HAA-15 includes the Special Operations Forces (SOF) Investigation Area, MCA Barracks Investigation Area, Retention Pond 29, Hangar Buildings 811 and 813, the former Industrial Wastewater Treatment Plant (IWTP), and the Old Hospital Area.

Site Location: Hunter Army Airfield, Savannah, Georgia.

1.2 Statement of Basis and Purpose

This decision document presents the Selected Remedy for HAA-15, at HAAF, Georgia, which was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record file for this Site, which is available for review at the Department of Public Works Prevention and Compliance Branch, 1550 Veterans Parkway Building 1137, Fort Stewart, Georgia 31314. The State of Georgia supports the Selected Remedy without comment; regulatory approval is included in Appendix A.

1.3 Assessment of the Site

The response action selected in this Record of Decision (ROD) is necessary to protect public health, welfare, or the environment from actual or threatened releases of hazardous substances from this site which may present an imminent and substantial endangerment to public health or welfare. Investigations from 1993 through 2017 have identified a plume of volatile organic compounds (VOCs) and chlorinated solvents in groundwater under the Site, and lead, arsenic, and poly aromatic hydrocarbons (PAHs) in soil in the Old Hospital Area. Contaminants of Concern (COCs) in groundwater include trichloroethene (TCE), cis-1,2-dichloroethene (DCE), vinyl chloride (VC), benzene, and 1,1-DCE. COCs in soil include lead, arsenic, and benzo(a)pyrene. Hangar 811, where TCE was used as a cleaner and solvent, the aircraft wash racks, and former IWTP adjacent to Building 850 have been identified as source areas for TCE.

1.4 Description of Selected Remedy

The strategy at HAA-15 is to reduce the mass of the primary COCs in groundwater through Enhanced Reductive Dechlorination (ERD), to allow COCs at lower concentrations to naturally attenuate, and to prevent human exposure to COCs in soil by removing impacted soil. This strategy is a balance of protection of the environment, regulatory compliance; reduction in toxicity, mobility, and volume (TMV) of contaminants; long- and short-term effectiveness; cost effectiveness; implementability; and community/state acceptability. This strategy of balancing these criteria is also consistent with the strategies employed at other sites across HAA (e.g., HAA-01, HAA-17). Performance standards for this remediation include Remedial Action Objectives (RAOs) and Applicable or Relevant and Appropriate Requirements (ARARs). RAOs for HAA-15 include:

Groundwater

1) Reduce potential cancer risk and potential non- cancer health hazards for people (i.e., site workers and construction workers) exposed to TCE and cis- 1,2- DCE in contaminated groundwater by reducing the concentrations of or controlling exposure to these COCs;
2) Reduce potential exposure of ecological receptors to COCs in groundwater; and

3) Prevent potential for migration of TCE and cis-1,2-DCE above maximum contaminant levels (MCLs) to off-site locations.
4) Return useable groundwaters to their beneficial use whenever practicable.

Soil

1) Reduce potential cancer risk and potential non- cancer health hazards for people (i.e., site workers and construction workers) exposed to lead and high molecular weight PAHs in contaminated soils by reducing the concentrations of or controlling exposure to these COCs in soils;
2) Reduce or control potential exposure to areas identified with metals in surface soil;
3) Reduce potential exposure of ecological receptors to COCs and metals in soil; and
4) Prevent potential for migration of unacceptable levels of PAHs and metals to off-site locations.

ARARs are divided into three categories: chemical-specific, action-specific, and location-specific requirements.

Chemical-specific: Chemical-specific ARARs establish health-based concentration limits, risk-based concentration limits, or ranges for specific hazardous substances in different environmental media that provide media cleanup levels or a basis for calculating cleanup levels for COCs. Chemical-specific ARARs identified for remedial action at the site include United States Environmental Protection Agency (USEPA) Regional Screening Levels (RSLs) for soil and USEPA MCLs, and Region 4 Tapwater RSLs for groundwater.

Location-specific: Location-specific ARARs set restrictions on the types of remedial activities that can be performed based on site-specific characteristics or location (e.g., proximity to wetlands, historic buildings, etc.) The Ecological Risk Assessment (ERA) concluded that the ecological risks are considered negligible for exposure to constituents in green space surface soil, pond sediment, and surface water, so no location specific ARARs were proposed. HAA-15 will remain a commercial/industrial use property requiring that all remedial alternatives address potential residential exposure to COCs in soil and groundwater through the application of institutional controls.

Action-specific: Action-specific ARARs set controls or restrictions on the design, implementation, and performance of actions. These provide a basis for assessing the feasibility and effectiveness of the remedial alternatives by specifying performance levels, actions, or technologies and specific levels for discharge of residual chemicals. Action-specific ARARs identified include air emission standards for any air discharge and compliance with National Pollutant Discharge Elimination System (NPDES) and base requirements for any treated water discharged to proximate canals.

The proposed action will reduce the risk associated with exposure to contaminated groundwater above Preliminary Remediation Goals (PRGs). PRGs are based on calculated Health Based Goals (HBG) and the USEPA MCLs. HAAF has established PRGs as follows:

Groundwater

- VOCs:
  - Bromodichloromethane – 0.13 μg/L;
  - Chloroform – 0.22 μg/L;
  - Cis-1,2-DCE – 70 μg/L;
  - Ethylbenzene – 700 μg/L;
  - Methylene chloride – 5 μg/L;

    - TCE – 5 µg/L; and
    - VC – 2 µg/L.

Soil

- PAHs:
    - Benzo(a)pyrene – 0.11 mg/kg for residents; no calculated HBG for construction workers.

- Inorganics:
    - Arsenic – 0.68 mg/kg for residents, 3 mg/kg for site workers.
    - Hexavalent chromium – 0.31 mg/kg for residents; no calculated HBG for construction workers.
    - Lead – 400 mg/kg for residents, 441 mg/kg for utility workers.

The selected remedy for HAA-15 is:
Groundwater:

- ERD
    - Injections in zones of high TCE concentrations around Building 811 and the former wash rack and former IWTP
        - 22 injection wells in three lines with 30 ft spacing in higher concentrations zone near Building 811
        - Four injection wells in the higher concentration zone near the former IWTP
    - Annual injections of emulsified vegetable oil (EVO) until performance monitoring demonstrates an in-situ reduction zone (IRZ) has been established
    - Installation of seven additional performance monitoring wells to supplement existing monitoring network
        - Five to characterize treatment within the main plume near Building 811
        - Two to characterize the secondary hot spot near the former IWTP
    - Performance monitoring to monitor ongoing effectiveness of the IRZ and determine if additional injections are required.
- Monitored Natural Attenuation (MNA)
    - Performance monitoring of selected wells to monitor the overall effectiveness of MNA in achieving remedial goals
- Land Use Controls (LUCs)
    - Onsite LUCs enforced by HAAF will prohibit installation of water wells within or downgradient to the source area.
- CERCLA five-year reviews

Soil

- Excavation and Disposal
    - Excavation of impacted surface soil
    - Offsite disposal at an approved landfill under manifest
    - Backfill with confirmed clean soil

1.5 Statutory Determinations

The Selected Remedy is protective of human health and the environments, complies with Federal and State Requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable.

The remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment), in that the selected remedy for groundwater utilizes treatment as a principal element.

Because it is anticipated to take more than five years to attain RAO and cleanup levels, a policy review may be conducted within five years of construction completion for the site to ensure that the remedy is, or will be, protective of human health and the environment.

1.6 ROD Data Certification Checklist

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record file for this site.

- Chemicals of concern and their respective concentrations.
- Baseline risk represented by the chemicals of concern.
- Cleanup levels established for chemicals of concern and the basis for these levels.
- How source materials constituting principal threats are addressed.
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD.
- Potential land and groundwater use that will be available at the site as a result of the Selected Remedy.
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected.
- Key factor(s) that led to selecting the remedy (i.e., description of how the Selected Remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision.)

1.7 Authorizing Signatures and Support Agency Acceptance of Remedy

The State of Georgia supports the Selected Remedy; regulatory approval is included in Appendix A.

2 DECISION SUMMARY

2.1 Site Name, Location, and Description

HAA-15, or the MCA Barracks Site, includes the SOF Investigation Area, MCA Barracks Investigation Area, Retention Pond 29, Hangar Buildings 811 and 813, the former IWTP, and the Old Hospital Area. HAAF is the responsible party for site activities, and the Georgia Environmental Protection Division (GAEPD) oversees regulatory actions for this site. HAA-15 is an Operable Unit (OU) within HAAF, managed under CERCLA by the Army with regulatory oversite by the GAEPD.

HAAF is an active military installation located in Savannah, Georgia that contains areas of industrial, commercial, and temporary residential properties. HAA-15 is located in the northeastern portion of HAAF and includes an active airfield and a 10-acre manmade stormwater retention pond. A Site map showing where HAA-15 is located within HAAF is shown as **Figure 2-1**, and the investigation areas comprising HAA-15 are shown on **Figure 2-2**.

2.2 Site History and Enforcement Activities

Investigations at HAA-15 from 1996 through 2017 have identified chlorinated VOCs (CVOCs) to be the primary COCs in groundwater at the Site. Based on historical operations, Sitewide investigations, and observed concentrations, Hangar Building 811 and the former wash racks and former IWTP where TCE was used as a cleaner/solvent, are considered the primary sources of CVOCs at HAA-15.

Pre-construction investigations at the SOF facility and MCA Barracks Facility in 1996 and 1998, respectively, identified TCE and PCE, and TCE (respectively) in groundwater above MCLs. Subsequent investigations from 1998 to 2006 attempted to delineate impacts in soil and groundwater. In 2005-2006, HGL performed soil sampling, groundwater sampling, and monitoring well installation and sampling across HAA-15. HGL expanded the investigation to include the aircraft hangars, aircraft wash racks, former IWTP, Old Hospital Area, Georgia Air Guard Motor Pool, the Motor Repair Shop, and Pond 29.

Arcadis performed RI investigations from 2009 to 2017 to delineate the sources and extent of impacts to groundwater at HAA-15, focusing primarily on TCE. This investigation was Site-wide across HAA-15, included a tracer study, Membrane Interface Probe (MIP) investigations, soil and groundwater sampling, soil vapor sampling, and surface water assessments. This investigation culminated in the completion of a Remedial Investigation/Feasibility Study (RI/FS; Arcadis 2019).

2.3 Community Participation

The Proposed Plans for HAA-15 were made available to the public in July 2021. They are located in the Administrative Record at Fort Stewart, online at the Fort Stewart Department of Public Works Prevention and Compliance Branch's webpage, and in the Southern Chatham County Public Library. Notice of availability of the plans was published in the Savannah Morning News and The Frontline prior to the public comment period on June 24 and July 1, 2021, respectively. A public comment period was held from July 14 to August 14, 2021. A public meeting was to be scheduled if requested during the public comment period, but no public meeting was requested. No comments were received during the public comment period.

2.4 Scope and Role of OU or Response Action

HAA-15 is an OU covering groundwater and soil impacts at the Site. The planned sequence of actions for HAA-15 is to implement ERD, MNA, and LUCs to manage impacts to groundwater and meet established

RAOs. The excavation and offsite disposal of impacted soil is planned to manage impacted soil. HAAF is responsible for implementing remediation at the Site, with regulatory oversite from the GAEPD.

2.5 Site Characteristics

HAA-15 is in the northeast portion of HAAF and includes administrative and industrial buildings, an airfield, and a 10-acre stormwater retention pond, Pond 29. The area is topographically relatively flat and commercial/industrial in use. There is green area to the north/northeast of Pond 29 that was the Old Hospital Area. The primary COCs in groundwater are CVOCs in the Hangar 811 area and in the former IWTP and washracks area. Impacted soil is limited to the Old Hospital area, particularly around the area that was formerly the boiler room.

Hangar 811 was constructed in late 1940 - early 1941. TCE used as a cleaner and solvent at 811 was discharged to a grease trap in front of Hanger 811. The grease trap was disconnected, cleaned and partially removed in 2007. TCE was detected at concentrations indicative of DNAPL across Lightning Drive from Hangar 811 and the former grease trap.

The wash racks and former IWTP are adjacent to Building 850, southeast of Hangar 811. Concentrations indicative of source mass or a downward migration pathway were not detected in unsaturated soil in the former IWTP area or in the shallow zone of the upper aquifer. The dates of construction for the former wash rack and former IWTP could not be determined.

2.5.1 Conceptual Site Model

The Conceptual Site Model (CSM) identifies the primary sources, primary release mechanism, secondary sources, potential pathways, and receptors. The CSM also identifies potentially complete pathways, wherein there exists a pathway to exposure and known potential receptor present or potentially present at the Site. The CSM is summarized in **Figure 2-3**.

2.5.1.1 Primary Sources and Release Mechanisms

Groundwater
Previous investigations have concluded that the primary sources of COCs in groundwater at HAA-15 are Hangar Building 811, and the former wash racks and former IWTP, where TCE was used as a cleaner/solvent. The highest concentrations of CVOCs at HAA-15 are observed close to Building 811, and a second hot spot is observed near the former IWTP. TCE concentrations in shallow groundwater are shown on **Figure 2-4**, and in deeper groundwater on **Figure 2-5**.

Building 811
The primary contributing source of TCE DNAPL to the subsurface was the cleaning and maintenance operations in Hangar 811. MIP investigations indicated two discreet TCE plumes emanating from the Hangar 811 area. The primary source mass is located north of the NW corner of Hangar 811, and a lesser source mass appears to be northeast of the NE corner of 811. Based on soil sampling around Hangar 811 and the former grease trap, it appears that TCE was released slowly over time during operations at Hangar 811 to migrate to the deep interval of the upper aquifer, rather than released from one single point-source mass.

The largest source, located north of the northwest corner of Hangar 811, appears to be contributing dissolved-phase TCE along a preferential migration pathway to the northwest. The mass flux of TCE across the site occurs in a narrow corridor in the deep zone of the upper aquifer to approximately 600 ft downgradient from the suspected source area. The geometry of the plume and the groundwater flow direction also corroborate that the primary source of the TCE impacts is associated with the area north of Hangar 811. The down and side gradient extents have been delineated and dissolved-phase concentrations of TCE have been determined to have migrated approximately 1,600 ft downgradient from the source mass identified in the Hangar 811 area. The lesser source mass located northeast of Hangar 811 is significantly smaller in concentration and areal extent relative to the source mass northwest of Hangar 811. Investigation data indicate that the mass is also migrating to the northeast and, based on MIP data from Transect B, has decreased substantially 300 ft downgradient.

Vertical delineation in the source areas indicated that the impacts are predominantly held up in the interbedded clays between 35 and 50 ft bgs. These interbedded clays in the deeper interval of the upper aquifer and the clay of the upper Hawthorne confining unit have effectively prevented any significant vertical migration beyond 50 ft bgs. The two potable wells in the area have open intervals below the Hawthorne confining unit in the upper Floridan Aquifer and are not at risk from the impacts at this site.

Washracks and Former IWTP

Based on groundwater flow direction and storm sewer routes, the impact around the former IWTP is a separate source, independent of that around Hangar 811. MIP investigations and groundwater analytical results indicate the plume is narrow and limited in downgradient extent. Vertical delineation in this area indicates the impacts are predominantly held up in the interbedded clays between 35 and 50 ft bgs.

Soil

Impacted soil at HAA-15 is limited to the Old Hospital Area. Surface soil in the Old Hospital Area exhibit benzo(a)pyrene, arsenic, and lead above the RSLs. A clear source of lead impacts has not been identified, but the impacts are in the vicinity of the former boiler room that provided steam heat to the old hospital. Coal was reported used to fuel the boilers and may be the source of the soil impacts.

2.5.1.2 Secondary Sources and Release Mechanisms

Groundwater

The highest CVOC concentrations in groundwater are to the north and northwest of Building 811 in the deeper units of the upper aquifer. Interbedded clays between 35-50 ft bgs have prevented significant vertical migration to the deeper aquifers. There is a second, smaller source area exhibiting lower COC concentrations to the north of the former washracks and IWTP. Primary COCs in groundwater at HAA-15 include TCE, cis-1,2-DCE, VC, and isolated detections of 1,1-DCE and benzene.

Groundwater may release contaminants through groundwater discharge to other units of groundwater, surface waters, or sediment.

Soils

Concentrations of metals and PAHs in exceedance of RSLs have been observed in surface soils around the Old Hospital Area. Surface soils may release contaminants via surface runoff and dust/volatile emissions to air, surface waters, or sediments.

2.5.1.3 Pathway- Exposure Medium and Routes

Groundwater

Pathway exposure media for groundwater include groundwater (direct), surface water, and sediment. Potential exposure routes for these media include ingestion, direct contact/uptake, or food chain exposure to groundwater; ingestion, dermal contact, inhalation of vapors, direct contact/uptake, and food chain exposure for surface water; and ingestion, dermal contact, direct contact/uptake, and food chain exposure for sediment.

Soil

Pathway exposure media for soil contamination in surface soil include surface soil (direct), air, surface water, and sediment. Potential exposure routes for these media include ingestion, dermal contact, direct contact/uptake, and food chain exposure for surface soil; inhalation for air; ingestion, dermal contact, inhalation of vapors, direct contact/update, and food chain exposure for surface water; and ingestion, dermal contact, direct contact/update, and food chain exposure for sediment.

2.5.1.4 Receptors

Receptors are people, plants, or animals that may be exposed to contaminants at the Site. HAA-15 is currently an industrial-use location at HAAF that is not used for residential purposes. Receptors at HAA-15 include site workers, construction workers, hypothetical future residents, trespassers, terrestrial wildlife, soil dwelling invertebrates, and terrestrial plants.

2.5.1.5 Potentially Complete Exposure Pathways

Exposure pathways include the source, route, and mechanisms through which a contaminant might reach a receptor. Complete exposure pathways, or potentially complete exposure pathways, exist when a continuous link exists between the contaminant source, release mechanism, transport medium, exposure route, and potential receptor. Exposure to lead in soil poses an unacceptable risk to hypothetical adult and child residents exposed to surface soil and utility worker exposure to combined surface and subsurface soil.

Groundwater
Groundwater at HAA-15 is not recommended for use as a potable water source, and none of the receptors are anticipated to interact directly with groundwater at the Site. The only potentially complete pathways identified in the CSM groundwater contaminants was for trespassers by ingestion of, dermal contact with, or inhalation of vapors in surface water, and by ingestion of or dermal contact with sediment.

Soil
Contaminants in surface soils may reach site workers, construction workers, hypothetical residents, trespassers, terrestrial wildlife, and invertebrates through ingestion and dermal contact. A potentially complete pathway also exists for trespassers, wildlife, invertebrates, and plants through direct contact/uptake; and for terrestrial wildlife through the food chain. The inhalation pathway is potentially complete through inhalation of contaminants by site workers, construction workers, hypothetical future residents, and trespassers. Contaminants in surface soil released to surface water and sediment could potentially reach trespassers through ingestion, dermal contact, or inhalation of vapors (surface water).

Contaminants in subsurface soils could potentially reach site workers, construction workers, hypothetical residents, and terrestrial wildlife through ingestion, dermal contact, direct contact/uptake, and food chain exposure. Soil invertebrates could potentially be exposed to subsurface soil through ingestion, dermal contact, and direct contact/uptake. A potentially complete pathway also exists for terrestrial plants through direct contact/uptake of subsurface soils.

2.5.2 Contamination

COCs at HAA-15 include target VOCs in groundwater and metals and PAHs in soil. TCE has been detected at concentrations indicative of DNAPL across Lightning Drive from Hangar 811. These COCs are discussed further in this section and summarized in **Tables 2-1a and 2-1b.**

Groundwater
TCE is commonly used as a solvent to remove grease from metal. Physiological effects of TCE exposure include dermatitis, central nervous system depression, neurological abnormalities, liver damage, abdominal pain, nausea, and vomiting. TCE is reasonably projected to be a human carcinogen.

Benzene is a natural constituent of crude oil and is therefore a common constituent in hydrocarbon products. Physiological effects of exposure to benzene include neurological and immunological damage. Benzene is a known human carcinogen.

Cis-1-2-DCE is commonly used in chemical mixtures, to produce solvents, and is a daughter product- or produced during breakdown of TCE. Physiological effects of exposure to cis-1,2-DCE include liver and kidney damage, drowsiness, nausea, and cardiovascular complications. Cis-1,2-DCE is reasonably projected to be a human carcinogen.

1,1-DCE is a chemical that is not found naturally in the environment. It is mainly utilized to manufacture specific plastics (such as plastics for food wrapping), as well as packaging materials. It is also used to make flame retardant coatings, as well as coating for steel piping. 1,1- DCE can cause liver, developmental, and neurological damage, as well as respiratory harm.

VC is used to manufacture polyvinyl chloride (PVC), a very common synthetic plastic polymer. Like cis-1,2-DCE, VC is also a daughter product of TCE. Physiological effects of exposure to VC include central nervous system depression, ataxia, tingling of the extremities, visual disturbances, coma, and death. VC can aggravate the eyes, mucous membranes, and the respiratory tract. VC is a known human carcinogen.

Soil
Benzo(a)pyrene is formed during the burning of solid waste, oil, coal, and other organic materials. Physiological effects of exposure to benzo(a)pyrene include darkening of the skin, rash, and eye irritation. Benzo(a)pyrene has been identified as a carcinogen.

Lead is a heavy metal that has a wide variety of uses, including manufacturing batteries, radiation protection, ammunition, as a gasoline constituent, and as roofing material. Some side effects of Lead exposure can result in developmental issues in children, miscarriage, brain damage, and seizures.

Arsenic is a metal used in semiconductors, as well as amalgamation of gold in mining practices, pyrotechnic manufacturing, and bronzing processes. Acute Arsenic poisoning can result in red and swollen skin, vomiting, muscle cramps, long- term exposure can cause digestive issues and damage to internal organs, as well as the skin.

2.5.3 Hydrogeology and Hydrology

The geology at HAA-15 consists primarily of sand from land surface to 10-20 ft bgs, then silty sand overlying interbedded silty sands and clays, fining downward to the Hawthorne clay. The Hawthorne is a regionally extensive clay unit at the base of the upper aquifer, considered to be a confining unit (120-125 ft bgs). A persistent clay unit in some areas of the site divides the upper aquifer system into two zones. The shallow upper zone is sandier and extends to depths between 20-25 ft bgs. The deeper upper zone is siltier and ranges from 35-45 ft bgs. Where the clay separating the upper zones is present, observed head differences in well pairs range from between 1 and 6 ft downward. More minor vertical head differences to the eastern and western peripheries of the site suggest the clay is limited in extent.

Groundwater in the upper aquifer flows north-northwest, away from the runway complex. The average shallow zone gradient was calculated to be 0.0085 ft/ft. Deep zone upper aquifer groundwater flow is also generally to the north-northwest with an average gradient calculated to be 0.012 ft/ft. A potentiometric surface map for the shallow zone is shown on Figure 2-6, and for the deep zone on Figure 2-7. The observed depth to groundwater in December 2014 ranged from 2.59 to 23.70 ft across HAA-15.

Pond 29, a 10-acre man-made pond, and drainage canals at the site appear to be discharge boundaries for the shallow unconfined groundwater. Pond 29 appears to have a minimal effect on flow direction, although it is believed to be a discharge point for shallow groundwater and representative of the shallow groundwater level when groundwater levels are high. Lamar Canal, in the northwest of HAA-15, is a major local waterway and a possible shallow groundwater discharge boundary (Pika/Arcadis 2019).

2.6 Current and Potential Future Site Resources Uses

2.6.1 Land use

HAAF is an active military installation and access to the Site is restricted. HAA-15 is located in the northeastern portion of HAAF. HAA-15 includes administrative buildings and commercial/industrial use buildings. The space around the 10-acre retention pond, Pond 29, includes a landscaped, maintained area of oak trees and green space designated for recreational use. HAA-15 will remain a commercial/industrial use property requiring that all remedial alternatives address potential residential exposure to COCs in soil and groundwater through the application of institutional controls. Residential PRGs are not developed for the property. No ecological-based PRGs are proposed. According to the Base Master Plan (**US Army 2017**), there are no current plans for future conversion of the site for permanent residential use.

2.6.2 Ground and Surface Water

There are no potable wells in the surficial aquifer at HAA-15, and the surficial aquifers in which contamination at HAA-15 is observed are not recommended for use as drinking water. Only when potable use of the groundwater was considered for residents did the calculated risks and hazards in the HHRA exceed the benchmarks, and it is recommended that that groundwater not be used as a potable water supply.

There are two potable wells at HAA-15 that supply water for HAAF. These wells are installed in the Floridan Aquifer with an open interval from approximately 260 to 504-555 ft bgs. There is a thick confining unit from 60 to 285 ft bgs separating the surficial aquifers from the underlying potable aquifer. VOC sampling on the public supply wells performed in March 2017 indicated there were no COCs present in the potable wells (Pika/Arcadis 2019).

Pond 29, or Oglethorpe Lake, was constructed in 1985 as a catchment basin for stormwater. The pond is 1,200 ft long and 400 ft wide (approximately 10 acres) and up to 9 ft deep. Pond 29 is of earthen construction with a soil bottom and is contained by an earthen dam. Stormwater enters the pond along the eastern shore from a ditch perpendicular to Douglas Street, and after periods of prolonged heavy rainfall, water can discharge from the pond through an overflow culvert into a ditch along the western shore, downstream of the dam. The pond is stocked with Bluegill Sunfish, Channel Catfish, Grass Carp, Largemouth Bass, and Read Ear Sunfish. The pond is considered cross-gradient to the CVOC plume beneath HAA-15.

2.7 Summary of Site Risks

Based on the land and water uses described in Section 2.6, the current primary risk of exposure to humans or ecological receptors consists of direct exposure to, ingestion of, or inhalation of vapors from groundwater by site workers and construction workers, and direct contact with or ingestion of soil by hypothetical future site workers and construction workers. No contaminants detected in sediment or surface water exceeded applicable screening levels. While there is no current risk to residential receptors, nor known plans for future residential use of the Site, remedies are expected to consider potential exposure to hypothetical future residents. The Ecological Risk Assessment (ERA), summarized in Section 2.7.2, found potential ecological risks to be considered negligible overall at HAA-15.

The primary basis for taking action at this Site is the threat of exposure to COCs in soils or shallow groundwater by site workers and construction workers.

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances to the environment.

2.7.1 Summary of Human Health Risk Assessment

The baseline HHRA estimates what risks HAA-15 poses if no action were taken. This provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section summarizes the HHRA for the Site as presented in the RI/FS (Pika/Arcadis 2019).

2.7.1.1 COCs

The first step of the HHRA process is compiling and evaluating data to select the Contaminants of Potential Concern (COPCs). The objective is to identify the most toxic, persistent, and prevalent COPCs at the site that are expected to contribute the majority of the potential exposure risk. COPC selection involves a conservative, risk-based screening evaluation, and can be based on criteria including toxicity, frequency of detection, comparison to background concentration, or whether a constituent can be considered a common laboratory contaminant (e.g., acetone).

COCs in this HHRA were identified for retention by comparing maximum detected concentrations of COPCs with health-based screening levels, including:

- USEPA RSLs: assuming a Hazard Quotient (HQ) of 0.1 and a target cancer risk of $1x10^{-6}$. (USEPA 2018a)
- USEPA MCL-based Soil Screening Levels (SSLs), or in the absence of MCL-based SSLs, the tap water-based SSLs (USEPA 2018a)
- USEPA Vapor Intrusion Screening Levels (VISLs) based on a target HQ of 0.1 and a target cancer risk of $1x10^{-6}$ (USEPA 2018b)
- Georgia Instream Water Quality Standards (IWQS; GAEPD 2015) were used to identify surface water COPCs, or in the absence of Georgia IWQS, the USEPA National Recommended Ambient Water Quality Criteria (AWQC) were used (USEPA 2015).

COCs are summarized in **Tables 2-1a and 2-1b.**

2.7.1.2 Exposure Assessment

The exposure assessment is the process of measuring or estimating the intensity, frequency, and duration of human exposure to substances present in the environment. The purpose of the assessment is to evaluate the ways the receptors might be exposed to COPCs at HAA-15. Exposure can only occur when the potential exists for a receptor to contact COPCs or when there is a mechanism for COPCs to be transported to a receptor. With no exposure, there is no risk. The exposure assessment includes characterization of the physical environment; identification of exposure pathways, including migration pathways, exposure points, and exposure routes; and identification of receptors- potentially exposed individuals and populations.

Exposure pathways are defined by four elements:

1. A source and mechanism of constituent release to the environment.
2. An environmental transport medium for the released constituent.
3. A point of potential contact by the receptor with the medium containing the constituent (exposure point).
4. A route of exposure to the receptor at the exposure point (e.g., dermal contact, ingestion, inhalation).

To identify and evaluate the ways a population may be exposed to COPCs, the assessment includes estimating concentrations along potential pathways using site-specific data and, when necessary, mathematical modeling. In this assessment, doses and risks were calculated for the reasonable maximum exposure scenarios.

Receptors

Receptors were identified to include site workers (e.g., those who periodically mow and maintain the site) and construction/utility workers. While there are no plans to use the site for residential purposes, hypothetical future residents were included in the assessment. Trespassers are considered unlikely based on the nature of restricted access to the military installation but were nevertheless evaluated as potential receptors.

Receptors at the Site were identified to include site workers, construction workers, and hypothetical future residents.

Exposure Pathways

The exposure pathways and the associated exposure medium identified for the receptors at the site are described below. Potential future use of groundwater as a potable water supply is assumed to be a complete exposure pathway. Soil contact may occur if the site were used in the future. Either workers or residents could contact the soil and be exposed through incidental ingestion, dermal contact, and inhalation of vapors or dust. If construction were to occur at HAA-15, construction workers or utility workers could contact the soil as well. Finally, VOCs were detected in groundwater, and potential inhalation exposure to VOCs migrating from the subsurface into a building were evaluated in the HHRA. The exposure pathways include:

- Hypothetical future adult and child residents potentially exposed to surface and subsurface soil through direct contact, groundwater used as a potable water supply, and inhalation of vapors migrating to indoor air;
- Hypothetical future commercial/industrial workers potentially exposed to surface and subsurface soil through direct contact, and inhalation of vapors migrating to indoor air;
- Hypothetical future construction/utility workers potentially contacting soil and shallow groundwater; and
- Adolescent trespassers contacting soil, surface water (incomplete exposure pathway – no COPCs identified), and sediments (incomplete exposure pathway – no COPCs identified).

Exposure Evaluation

Exposure point concentrations were estimated using site-specific data and a statistical approach consistent with USEPA methodology. Receptor exposure assumptions including body weight and ingestion rates and scenario specific assumptions including the total period of receptor is exposed and the frequency of exposure were obtained based on USEPA guidance. Receptor exposure assumptions were selected such that the risk calculated would be for the Reasonable Maximum Exposure (RME) scenario. Potential risk from exposure to constituents in each medium were calculated considering the fate and transport of COPCs, which is dependent on their physical and chemical properties, the environmental transformation processes affecting them, and the media through which they migrate. Calculations, assumptions, and chemical properties (e.g., molecular weight, solubility, diffusivity in air and water) are all included in the HHRA within the RI/FS (Pika/Arcadis 2019).

2.7.1.3 Toxicity Assessment

The toxicity assessment describes the relationship between the administered and/or the absorbed dose of a constituent and the magnitude or likelihood of adverse health effects. Toxicity values for potential non-carcinogenic and carcinogenic effects were obtained consistent with the recommended USEPA hierarchy and USEPA guidance. Therefore, the following sources were used to obtain toxicity values, in the order in which they are presented below.

- USEPA's Integrated Risk Information System (USEPA 2019a)
- USEPA Provisional Peer Reviewed Toxicity Values (USEPA 2019b)
- The USEPA Superfund Program Health Effects Assessment Summary Tables (USEPA 2011b)

- Toxicity values from the agency for Toxic Substances and Disease Registry (2019)
- The California Environmental Protection Agency, Office of Environmental Health Hazard Assessment's Toxicity Criteria Database (CalEPA 2019)

Summaries of Cancer and Non-Cancer Toxicity Data for HAA-15 are provided in **Tables 2-2a** and **2-2b**, respectively.

2.7.1.4 Risk Characterization

Risk characterization is the integration of the integration of the results of the data evaluation, exposure assessment, and toxicity assessment to yield a quantitative measure of cancer risk and non-cancer hazard. Potential risks to human health are evaluated quantitatively by combining calculated exposure levels and toxicity data. Risk calculations are presented in the RI/FS (Pika/Arcadis 2019) and summarized in **Tables 2-3a and 2-3b** of this ROD.

The individual risks and hazards were calculated by medium and receptor to determine the total site risk and hazard by receptor, as shown on **Tables 2-3a and 2-3b**. The calculated risks for the current or hypothetical future site worker are within the USEPA target risk range of 1×10^{-4} and 1×10^{-6}, while the non-cancer hazards were less than the benchmark of 1. For the hypothetical future construction worker, the calculated risks are within the USEPA target risk range and the total HI is above the regulatory benchmark of 1, and primarily driven by lead in surface soil and TCE in shallow groundwater. The calculated risks for the hypothetical future utility worker are within the USEPA target risk range of 1×10^{-4} and 1×10^{-6}, while the total Hazard Index (HI) is below the regulatory benchmark of 1. The calculated risks for the hypothetical future adolescent trespasser were below the target risk range and the non-cancer hazards were less than the benchmark of 1. A hypothetical future resident exposed to soil and inhalation of vapors migrating from shallow groundwater into a home were within the target risk range of 1×10^{-6} to 1×10^{-4} and less than or equal to the non-cancer hazard of 1. Only when potable use of the groundwater was considered for residents did the calculated risks and hazards exceed the benchmarks. Therefore, it is recommended that groundwater not be used as a potable water supply.

Exposure to lead in soil posed an unacceptable risk to hypothetical adult and child residents exposed to surface soil and utility worker exposure to combined surface and subsurface soil. (Pika/Arcadis 2019)

2.7.2 Summary of Ecological Risk Assessment

The ERA estimates what risks HAA-15 poses to ecological receptors if no action were taken. This section summarizes the ERA for this Site, as presented in the RI/FS (Pika/Arcadis 2019). The ERA was conducted for the green space at HAA-15.

COPECs

The refinement of Contaminants of Potential Ecological Concern (COPECs) is necessary to help focus further risk assessment activities on those constituents that pose the greatest potential hazard to ecological receptors. It is intended as an incremental iteration of exposure, effects, and risk characterization. Constituents are either excluded as COPECs or retained for further evaluation in the ERA process. The process to refine COPECs includes:

1. Comparison with background and upgradient concentrations- This is only applicable for inorganic constituents unless organic constituents being considered also occur in background or upgradient media unaffected by the site. Soil background levels for inorganics were identified from the Revised Final CSR and were incorporated in the ERA.

2. Frequency of Detection – constituents detected in greater than 5% of the samples in a given medium are typically retained as COPECs and considered in the next step of the refinement process.

For HAA-15 the COPEC retained through the end of the screening is mercury.

Exposure Assessment
The greenspace at HAA-15 comprises a landscaped, maintained area of oak trees and a 10-acre manmade stormwater retention pond (Pond 29 or Oglethorpe Lake) in the western portion of the Site. The pond is designated for recreational use by the National Recreation Lake Study Commission. The green space provides terrestrial and aquatic habitats for ecological receptors.

The pond is stocked with Bluegill Sunfish, Channel Catfish, Grass Carp, Largemouth Bass, and Read Ear Sunfish. Other wildlife that may occur in the green space include the common grey squirrel, fox squirrel, songbirds and various waterfowl, white tailed deer, reptiles, and amphibians (e.g., turtles and frogs). No threatened or endangered species were identified at HAA-15.

Indicator species were chosen to represent a cross-section of feeding guilds for selected assessment endpoints. The American robin (*Turdus migratorius*) was chosen to represent the invertivorous birds, and the short-tailed shrew (*Blarina brevicaudus*) was chosen to represent the invertivorous mammals. The American robin is prolific in the United States with a home range that includes Georgia, tends to forage in open areas and the ecotone between woodlands and open areas, and has sufficient exposure-related and toxicological information available to be used in assessments. The short-tailed shrew is one of the most common mammals in North America and may be present at the Site. The short-tailed shrew also has a high ingestion rate and as such may be used as a conservative species in an ERA. With a relatively high consumption of earthworms, and if hazards are not expected for this species, then hazards should not be expected for species with lesser exposures to bio accumulative constituents (e.g., herbivorous mammals).

Risks were characterized for ecological receptors by considering direct contact with constituents of potential ecological concern (COPECs) in surface soil (0 to 4 feet below ground surface) and through ingestion of prey tissue through a food web model to upper-trophic level wildlife. Pathways of concern are summarized in **Table 2-4**.

Ecological Effects Assessment
Toxicity Reference Values (TRVs) were obtained from the toxicological database presented in USEPA's EcoSSL documents (USEPA 2007) or, when unavailable in the EcoSSL documents, from the open literature. Toxicological benchmarks were used in food chain modeling such that a range of predicted food chain impacts could be evaluated. Food chain ingestion- based exposure calculations were used to identify potential adverse effects for wildlife at the site via wildlife dose models. Estimated ingestion intakes were divided by TRVs to obtain HQs for bioaccumulative COPECs. A HQ value of 1 or less is considered to indicate that adverse effects are not expected. An HQ above 1 indicates the need for further investigation. COPEC Concentrations Expected to Provide Adequate Protection of Ecological Receptors are summarized in **Table 2-5**.

Eco Risk Characterization
Risks were characterized for ecological receptors at the HAA-15 green space by considering direct contact with COPECs in surface soil (0 to 2 ft below land surface), and pond sediment and surface water, and through ingestion of prey tissue via the food web to upper-trophic level wildlife. For Pond 29, no COPECs were identified in sediment and surface water, or for the groundwater to surface water pathway. For soil, most COPECs have HQs below 1. While the HQs for exposure to some COPECs in soil (i.e., lead and mercury) were above 1, population-level effects for terrestrial receptors are not expected considering the *de minimis* area with concentrations above screening values, and the conservativeness of the screening

values. Overall, the potential ecological risks are considered negligible for exposure to constituents in green space surface soil and in pond sediment and surface water.

Because mercury is considered bioaccumulative and the HQ for direct contact to terrestrial organisms exceeded the threshold value of 1, mercury was also assessed in dose models to upper-trophic level wildlife. The HQs for both the shrew and the robin are well below 1. Based on this assessment, potential ecological risk at the HAA-15 green space is considered negligible, and further evaluation is not warranted (Pika/Arcadis 2019).

2.8 Remedial Action Objectives

Cleanup at HAA-15 will afford protection of human and environmental health for the current and reasonably anticipated future land use at HAA-15. For HAA-15, this will entail removing contaminated soils, and reducing concentrations of COCs in groundwater to acceptable levels (i.e., PRGs established in accordance with calculated health-based goals and USEPA MCLs).

RAOs are site-specific, initial clean-up objectives that are established on the basis of the nature and extent of contamination, the resources that are currently and potentially threatened, and the potential for human and environmental exposure. HAA-15 contains multiple administrative and industrial facilities as well as barracks. Military and civilian workers are present at the Site during the work week. While family housing is not provided at the site, the barracks provide housing to transient military personnel. Access to the site is restricted, and trespassers are not expected. It is unlikely that the site will be used for permanent residential housing based on the HAAF Master Plan not including plans for family housing in the area (US Army 2017); the nearest family housing is one mile southeast of this site.

The Defense Environmental Restoration Program (DERP) Manual states, "if remedial action for groundwater is necessary to protect human health or the environment, the DoD Component should consider the NCP expectation that useable groundwater will be returned to their beneficial uses whenever practicable, within a timeframe that is reasonable given the particular circumstances of the site, when establishing RAOs in accordance with the NCP (300.430[a][1][iii][F])." The cited section of the NCP states "EPA expects to return usable groundwaters to their to their beneficial uses wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site. When restoration of groundwater to beneficial uses is not practicable, EPA expects to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction."

Upper surficial aquifer groundwater is not used as a potable water supply. The deeper Floridan aquifer is used as the potable water supply, and there are two potable wells installed into the Floridan aquifer in the HAA-15 area. HAA Well #1 and #2 are not hydraulically connected to the surficial aquifer where the contamination has been observed. The depth to water in the shallow upper aquifer is approximately 2 to 10 ft bgs, and construction workers may contact the groundwater during construction activities. Volatile organics present in the groundwater may migrate into buildings at the site by way of vapor intrusion. The RAOs for HAA-15 include:

Groundwater

1) Reduce potential cancer risk and potential non- cancer health hazards for people (i.e., site workers and construction workers) exposed to TCE and cis- 1,2- DCE in contaminated groundwater by reducing the concentrations of or controlling exposure to these COCs;

2) Reduce potential exposure of ecological receptors to COCs in groundwater; and

3) Prevent potential for migration of TCE and cis-1,2-DCE above maximum contaminant levels (MCLs) to off-site locations.

4) Return useable groundwaters to their beneficial use whenever practicable.

Soil

1) Reduce potential cancer risk and potential non- cancer health hazards for people (i.e., site workers and construction workers) exposed to lead and high molecular weight PAHs in contaminated soils by reducing the concentrations of or controlling exposure to these COCs in soils;
2) Reduce or control potential exposure to areas identified with metals in surface soil;
3) Reduce potential exposure of ecological receptors to COCs and metals in soil; and
4) Prevent potential for migration of unacceptable levels of PAHs and metals to off-site locations.

ARARs are divided into three categories: chemical-specific, action-specific, and location-specific requirements.

Chemical-specific: Chemical-specific ARARs establish health-based concentration limits, risk-based concentration limits, or ranges for specific hazardous substances in different environmental media that provide media cleanup levels or a basis for calculating cleanup levels for COCs. Chemical-specific ARARs identified for remedial action at the site include USEPA RSLs for soil and USEPA MCLs, and Region 4 Tapwater RSLs for groundwater.

Location-specific: Location-specific ARARs set restrictions on the types of remedial activities that can be performed based on site-specific characteristics or location (e.g., proximity to wetlands, historic buildings, etc.). The Ecological Risk Assessment (ERA) concluded that the ecological risks are considered negligible for exposure to constituents in green space surface soil, pond sediment, and surface water, so no location specific ARARs were proposed. HAA-15 will remain a commercial/industrial use property requiring that all remedial alternatives address potential residential exposure to COCs in soil and groundwater through the application of institutional controls.

Action-specific: Action-specific ARARs set controls or restrictions on the design, implementation, and performance of actions. These provide a basis for assessing the feasibility and effectiveness of the remedial alternatives by specifying performance levels, actions, or technologies and specific levels for discharge of residual chemicals. Action-specific ARARs identified include air emission standards for any air discharge and compliance with NPDES and base requirements for any treated water discharged to proximate canals.

PRGs were established based on USEPA RSLs, USEPA MCLs, and Georgia IWQS Criteria. PRGs for the Site include:

Groundwater

- VOCs:
  - Bromodichloromethane – 0.13 µg/L;
  - Chloroform – 0.22 µg/L;
  - Cis-1,2-DCE – 70 µg/L;
  - Ethylbenzene – 700 µg/L;
  - Methylene chloride – 5 µg/L;
  - TCE – 5 µg/L; and
  - VC – 2 µg/L.

Soil

- PAHs:
  - Benzo(a)pyrene – 0.11 mg/kg for residents; no calculated HBG for construction workers.

- Inorganics:
  - Arsenic – 0.68 mg/kg for residents, 3 mg/kg for site workers.
  - Lead – 400 mg/kg for residents, 441 mg/kg for utility workers.

The RAOs address risks identified in the Risk Assessment (RA) by reducing or limiting exposure of site workers and construction workers to COCs in groundwater and soils, reducing concentrations of COCs in soil and groundwater, and preventing potential for migration of COCs to offsite locations.

2.9 Description of Alternatives

Remedial alternatives are discussed in this section. Alternatives are presented in consecutive order corresponding to their order in the RI/FS report. Alternatives are evaluated based on effectiveness (overall protectiveness of human health and the environment; compliance with RAOs; long-term and short-term effectiveness; and reduction of TMV of contaminants), implementability, cost effectiveness, and state and community acceptance.

The alternatives are:

Groundwater
Alternative 1: No Action
Alternative 2: MNA and LUCs
Alternative 3: ERD, MNA, and LUCs
Alternative 4: In situ chemical oxidation (ISCO) via injection wells, MNA, and LUCs

Soil
Alternative 1: No Action
Alternative 2: Capping with vegetative cover
Alternative 3: Excavation and Disposal
Alternative 4: In Situ Phytoremediation

These alternatives are summarized below.

2.9.1 Groundwater

2.9.1.1 Groundwater Alternative 1: No Action

Under this alternative, HAAF would take no action at the site to prevent exposure to groundwater contamination or to reduce TMV of contaminants. There are no technological barriers to implementation of the No Action alternative, however the potential risks identified in the RA would not be mitigated by this response. This response is evaluated as required based USEPA guidance.

2.9.1.2 Groundwater Alternative 2: MNA and LUCs.

MNA is a potentially applicable technology for the aqueous groundwater contamination associated with the source areas at Hangar 811 and the former wash rack and former IWTP near Building 850. MNA for the CVOC groundwater plume is an alternative based on natural processes providing sufficient degradation or attenuation of target contaminants to meet remedial goals in a reasonable timeframe. These processes include biological process, chemical processes (e.g., hydrolysis, precipitation), and physical processes (e.g., dilution, dispersion, volatilization). Groundwater Alternative 2 will utilize:

- MNA via a long-term monitoring program to demonstrate continued reduction in COC concentrations.

- LUCs will be implemented to maintain protection of human health and the environment:
  - Prohibition of potable water well installation and groundwater consumption until site groundwater concentrations are at levels that allow unrestricted use and unlimited exposure (UU/UE).

Implementation of the groundwater monitoring program involves continued monitoring of COC concentrations to quantify attenuation rates and demonstrate transformation of the COCs. The infrastructure required to implement monitoring is an adequate monitoring network, which is already in place at the site, translating to relatively low capital costs and moderate O&M costs for sampling, analysis, and monitoring. Because the site is characterized, groundwater monitoring would be relatively infrequent (i.e., semi-annually).

LUCs would also be put in place to maintain protection of human health and the environment by restricting use of the land and groundwater until such time as the groundwater contaminants are at levels that allow UU/UE.

This remedy will also include CERCLA five-year reviews until RAOs are achieved. Under CERCLA 121(c), any remedial action that results in contaminants remaining onsite at concentrations greater than those allowing unrestricted use must be reviewed as least once every 5 years.

Estimated Capital Cost: $30,000
Estimated Present Worth Cost: $650,000
Estimated Construction Timeframe: 0 years
Estimated Time to Achieve RAOs: >100 years

2.9.1.3 Groundwater Alternative 3: ERD, MNA, and LUCs

Groundwater Alternative 3 will actively reduce concentrations of CVOCs in groundwater associated with the TCE and cis-1,2-DCE impacted groundwater near Hangar 811 and the former washrack and former IWTP near Building 850 by mass removal. Groundwater Alternative 3 will utilize:

- ERD system for mass removal of CVOCs
  - Injections of EVO to establish a long-lived source of organic carbon to promote degradation of CVOCs.
  - Will target the area with elevated CVOC concentrations
  - Annual EVO injections will be required until performance monitoring determines that an in-situ reduction zone (IRZ) has been established.
- MNA to treat residual COCs after an IRZ is established
- Onsite LUCs prohibiting potable water well installation and groundwater consumption until site groundwater concentrations are at levels that allow UU/UE.

Installation of injection wells will include 22 injection wells in three transects located near Hangar Building 811 and four injection wells near the former wash rack/ITWP. Exact location and quantity of injection wells are pending the results of baseline sampling. Continued monitoring in the form of performance sampling events and long term MNA monitoring for VOCs will be conducted for several years after injections. These groundwater monitoring programs will track progress of remediation, ensure that conditions remain favorable for continued natural attenuation, and determine when the RAOs have been achieved. This remedy will also include CERCLA five-year reviews until RAOs are achieved, during which the effectiveness of the implemented remedy will be assessed and whether the implementation of additional remedial action is appropriate.

Estimated Capital Cost: $500,000

Estimated Present Worth Cost: $1,100,000
Estimated Construction Timeframe: 1 year
Estimated Time to Achieve RAOs: 11 years

2.9.1.4 Groundwater Alternative 4: ISCO, MNA, and LUCs.

Groundwater Alternative 4 will actively reduce concentrations of CVOCs in groundwater by enhancing the mass removal of TCE and cis-1,2-DCE impacted groundwater near Hangar 811 and the former Wash Rack and former IWTP near Building 850. Groundwater Alternative 4 will utilize:

- ISCO for mass removal of CVOCs
  - Injections of oxidizing compounds to the aquifer to chemically destroy contaminants
  - Will target the area with elevated CVOC concentrations
  - Performance sampling events will be conducted for two years after injections
- MNA to treat residual COCs after an IRZ is established
- Onsite LUCs prohibiting potable water well installation and groundwater consumption within or downgradient of the source area.

ISCO injections would be implemented via a network of 22 permanent injection wells installed in three transects near Hangar Building 811 and four injection wells in a fourth IRZ area located near the former Wash Rack/IWTP. The oxidizing chemistry that is mostly likely to be optimal is sodium persulfate (oxidizer) and an activator such as sodium hydroxide. The injection program will include two biennial injections of approximately 4,500 gallons of 60 grams per liter (g/L) sodium persulfate and 40 g/L sodium hydroxide.

Performance sampling events will be conducted for two years after injections. Once the injection and initial performance monitoring events are complete, MNA monitoring will continue. These groundwater monitoring programs will track progress of remediation, to ensure that conditions remain favorable for continued natural attenuation, and to determine when the RAOs have been achieved. This remedy will also include CERCLA five-year reviews until the RAOs are achieved, during which the effectiveness of the implemented remedy will be assessed and whether the implementation of additional remedial action is appropriate.

Estimated Capital Cost: $250,000
Estimated Present Worth Cost: $1,100,000
Estimated Construction Timeframe: 1 year
Estimated Time to Achieve RAOs: 11 years

2.9.2 Soil

2.9.2.1 Soil Alternative 1: No Action

Under this alternative, HAAF would take no action at the site to prevent exposure to soil contamination or to reduce TMV of contaminants. There are no technological barriers to implementation of the No Action alternative, however the potential risks identified in the RA would not be mitigated by this response. This response is evaluated as required based USEPA guidance.

2.9.2.2 Soil Alternative 2: Capping- Vegetative Cover

Soil Alternative 2 will limit potential contact with impacted soils in the greenspace near the Old Hospital Area. Soil Alternative 2 will utilize:

- Vegetative Cover
  - Features a minimum of 1.5 ft of compacted soil and 6 inches of topsoil

- Eliminates direct contact with impacted soils.
- Annual inspection of the vegetative cover to ensure continued integrity.
- LUCs will be implemented to ensure the site will not be used for residential purposes.
    - Implemented in the Base Master Plan

Installation of a vegetative cover is a proven and effective method of providing an exposure barrier, erosion control, and some long-term enhancement of ecological habitat. Vegetative covers minimize infiltration of rainwater and subsequent dissolution of contaminants and are commonly used, easy to construct, and relatively inexpensive. Implementation of the vegetative cover would be relatively simple at HAA-15, as the greenspace near Pond 29 is grassy and relatively level, and installation could be completed with standard construction equipment and methods. However, this alternative does not reduce source zone TMV and will require LUCs. This remedy will include CERCLA five-year reviews until RAOs are achieved, and these restrictions will remain in place until it could be demonstrated that soil concentrations have declined below applicable PRGs.

Estimated Capital Cost: $13,000
Estimated Present Worth Cost: $39,000
Estimated Construction Timeframe: 1 year
Estimated Time to Achieve RAOs: 10 years

2.9.2.3 Soil Alternative 3: Excavation and Disposal

Soil Alternative 3 will actively reduce TMV of contaminants in soil at HAA-15 by physically removing surface wastes/impacted media. Soil Alternative 3 will utilize:

- Excavation and off-site disposal of impacted soils at an approved landfill
    - Sampling will be conducted to ensure attainment of RAOs
    - Excavation will be backfilled with clean soil, graded, and revegetated

Excavation of impacted soils would be conducted using typical construction equipment (e.g., backhoes, drag lines, clamshells, vacuum trucks, and front-end loaders).

Materials handling is a concern that affects the implementability of excavation. Staging areas would be used to prepare wastes for disposal or treatment; the staging areas would be graded to reduce ponding, lined to prevent groundwater contamination, and bermed to prevent runoff. The offsite transportation of wastes resulting from excavation must meet Federal and the State of Georgia shipping and manifesting regulations. Characterization of the material would be required to ensure proper disposal, treatment requirements, and to ensure compliance of material left in place.

Excavation and removal of impacted soil eliminates the environmental and health concerns associated with direct contact of contaminated soil. However, consideration must be given to the health and safety of remedial workers. On- site air monitoring and dust and vapor control provisions would be necessary during excavation operations. Excavation activities can result in the release of fugitive dusts and runoff from disturbed soil. Dust controls could include water sprays or application of chemical dust suppressants. Surface water controls may also be required.

Estimated Capital Cost: $150,000
Estimated Present Worth Cost: $200,000
Estimated Construction Timeframe: 1 year
Estimated Time to Achieve RAOs: 5 years

2.9.2.4 Soil Alternative 4: In Situ Phytoremediation

Soil Alternative 4 takes advantage of the natural processes of plants including water and chemical uptake, metabolism within the plant, exudate release into soil that leads to contaminant reduction, and the physical and biochemical impacts of plant roots. Soil Alternative 4 will utilize:

- Planting India Mustard in the Old Hospital Area
  - Indian Mustard has been demonstrated to successfully extract lead from surface soil between 0 to 15 centimeters deep.
  - Prior to planting, the area would be graded to control drainage and prevent accumulation of surface water
  - Soil preparations including tilling, addition of fertilizer, soil conditioners, and pH control agents
  - If necessary, an irrigation system would be installed
- After planting, O&M would include
  - Mulching, weeding pruning, fertilizing, watering
  - Removal/replacement of dead/damaged plants as necessary to maintain sufficient density
  - Seed type, fertilizer, lime, and agricultural test reports in compliance with local, state, and federal regulations.
- LUCs will be implemented to ensure the site will not be used for residential purposes.
  - Implemented in the Base Master Plan

Estimated Capital Cost: $14,000
Estimated Present Worth Cost: $40,000 over 5 years
Estimated Construction Timeframe: 1 year
Estimated Time to Achieve RAOs: 5 years

2.10 Comparative Analysis of Alternatives

Alternatives are evaluated relative to 9 evaluation criteria listed in the NCP:

- *Overall protectiveness of human health and the environment*- whether the alternative eliminates, reduces, or controls threats to public health and the environment through institutional controls, engineering controls, or treatment.
- *Compliance with ARARs* – whether the alternative meets Federal and State environmental statutes, regulations, and other requirements pertaining to the site, or whether a waiver is justified.
- *Long-term effectiveness and permanence* – the ability of an alternative to maintain protection of human health and the environment over time.
- *Reduction of toxicity, mobility, volume, or mass of contaminants* - an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environments, and the amount of contamination present.
- *Short-term effectiveness* – the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.
- *Implementability* – the technical and administrative feasibility of implementing an alternative, including factors such as the relative availability of goods and services.
- *Cost* – includes estimated capital and annual O&M costs, as well as present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.

- *State/support agency acceptance* – whether the State agrees with HAAF's analyses and recommendations, as described in the RI/FS and Proposed Plan.
- *Community acceptance* – whether the local community agrees with the analysis and preferred alternative. Comments received on the Proposed Plan are an important indicator of community acceptance.

A comparative analysis of the alternatives is provided below and summarized in **Tables 2-6a, b and Tables 2-7a, b**.

2.10.1 Protection of Human Health and the Environment

Each remedial alternative except the "no action" alternative would provide adequate protection of human health and the environment by eliminating, reducing, or controlling risk through treatment, engineering controls, and/or institutional controls.

Groundwater Alternatives 3 (ERD) and 4 (ISCO) will provide adequate protection of human health and the environment from short- and long-term risks through source remediation and natural attenuation of peripheral impacts. Alternative 3 uses EVO, a nonhazardous substrate, to achieve remediation, while Alternative 4 involves the use of hazardous oxidizing chemical and appropriate safeguards would be required. Alternative 2 (MNA) is feasible but may not achieve remediation over an acceptable timeframe in the absence of a more active remedial measure.

LUCs instituted as part of the groundwater and/or soil alternatives will further protect human health and the environment by limiting the types of construction that can occur at the site (e.g., no water supply wells, restrictions of residential buildings).

Soil Alternative 3 would eliminate human exposure to impacted soil by removal of impacted soils from the Site. Soil alternative 4 would protect human health and the environment by providing vegetative cover to prevent human interaction with impacted surface soils and by eventually removing metal contamination in soils through phytoextraction. Soil alternative 2 would limit human exposure to impacted soil through installation and maintenance of a vegetative cap.

2.10.2 Compliance with ARARs

With the exception of the "no action" alternatives, the soil and groundwater alternatives would meet their respective ARARs. The "No Action" alternatives will not be discussed further in this comparison. Each groundwater alternative applies MNA and/or source reduction technologies to reduce contamination below chemical-specific ARARs including USEPA RSLs/MCLs, and Region 4 Tapwater RSLs for groundwater. Each alternative addresses potential residential exposure to COCs through institutional controls. Action-specific ARARs, where applicable, are met by these alternatives (e.g., compliance with NPDES and installation requirements for any treated water discharged to proximate canals).

Each Soil alternative applies source reduction and/or barrier installation to prevent human exposure to COCs in soil. Each would reduce contamination or exposure to below chemical-specific ARARs including USEPA RSLs for soil. Each alternative either removes contamination or further addresses potential residential exposure to COCs through institutional COCs. Action-specific ARARs are met by these alternatives, when applicable (e.g., air emission standards during excavation).

2.10.3 Long-Term Effectiveness and Permanence

Groundwater Alternatives 2, 3, and 4 would achieve long- term effectiveness and permanence of maintaining protection to human health and the environment. Under Groundwater Alternatives 3 and 4, in situ technologies (ERD and ISCO, respectively) would actively target the elevated CVOC concentration zones through up to 2 injections, while natural attenuation will reduce concentrations in areas of lower concentrations. The application of a long-lived carbon source to the aquiver in Alternative 3 will reduce the probability of dissolved phase COC rebound that may occur with Alternative 4. Under Groundwater Alternative 2, long-term monitoring will ensure COC concentrations continue to decline, though RAOs may not be achieved in an acceptable timeframe.

Observed impacts to soil are residual, and the Old Hospital Area is no longer an actively contributing source of contamination in soils. Soil Alternative 3 would achieve long-term effectiveness and permanence by physically removing impacted soil from the Old Hospital Area. Soil Alternative 4 would achieve long-term effectiveness through maintenance of vegetative cover and implementation of institutional controls, as well as the gradual removal of contaminants in soil through phytoextraction. Soil Alternative 2 would achieve long-term effectiveness and permanence through maintenance of vegetative cover and implementation of institutional controls.

2.10.4 Reduction of Toxicity, Mobility, Volume, and Mass

Reduction of the mobility, toxicity, volume, and mass of COCs in groundwater would be confirmed through regular groundwater monitoring for each proposed groundwater alternative. In addition, Groundwater Alternatives 3 and 4 would utilize in situ technologies to accelerate the reduction in volume and mass of the elevated CVOC concentration zones. Groundwater Alternative 2 does not actively reduce TMV of COCs in groundwater.

Soil alternative 3 would permanently reduce the TMV of COCs by physically removing impacted soils from the Site. Soil Alternative 4 would permanently reduce the mobility of COCs through the erosion control provided by a vegetative cap, as well as reducing TMV of metals by phytoextraction followed by plant harvesting and off-site disposal. TMV of organic COCs in soil may decrease over time via natural attenuation processes. Soil Alternative 2 would permanently reduce the mobility of COCs through the erosion control provided by a vegetative cap. TMV of organic COCs in soil may decrease over time via natural attenuation processes.

2.10.5 Short-Term Effectiveness

Groundwater Alternative 2 would result in minimal risks to the community, site workers, and the environment through LUCs and long-term monitoring. Groundwater Alternative 3 would result in minimal risks to the community, workers, and the environment. Degradable carbon that would be used to create the in situ reactive zone would be in the form of molasses, corn syrup, whey, or other similar products that would not result in additional risks to the community, workers, and the environment. Groundwater Alternative 4 requires the use of strong oxidizers and would result in moderate risks to the community, site workers, and the environment. Groundwater Alternatives 2, 3, and 4 would handle purge water from monitoring well sampling using approved methods.

Soil Alternatives 2 and 4 would result in minimal exposure risks to the community and workers via institutional controls. Soil Alternative 3 would be immediately effective upon removal of impacted soils, but removal activities may result in minimal exposure risks to the community and workers via the release of fugitive dusts and runoff from disturbed soils during excavation activities. Dust controls may include water sprays or application of chemical dust suppressants.

2.10.6 Implementability

Groundwater Alternatives 2, 3, and 4 are technically and administratively feasible. A site-wide groundwater monitoring network currently exists. Groundwater Alternative 2 would not require installation of additional wells. Groundwater Alternatives 3 and 4 would require installation of permanent injection wells to implement ERD and ISCO, respectively. Injection points would be installed using standard direct push technology (DPT) or drilling methods and materials. These services are readily available, as are the services and materials necessary for the collection and analysis of groundwater samples.

Soil Alternatives 2, 3, and 4 are technically implementable as the impacted area of the Old Hospital Area is limited in size, inactive, and easily accessible. Excavation, transportation, and approved disposal services are readily available.

2.10.7 Cost

The estimated present worth cost of Groundwater Alternative 2 is less than Groundwater Alternatives 3 and 4 (which are of comparable cost). However, concentration trend data indicate that the time to achieve remedial goals could be extensive and could potentially increase the overall cost for all three alternatives.

The estimated present worth cost of Soil Alternative 2 is slightly less than Soil Alternative 3, and both are less than Soil Alternative 3. However, Soil Alternative 3 would reach RAOs immediately upon implementation and would not carry long term maintenance or continued reporting costs.

2.10.8 State/Support Agency Acceptance

The State of Georgia supports the Preferred Alternatives, Groundwater Alternative 3 (ERD, MNA, and LUCs) and Soil Alternative 3 (Excavation and Disposal) without comment. The GAEPD acceptance letter of the Proposed Plans will be included in Appendix A upon receipt.

2.10.9 Community Acceptance

The Proposed Plans for HAA-15 were made available to the public in July 2021 in the Administrative Record at Fort Stewart, online, and in the Southern Chatham County Public Library. Notice of availability of the plans was published in the Savannah Morning News and The Frontline prior to the public comment period starting on June 24 and July 1, 2021, respectively. A public comment period was held from July 14 to August 14, 2021. The public accepted the Preferred Alternatives without comment.

2.11 Principal Threat Waste

The NCP establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable. The “principal threat” concept applies to the characterization of “source materials”. A source material is material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to ground water, surface water, air, or acts as a source for direct exposure. Contaminated groundwater generally is not considered to be a source material, however DNAPL in groundwater may be viewed as a source material. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur.

Source material at HAA-15 includes TCE observed at concentrations indicative of DNAPL around Hangar Building 811. CVOCs associated with potential DNAPL presence around Building 811 would be addressed by Groundwater Alternatives 3 and 4 through active reduction in TMV through ERD or ISCO.

2.12 Selected Remedy

The preferred alternative selected for remediating the CVOC impacts to groundwater at HAA-15 is Groundwater Alternative 3 (ERD, MNA, and LUCs). The preferred alternative selected for soil impacts around the Old Hospital Area is Soil Alternative 3 (Excavation and Disposal).

2.12.1 Summary of Rationale for the Selected Remedies

All of the groundwater alternatives are implementable, but Groundwater Alternative 3 was rated the most favorable. Groundwater Alternative 3 is more likely to meet the RAOs in an acceptable timeframe, is effective in mitigating and controlling risks at the site, and results in the reduction of the volume and mobility of onsite waste. Furthermore, Alternative 3 eliminates the risks and costs associated with handling hazardous chemicals (i.e., chemical oxidants). Monitoring will ensure continued degradation of the dilute plume, and LUCs will prohibit the installation of potable wells.

All of the soil alternatives are implementable, but Soil Alternative 3 was considered the most favorable, due to higher-level COC concentrations present, the localized extent of impacts, high and immediate effectiveness of the alternative, ease in implementation, and overall cost effectiveness.

2.12.2 Description of the Selected Remedies

Groundwater Alternative 3

This alternative includes an ERD system to enhance mass removal associated with CVOCs near the Building 811 and former wash rack/IWTP area, MNA for remaining contaminants, Onsite LUCs preventing installation of potable wells within or downgradient to the source areas, and CERCLA five-year reviews until RAOs are achieved.

An ERD system will enhance the mass removal associated with the chlorinated VOC impacted groundwater at HAA-15. The conceptual design assumptions for the ERD installation associated with Alternative 3 are as follows:

- Installation of 22 injection wells in three injection lines located in the chlorinated VOC source zone near Building 811 targeting the plume core, using DPT (**Figure 2-8**).
- Installation of four injection wells in a fourth IRZ area located in the higher concentration zone near the former wash rack and former IWTP.
- Wells would be constructed of 10-ft vertical stainless-steel V-wire wrap screens to target the zone with the highest concentrations of TCE and cis-1,2-DCE. Actual well depths will vary from 45 to 50 ft bgs depending on location-specific analytical data.
- Annual EVO injections of up to 6,500 gallons of a 2% EVO solution per well would be required until routine performance monitoring determines when an IRZ has been established, such that the geochemistry is adequate for in-situ enhanced bioremediation and VOC degradation end products ethene and/or ethane are being produced.
- Seven additional performance monitoring wells will be installed to supplement the existing monitoring wells, with five wells installed to characterize treatment within the main plume and two wells within the former IWTP hot spot. New wells will have 10-ft screens and will be installed to total depths of approximately 45 to 50 ft bgs.

Implementation of ERD would reduce the higher concentration zone within three years of operation, allowing for the residual mass to attenuate naturally. Long-term monitoring of downgradient monitoring wells and any necessary new monitoring well installations at the site would also be conducted to ensure that the selected remedy continues to be effective.

The remedy would also include five-year reviews until RAOs are achieved, per CERCLA 121(c), which requires any remedial action that results in contaminants remaining onsite at concentrations greater than those allowing unrestricted use must be reviewed at least once every five years. During five-year reviews, an assessment is made of whether the implemented remedy continues to be protective of human health and the environment or whether the implementation of additional remedial action is appropriate.

Additionally, MNA and onsite LUCs would also be implemented to control the remaining risk/hazards associated with COCs that remain in excess of unrestricted use. MNA will include:

- Monitoring performance monitoring wells following completion of ERD injections
- Analyze for VOCs, light gases, and field parameters

- Assume 30 years for costing based on USEPA guidance (1988), though this may not reflect actual time to cleanup

The infrastructure required to implement monitoring is an adequate monitoring network, which is already in place at HAA-15, translating to relatively low capital costs and moderate O&M costs for sampling, analysis, and monitoring. Monitoring would be performed in conjunction with LUCs to maintain protection of human health and the environment until site groundwater contaminant concentrations are at levels that allow UU/UE.

LUCs will be put in place so that protection to human health and the environment is maintained and land and groundwater use is restricted until site groundwater contaminant concentrations are at levels that allow unrestricted use and unlimited exposure. The USEPA requires LUCs when site levels do not allow unrestricted use and unlimited exposure. They can also serve to notify current and future users about the environmental conditions of the property. LUCs are expected to remain in place until site groundwater contaminant concentrations are at levels that allow UU/UE.

ERD and MNA address the chemical specific ARARs of USEPA MCLs, and Region 4 Tapwater RSLs by source reduction of contamination until concentrations meet these requirements. LUCs address location-specific ARARs by restricting potential residential exposure to COCs in groundwater through application of institutional controls. Action-specific ARARs including adherence to air emission standards or NPDES requirements do not apply to this alternative as no air emissions or discharges of water to surface water/canals are anticipated.

Soil Alternative 3

Soil Alternative 3 includes excavation and disposal of impacted soil around the Old Hospital Area, physically removing impacted soils. Excavating soils would maintain RAOs by eliminating exposure to impacted soils, thereby protecting against both current and future exposure to COCs in surface soils. It can be implemented using typical construction equipment, including backhoes, drag lines, clamshells, vacuum trucks, and front-end loaders.

- Excavate 4,600 square ft area to two ft bgs, for a total estimated volume of 8,200 cubic ft (340 cubic yards [cys]). The planned excavation extent is shown in **Figure 2-9**.
    - Set up temporary containment area for storing excavated material
    - Composite sampling of excavated waste for developing waste profile
    - Post-excavation confirmation sampling for benzo(a)pyrene (EPA Method 8270) and lead, mercury, and arsenic (EPA 6010)
    - Backfill to grade with certified clean fill
    - Restore surface with new grass vegetative cover for erosion control
- Dispose of 340 cys of non-hazardous excavation material to approved offsite disposal facility

Materials handling is a concern that affects the implementability of excavation. Staging areas are used to prepare wastes for disposal or treatment; the staging areas would be graded to reduce ponding, lined to prevent groundwater contamination, and bermed to prevent runoff. The off-site transportation of wastes resulting from excavation must meet Federal and State of Georgia shipping and manifesting regulations. Excavated soil would be transported to an approved landfill for disposal. Characterization of the material would be required to ensure proper disposal, treatment requirements, and to ensure compliance of material left in place. Labor and materials for transportation of the material is generally available. Backfilling, grading, and revegetation after excavation are necessary to prevent large open areas that would collect rainwater. Sampling would be performed to ensure the attainment of remediation goals and the complete removal of contaminants. The excavated area would be backfilled with clean soil.

Excavation and removal of impacted soil eliminates the environmental and health concerns associated with direct contact of contaminated soil. However, consideration must be given to the health and safety of remedial workers. On-site air monitoring and dust and vapor control provisions would be necessary during excavation operations. Excavation activities can result in the release of fugitive dusts and runoff from disturbed soil. Dust controls could include water sprays or application of chemical dust suppressants. Surface water controls may also be required. Excavation at HAA-15 would create minimal disturbance of the overall operational activities of the surrounding facilities.

Excavation and disposal addresses chemical-specific ARARs of USEPA RSLS by removing soils exhibiting concentrations in excess of RSLs. Location-specific ARARs were not identified for this alternative because the Ecological Risk Assessment (ERA) concluded that the ecological risks are considered negligible for exposure to constituents in green space surface soil. Action-specific ARARs include adherence to air emission standards during excavation and disposal of impacted-soils, achieved through air monitoring and dust control measures.

2.12.3 Summary of Estimated Remedy Costs

The information in the following cost estimate summary is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, and ESD, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

Selected Remedy Cost Estimates

Alternative	Total Cost	Present Worth Total Cost	Capital Cost	Total Annual O&M and Periodic Costs	Present Worth of Total Annual O&M and Periodic Costs	Estimated Timeframe of Alternative
Groundwater Alternative 3	$1,900,00	$1,100,000	$250,000	$1,600,000	$500,000	30 Years
Soil Alternative 3	$200,000	$200,000	$150,000	$53,000	$46,000	5 years

Notes:

1. The estimated timeframe of each alternative assumed for costing may not reflect the actual time to cleanup.
2. Estimations based off USEPA Guidance (1988).

2.12.4 Expected Outcomes of Selected Remedy

The selected remedies are expected to result in restricted use of the site with exposure controlled through use of treatment and institutional controls. Removal of impacted soils in the Old Hospital Area are expected to mitigate any restrictions on the greenspace area based on observed impacts in surface soils, but long-term attenuation of CVOCs in groundwater will require onsite LUCs prohibiting residential use of the site and prohibition of use of the shallow surficial aquifer as a potable water source.

2.13 Statutory Determinations

Under CERCLA and the NCP, selected remedies must be protective of human health and the environment, comply with ARARs (unless a waiver is justified), be cost effective, and use permanent solutions and treatment or resource recovery technologies to the extent practicable. The following sections discuss how the selected remedy meets these statutory requirements and explains the Five-Year Review requirements.

2.13.1 Protection of Human Health and the Environment

The selected remedies (Groundwater Alternative 3: ERD, MNA, and LUCs and Soil Alternative 3- Excavation and Disposal) are protective of human health and the environment.

Groundwater Alternative 3 will reduce the mass/volume of contaminants present in groundwater through ERD and MNA. This remedy will prevent direct exposure to contaminants through the use of onsite LUCs preventing use of groundwater as a potable source while COCs are still present above applicable screening levels.

2.13.2 Compliance with ARARs

Remedial actions selected must comply with all ARARs. ARARs for this project include:

- Chemical specific ARARs include USEPA RSLs for soil, USEPA MCLs and USEPA Region 4 Tapwater RSLs for groundwater.
- Location-specific ARARs include institutional controls such that HAA-15 remains a commercial/industrial use property to prevent residential exposure to COCs in groundwater.
- The Ecological Risk Assessment (ERA) concluded that the ecological risks are considered negligible for exposure to constituents in green space surface soil, and no location-specific ARARs were identified for soils at the site.
    - Residential PRGs and eco based PRGs have not been developed for the property. Remediation goals for COCs based on human health endpoints will also address marginal hazards to eco receptors.
- Action-specific ARARs identified include air emission standards for any air discharge including air monitoring and dust control during excavation, and compliance with NPDES and base requirements for any treated water discharged to proximate canals.

The selected remedies will comply with all ARARs. ERD and MNA address the chemical specific ARARs of USEPA MCLs, and Region 4 Tapwater RSLs by source reduction of contamination until concentrations meet these requirements. LUCs address location-specific ARARs by restricting potential residential exposure to COCs in groundwater through application of institutional controls. Action-specific ARARs including adherence to air emission standards or NPDES requirements do not apply to this alternative as no air emissions or surface water discharges are anticipated.

Excavation and disposal addresses chemical-specific ARARs of USEPA RSLS by removing soils exhibiting concentrations in excess of RSLs. Location-specific ARARs were not identified for this alternative because the Ecological Risk Assessment (ERA) concluded that the ecological risks are considered negligible for exposure to constituents in green space surface soil. Action-specific ARARs include adherence to air emission standards during excavation and disposal of impacted-soils, achieved through air monitoring and dust control measures.

2.13.3 Cost-Effectiveness

The cost-effectiveness of the proposed remedy must be considered. Cost effective remedies are considered those for which the costs are proportional to its overall effectiveness. While more than one cleanup alternative can be cost-effective, but the NCP does not mandate that the selection of the most cost-effective cleanup alternative. The most cost-effective remedy may not necessarily be the remedy that provide the best tradeoff with respect to the remedy selection criteria.

Cost effectiveness is considered by evaluating the long-term effectiveness and permanence, reduction in TMV through treatment, and short-term effectiveness.

The selected remedies are cost effective. Groundwater Alternative 3 is more expensive than Groundwater Alternative 2 but is more effective in the long and short term, and in reduction of TMV. Alternative 3 is less expensive than Alternative 4 but is comparably effective in the long and short term, and in the reduction of TMV. Soil Alternative 3 is more expensive than Soil Alternative 2 and 4 but is more effective in the long and short term, and in reduction of TMV.

2.13.4 Utilization of Permanent Solutions and Alternative Treatment

The selected remedies provide the best balance of trade offs among the alternatives with respect to the balancing criteria such that it represents the maximum extent to which permanence and treatment can be practicably utilized at this time. Emphasis is placed on long term effectiveness and reduction of TMV through treatment. The selected groundwater remedy includes use of ERD to actively reduce TMV of primary COCs with MNA for remaining COCs. This alternative was equally as effective in the long term and in reduction of TMV as Alternative 4 and more effective in both criteria than Alternative 2.

The selected soil remedy is effective in the long term by preventing potential contact with COCs in soil and provides the best balance of trade-offs. Alternative 2 limits the mobility of contaminants in soil with a vegetative cap and Alternative 4 reduces TMV of COCs in the long term. However, Alternative 3 is more effective in the long term with removal of impacted soil, particularly given the limited, localized nature of COC impact to surface soils in the Old Hospital Area.

2.13.5 Preference for Treatment as a Principal Element

This remedial action satisfies the statutory preference for treatment as a principal element in that the selected remedy for Groundwater utilizes treatment as a principal element. Treatment includes ERD to reduce TMV of COCs present. The selected remedy for soil involves removal as a principal element.

2.13.6 Five Year Review Requirements

CERCLA five-year reviews are required in any remedial action that results in contaminants remaining onsite at concentrations greater than those allowing unrestricted use. These will be required for HAA-15 until it is demonstrated that soil and groundwater concentrations have declined below applicable PRGs. The review will evaluate whether the implemented remedies currently are or will be protective of human health and the environment, and whether additional action is required.

2.14 Documentation of Significant Changes

The Proposed Plans for HAA-15 were released for public comment in July 201. The Proposed Plans identified Groundwater Alternative 3 (ERD, MNA, and LUCs) and Soil Alternative 3 (Excavation and Disposal) as the Preferred Alternatives. No comments were received during the public comment period, and no significant changes to the remedy as originally identified in the Proposed Plans were necessary or appropriate.

3 RESPONSIVENESS SUMMARY

3.1 Stakeholder Issues and Lead Agency Responses

The Proposed Plans for HAA-15 were released for public comment in July 2021. The Proposed Plans identified Groundwater Alternative 3 (ERD, MNA, and LUCs) and Soil Alternative 3 (Excavation and Disposal) as the Preferred Alternatives. No comments were received during the public comment period, and the State of Georgia supports the Preferred Alternatives without comment.

3.2 Technical and Legal Issues

There are no known technical or legal issues at this time.

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Tables

Table 2-1a

Summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations in Soils

Area: Main Site

Scenario Timeframe: Current

Exposure Point	Chemical of Concern	Media	Exposure Media	Concentration Detected Min	Concentration Detected Max	Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
Soil On-Site - Direct Contact	Benzo(a)pyrene	Surface Soil (0-2ft)	Soil	NM	NM	NA	NA	NA	mg/kg	UCL
	Arsenic			4.50E-01	4.50E-01	mg/kg	1 - 1	NA		
	Hexavalent Chromium			3.20E+00	3.20E+00		1 - 1	NA		
	Lead			2.30E-02	2.30E-02		1 - 1	NA		
	Arsenic	Combined Surface and Subsurface Soil (0-15ft)	Soil	4.50E-01	1.20E+00	mg/kg	3 - 6	NA	mg/kg	UCL
	Hexavalent Chromium			1.30E+00	4.00E+00		6 - 6	NA		
	Lead			1.50E+00	4.80E+00		6 - 6	NA		

Area: Green Space

Scenario Timeframe: Current

Exposure Point	Chemical of Concern	Media	Exposure Media	Concentration Detected Min	Concentration Detected Max	Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
Soil On-Site - Direct Contact	Benzo(a)pyrene	Surface Soil (0-2ft)	Soil	9.30E-03	4.10E-01	mg/kg	5 - 10	1.74E-01	mg/kg	UCL
	Arsenic			6.00E-01	7.00E+00		9 - 10	4.29E+00		
	Hexavalent Chromium			2.00E+00	5.10E+00		10 - 10	NA		
	Lead			2.50E+00	5.30E+03		13 - 13	2.23E+03		
	Benzo(a)pyrene	Combined Surface and Subsurface Soil (0-15ft)	Soil	9.30E-03	1.40E+00	mg/kg	10 - 24	4.29E-01	mg/kg	UCL
	Arsenic			4.90E-01	7.00E+00		21 - 25	1.89E+00		
	Hexavalent Chromium			1.80E+00	8.70E+00		25 - 25	4.30E+00		
	Lead			2.00E+00	5.30E+03		31 - 31	9.61E+02		

Area: Motor Repair Shop

Scenario Timeframe: Current

Exposure Point	Chemical of Concern	Media	Exposure Media	Concentration Detected Min	Concentration Detected Max	Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration	Statistical Measure
Soil On-Site - Direct Contact	Benzo(a)pyrene	Surface Soil (0-2ft)	Soil	NM	NM	mg/kg	NA	NA	mg/kg	UCL
	Arsenic			NM	NM		NA	NA		
	Hexavalent Chromium			2.20E+00	2.20E+00		1 - 1	NA		
	Lead			3.20E+00	3.20E+00		1 - 1	NA		
	Hexavalent Chromium	Combined Surface and Subsurface Soil (0-15ft)	Soil	1.80E+00	8.70E+00	mg/kg	2 - 2	NA	mg/kg	UCL
	Lead			2.00E+00	5.30E+03		2 - 2	NA		

Notes:
NM - Not Measured
NA - Not Applicable
mg/kg - milligrams per kilogram
mg/L - milligrams per liter
UCL - Upper Confidence Limit

Table 2-1b

Summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations in Groundwater

Area: All Groundwater
Media: Groundwater
Exposure Media: Tap Water
Scenario Timeframe: Current

Exposure Point	Chemical of Concern	Concentration Detected (mg/L)		Frequency of Detection	Exposure Point Concentration (mg/L)	Statistical Measure
		Min	Max			
Tap Water	Bromodichloromethane	4.50E-04	4.50E-04	1 - 114	4.50E-04	UCL
	Chloroform	2.50E-04	1.80E-03	11 - 114	5.18E-04	
	Cis-1,2-Dichloroethene	1.70E-04	9.70E+00	62 - 114	8.60E-01	
	Ethylbenzene	1.10E-03	6.80E-03	4 - 114	6.80E-03	
	Methylene Chloride	5.20E-04	2.40E-02	2 - 114	2.40E-02	
	Trichloroethene	1.20E-04	3.20E+01	59 - 114	2.34E+00	
	Vinyl Chloride	7.10E-05	6.30E-03	12 - 114	5.87E-04	

Area: Shallow Groundwater (0-25ft)
Media: Groundwater
Exposure Media: Drinking Water
Scenario Timeframe: Current

Exposure Point	Chemical of Concern	Concentration Detected (mg/L)		Frequency of Detection	Exposure Point Concentration (mg/L)	Statistical Measure
		Min	Max			
Drinking Water	Bromodichloromethane	NA	NA	NA	NA	Max
	Chloroform	2.50E-04	1.10E-03	5 - 45	5.19E-04	UCL
	Cis-1,2-Dichloroethene	1.80E-04	1.20E-01	22 - 45	2.44E-02	UCL
	Ethylbenzene	1.60E-03	3.20E-03	2 - 45	3.2-03	Max
	Methylene Chloride	NA	NA	NA	NA	NA
	Trichloroethene	1.20E-04	1.90E-01	19 - 45	2.60E-02	UCL
	Vinyl Chloride	2.70E-04	1.90E-03	3 - 45	1.90E-03	UCL

Notes:
NA - Not Applicable
mg/L - milligrams per liter
UCL - Upper Confidence Limit

Table 2-2a
Cancer Toxicity Data Summary

Pathway: Oral, Dermal				
Chemical of Concern	**Oral Cancer Slope Factor (mg/kg/day)$^{-1}$**	**Dermal Cancer Slope Factor (mg/kg/day)$^{-1}$**	**Weight of Evidence/Cancer Guideline Description**	**Source**
Bromodichloromethane	6.20E-02	6.20E-02	B2	I
Chloroform	3.20E-02	3.10E-02	L/N	C
cis-1,2-dichloroethene	NA	NA	I	N/A
Ethylbenzene	1.10E-02	1.10E-02	D	C
Methylene chloride	2.00E-03	2.00E-03	B2	I
Trichloroethene	4.60E-02	4.60E-02	H	I
Vinyl Chloride	7.20E-01	7.20E-01	A	I
Arsenic	1.50E+00	1.50E+00	A	I
Hexavalent Chromium	5.00E-01	2.21E+02	A	C
Lead	NA	NA	NA	NA

Pathway: Inhalation			
Chemical of Concern	**Inhalation Unit Risk (µg/m^3)$^{-1}$**	**Weight of Evidence/Cancer Guideline Description**	**Source**
Bromodichloromethane	3.70E-05	B2	C
Chloroform	2.30E-05	L/N	I
cis-1,2-dichloroethene	NA	I	N/A
Ethylbenzene	2.50E-06	D	C
Methylene chloride	1.00E-08	B2	I
Trichloroethene	4.10E-06	H	I
Vinyl Chloride	4.40E-06	A	I
Arsenic	4.30E-03	A	I
Hexavalent Chromium	8.40E-02	A	S
Lead	NA	NA	NA

Notes:
(mg/kg/day)$^{-1}$ - Inverse miligram per kilogram per day (risk per unit dose)
(µg/m3)$^{-1}$ - Inverse microgram per meter cubed
A - Human Carcinogen (sufficient evidence of carcinogenicity in humans) (USEPA, 2019a)
B - Not Classifiable as to Human Carcinogenicity (inadequate or no evidence)
B2 - sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
C - California Enviornmental Protection Agency, Toxicity Criteria Database (CalEPA, 2019)
I - USEPA, Integrated Risk Information System (IRIS) (USEPA 2019a)
S - USEPA RSLs user guide (Section 5; USEPA 2019a)

Table 2-2b
Non-Cancer Toxicity Data Summary

Pathway: Oral, Dermal								
Chemical of Concern	**Oral RfD Value (mg/kg/day) [a]**				**Dermal RfD (mg/kg/day) [b]**		**Primary Target Organ**	**Combined Uncertainty/Modifying Factors**
	Subchronic	**[ref]**	**Chronic**	**[ref]**	**Subchronic**	**Chronic**		
Bromodichloromethane	8.00E-03	P	2.00E-02	I	8.03E-03	2.00E-02	Kidney	Medium/1000
Chloroform	1.00E-01	A	1.00E-02	I	1.00E-01	1.00E-02	Liver	NA/1000
cis-1,2-dichloroethene	2.00E-02	P	2.00E-03	I	2.00E-02	2.00E-03	Kidney	Low/3000
Ethylbenzene	5.00E-02	P	1.00E-01	I	5.00E-02	1.00E-01	Liver, kidney	Low/1000
Methylene chloride	6.00E-02	H	6.00E-03	I	6.00E-02	6.00E-03	Liver	High/30
Trichloroethene	5.00E-04	A	5.00E-04	I	5.00E-04	5.00E-04	Developmental, heart, immune system	Medium to high/10 to 1000
Vinyl Chloride	3.00E-03	c	3.00E-03	I	3.00E-03	3.00E-03	Liver	Medium/30
Arsenic	3.00E-04	c	3.00E-04	I	3.00E-04	3.00E-04	Skin, vascular	Medium/30
Hexavalent Chromium	5.00E-03	A	3.00E-03	I	1.30E-04	7.50E-05	NA	Low/300
Lead	NA	NA	NA	NA	NA	NA	NA	NA

Pathway: Inhalation						
Chemical of Concern	**Inhalation RfD Value (mg/kg/day) [a]**				**Primary Target Organ**	**Combined Uncertainty/Modifying Factors**
	Subchronic	**[ref]**	**Chronic**	**[ref]**		
Bromodichloromethane	2.00E-02	P	NA		NA	NA
Chloroform	2.44E-01	A	9.80E-02	A	Liver	NA/100
cis-1,2-dichloroethene	NA	NA	NA	NA	NA	NA
Ethylbenzene	9.00E+00	P	1.00E+00	I	Developmental	Low/300
Methylene chloride	1.04E+00	A	6.00E-01	I	Liver	medium to high/30
Trichloroethene	2.15E-03	A	2.00E-03	I	Developmental, heart, immune system	medium to high/10 to 100
Vinyl Chloride	7.67E-02	A	1.00E-01	I	Liver	Medium/30
Arsenic	1.50E-05	c	1.50E-04	C	Developmental, cardiovascular, lung, skin, NS	NA
Hexavalent Chromium	3.00E-04	A	1.00E-04	I	Lung	Medium/30
Lead	NA	NA	NA	NA	NA	NA

Notes:
A - Agency for Toxic Substances Disease Registry (ATSDR 2017)
c - The chronic value is used if available
I - USEPA, Integrated Risk Information System (IRIS) (USEPA 2019a)
P - Provisional Peer Reviewed Toxicity Values (PPRTV) (USEPA 2019b)
NA - Not Applicable
mg/kg/day - Milligram per kilogram per day
[a] - Toxicity values were obtained following USEPA recommended hierarchy (USEPA 2003a)
[b] - The oral-to-dermal adjustment factor (oral absorption efficiency) as used to calculate the dermal RfD values (USEPA 2004b)

Table 2-3a

Risk Characterization Summary - Carcinogens and Non-Carcinogens in the Green Space

Scenario Timeframe: Current
Receptor Population: Current or Hypothetical Future Site Worker in the Green Space
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemcial of Concern	Carcinogenic Risk				Primary Target Organ/Critical Effect	Non-Carcinogenic Risk			
				Oral	Dermal	Inhalation	Exposure Routes Total		Oral	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil (0-2ft)	Soil On-site - Direct Contact	Benzo(a)pyrene	5.30E-08	2.90E-08	1.30E-14	8.20E-08		5.00E-04	5.00E-04	3.10E-08	1.00E-03
			Arsenic	1.20E-06	2.50E-07	2.30E-12	1.45E-06		7.30E-03	7.30E-03	1.00E-07	1.46E-02
			Hexavalent Chromium	NA	NA	NA	NA		NA	NA	NA	NA
			Lead	NA	NA	NA	NA		NA	NA	NA	0.00E+00
	Subsurface Soil (0-15ft)	Soil On-site - Direct Contact	Benzo(a)pyrene	1.30E-07	7.20E-08	3.30E-14	2.02E-07		1.20E-03	6.70E-04	7.60E-08	1.87E-03
			Arsenic	5.20E-07	1.10E-07	1.00E-12	6.30E-07		3.20E-03	6.90E-04	4.50E-08	3.89E-03
			Hexavalent Chromium	6.60E-07	NA	4.60E-11	6.60E-07		1.20E-03	NA	1.50E-08	1.20E-03
			Lead	NA	NA	NA	NA		NA	NA	NA	NA
						Surface Soil Risk Total =	**1.53E-06**				**Surface Soil Hazard Index Total =**	**1.56E-02**
						Subsurface Soil Risk Total =	**1.49E-06**				**Subsurface Soil Risk Total =**	**6.96E-03**

Scenario Timeframe: Current
Receptor Population: Hypothetical Future Construction Worker in the Green Space
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemcial of Concern	Carcinogenic Risk				Primary Target Organ/Critical Effect	Non-Carcinogenic Risk			
				Oral	Dermal	Inhalation	Exposure Routes Total		Oral	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil (0-2ft)	Soil On-site - Direct Contact	Benzo(a)pyrene	3.70E-09	1.50E-09	2.30E-11	5.22E-09		1.70E-03	7.10E-04	2.60E-03	5.01E-03
			Arsenic	8.10E-08	1.3e-	4.00E-09	8.50E-08		2.50E-02	4.00E-03	8.70E-03	3.77E-02
			Hexavalent Chromium	NA	NA	NA	NA		NA	NA	NA	NA
			Lead	NA	NA	NA	NA		NA	NA	NA	NA
	Subsurface Soil (0-15ft)	Soil On-site - Direct Contact	Benzo(a)pyrene	9.00E-09	3.80E-09	5.60E-11	1.29E-08		4.20E-03	1.80E-03	6.50E-03	1.25E-02
			Arsenic	3.60E-08	5.70E-09	1.80E-09	4.35E-08		1.10E-02	1.80E-03	3.80E-03	1.66E-02
			Hexavalent Chromium	4.50E-08	NA	7.80E-08	1.23E-07		2.50E-03	NA	4.40E-04	2.94E-03
			Lead	NA	NA	NA	NA		NA	NA	NA	NA
						Soil Risk Total =	**9.02E-08**				**Surface Soil Hazard Index Total =**	**4.27E-02**
						Subsurface Soil Risk Total =	**1.79E-07**				**Subsurface Soil Risk Total =**	**3.20E-02**

Scenario Timeframe: Current
Receptor Population: Hypothetical Utility Worker in the Green Space
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemcial of Concern	Carcinogenic Risk				Primary Target Organ/Critical Effect	Non-Carcinogenic Risk			
				Oral	Dermal	Inhalation	Exposure Routes Total		Oral	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil (0-2ft)	Soil On-site - Direct Contact	Benzo(a)pyrene	7.00E-09	2.90E-09	4.30E-11	9.94E-09		6.60E-05	2.70E-05	1.00E-04	1.93E-04
			Arsenic	1.60E-07	2.50E-08	7.70E-09	1.93E-07		9.70E-04	1.60E-04	3.30E-04	1.46E-03
			Hexavalent Chromium	NA	NA	NA	NA		NA	NA	NA	NA
			Lead	NA	NA	NA	NA		NA	NA	NA	NA
	Subsurface Soil (0-15ft)	Soil On-site - Direct Contact	Benzo(a)pyrene	1.70E-07	7.20E-09	1.10E-10	1.77E-07		1.60E-04	6.70E-05	2.50E-04	4.77E-04
			Arsenic	6.90E-08	1.10E-08	3.40E-09	8.34E-08		4.30E-04	6.80E-05	1.50E-04	6.48E-04
			Hexavalent Chromium	8.70E-08	NA	1.50E-07	2.37E-07		1.60E-04	NA	5.00E-05	2.10E-04
			Lead	NA	NA	NA	NA		NA	NA	NA	NA
						Soil Risk Total =	**2.03E-07**				**Surface Soil Hazard Index Total =**	**1.65E-03**
						Subsurface Soil Risk Total =	**4.98E-07**				**Subsurface Soil Risk Total =**	**1.34E-03**

Scenario Timeframe: Current
Receptor Population: Hypothetical Adolescent Trespasser in the Green Space
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemcial of Concern	Carcinogenic Risk				Primary Target Organ/Critical Effect	Non-Carcinogenic Risk			
				Oral	Dermal	Inhalation	Exposure Routes Total		Oral	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil (0-2ft)	Soil On-site - Direct Contact	Benzo(a)pyrene	3.60E-09	3.90E-09	6.40E-17	7.50E-09		8.50E-05	9.00E-05	3.70E-10	1.75E-04
			Arsenic	8.10E-08	3.30E-08	1.10E-14	1.14E-07		1.30E-03	5.10E-04	1.20E-09	1.81E-03
			Hexavalent Chromium	NA	NA	NA	NA		NA	NA	NA	NA
			Lead	NA	NA	NA	NA		NA	NA	NA	NA
	Subsurface Soil (0-15ft)	Soil On-site - Direct Contact	Benzo(a)pyrene	2.70E-08	2.90E-08	4.70E-16	5.60E-08		2.10E-03	2.20E-04	9.20E-10	2.32E-03
			Arsenic	3.60E-08	1.50E-08	5.00E-15	5.10E-08		5.50E-04	2.30E-04	2.30E-04	1.01E-03
			Hexavalent Chromium	1.30E-07	NA	6.60E-13	1.30E-07		2.10E-04	NA	1.80E-10	2.10E-04
			Lead	NA	NA	NA	NA		NA	NA	NA	NA
						Soil Risk Total =	**1.22E-07**				**Surface Soil Hazard Index Total =**	**1.99E-03**
						Subsurface Soil Risk Total =	**2.37E-07**				**Subsurface Soil Risk Total =**	**3.54E-03**

Table 2-3a

Risk Characterization Summary - Carcinogens and Non-Carcinogens in the Green Space

Scenario Timeframe: Current
Receptor Population: Hypothetical Resident in the Green Space

Medium	Exposure Medium	Exposure Point	Chemcial of Concern	Carcinogenic Risk Age-Specific with a Mutagenic Mode of Action							
				0-2 years				2-6 years			
				Oral	Dermal	Inhalation	Exposure Routes Total	Oral	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil (0-2ft)	Soil On-site - Direct Contact	Benzo(a)pyrene	6.40E-07	2.00E-07	4.50E-14	8.40E-07	3.80E-07	1.20E-07	2.70E-14	5.00E-07
			Arsenic	NA	NA	NA	NA	NA	NA	NA	NA
			Hexavalent Chromium	NA	NA	NA	NA	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA
	Subsurface Soil (0-15ft)	Soil On-site - Direct Contact	Benzo(a)pyrene	1.60E-06	4.80E-07	1.10E-13	2.08E-06	9.40E-07	2.90E-07	6.60E-14	1.23E-06
			Arsenic	7.90E-06	NA	1.50E-10	7.90E-06	4.70E-06	NA	9.30E-11	4.70E-06
			Hexavalent Chromium	1.30E-07	NA	6.60E-13	1.30E-07	2.10E-04	NA	1.80E-10	2.10E-04
			Lead	NA	NA	NA	NA	NA	NA	NA	NA
						Soil Risk Total =	**8.40E-07**			**Surface Soil Hazard Index Total =**	**5.00E-07**
						Subsurface Soil Risk Total =	**1.01E-05**			**Subsurface Soil Risk Total =**	**2.16E-04**

Scenario Timeframe: Current
Receptor Population: Hypothetical Resident in the Green Space (Continued)

Medium	Exposure Medium	Exposure Point	Chemcial of Concern	Carcinogenic Risk Age-Specific with a Mutagenic Mode of Action							
				6-16 years				16-26 years			
				Oral	Dermal	Inhalation	Exposure Routes Total	Oral	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil (0-2ft)	Soil On-site - Direct Contact	Benzo(a)pyrene	8.90E-08	4.90E-08	6.70E-14	1.38E-07	3.00E-08	1.60E-08	2.20E-14	4.60E-08
			Arsenic	NA	NA	NA	NA	NA	NA	NA	NA
			Hexavalent Chromium	NA	NA	NA	NA	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA
	Subsurface Soil (0-15ft)	Soil On-site - Direct Contact	Benzo(a)pyrene	2.20E-07	1.20E-07	1.60E-13	3.40E-07	7.30E-08	4.00E-08	5.50E-14	1.13E-07
			Arsenic	1.10E-06	NA	2.30E-10	1.10E-06	3.70E-07	NA	7.70E-11	3.70E-07
			Hexavalent Chromium	2.10E-04	NA	1.80E-10	2.10E-04	2.10E-04	NA	1.80E-10	2.10E-04
			Lead	NA	NA	NA	NA	NA	NA	NA	NA
						Surface Soil Hazard Index Total =	**1.38E-07**			**Surface Soil Hazard Index Total =**	**4.60E-08**
						Subsurface Soil Risk Total =	**2.11E-04**			**Subsurface Soil Risk Total =**	**2.10E-04**

Scenario Timeframe: Future
Receptor Population: Hypothetical Resident for Future Exposure in the Green Space

Medium	Exposure Medium	Exposure Point	Chemcial of Concern	Non-Cancer Hazard				Non-Cancer Hazard			
				0-6 years				6-26 years			
				Oral	Dermal	Inhalation	Exposure Routes Total	Oral	Dermal	Inhalation	Exposure Routes Total
Soil	Surface Soil (0-2ft)	Soil On-site - Direct Contact	Benzo(a)pyrene	7.40E-03	2.30E-03	1.30E-07	9.70E-03	7.00E-04	3.80E-04	1.30E-07	1.08E-03
			Arsenic	1.10E-01	1.30E-02	4.30E-07	1.23E-01	1.00E-02	2.20E-03	4.30E-07	NA
			Hexavalent Chromium	NA	NA	NA	NA	NA	NA	NA	NA
			Lead	NA	NA	NA	NA	NA	NA	NA	NA
	Subsurface Soil (0-15ft)	Soil On-site - Direct Contact	Benzo(a)pyrene	2.70E-08	2.9-8	4.70E-16	2.70E-08	2.70E-08	2.9-8	4.70E-16	2.70E-08
			Arsenic	3.60E-08	1.50E-08	5.00E-15	5.10E-08	3.60E-08	1.50E-08	5.00E-15	5.10E-08
			Hexavalent Chromium	1.30E-07	NA	6.60E-13	1.30E-07	1.30E-07	NA	6.60E-13	1.30E-07
			Lead	NA	NA	NA	NA	NA	NA	NA	NA
						Soil Risk Total =	**1.33E-01**			**Surface Soil Hazard Index Total =**	**1.08E-03**
						Subsurface Soil Risk Total =	**2.08E-07**			**Subsurface Soil Risk Total =**	**2.08E-07**

Table 2-3b

Risk Characterization Summary - Carcinogens and Non-Carcinogens in a Trench

Scenario Timeframe: Current
Receptor Population: Current or Hypothetical Future Construction Worker in a Trench
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemcial of Concern	Carcinogenic Risk				Non-Carcinogenic Risk			
				Oral	Dermal	Inhalation	Exposure Routes Total	Oral	Dermal	Inhalation	Exposure Routes Total
Groundwater	Shallow Groundwater (0-25ft)	Drinking Water	Bromodichloromethane	NA	NA	NA	0.00E+00	NA	NA	NA	0.00E+00
			Chloroform	2.00E-12	7.30E-11	1.20E-07	1.20E-07	9.30E-08	3.30E-06	3.00E-03	3.00E-03
			Cis-1,2-DCE	NA	NA	NA	0.00E+00	2.20E-05	1.10E-03	NA	1.12E-03
			Ethylbenzene	4.50E-12	1.00E-09	8.50E-08	8.60E-08	1.10E-06	2.60E-04	5.30E-04	7.91E-04
			Methylene Chloride	NA	NA	NA	0.00E+00	NA	NA	NA	0.00E+00
			Trichloroethene	1.50E-10	9.70E-09	1.00E-06	1.01E-06	9.30E-04	5.90E-02	1.60E+01	1.61E+01
			Vinyl Chloride	1.70E-10	6.30E-09	1.20E-07	1.26E-07	1.10E-05	4.10E-04	4.90E-02	4.94E-02
						Shallow Groundwater Total =	**1.34E-06**		**Shallow Groundwater Hazard Index Total =**		**1.61E+01**

Scenario Timeframe: Current
Receptor Population: Current or Hypothetical Future Utility Worker in a Trench
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemcial of Concern	Carcinogenic Risk				Non-Carcinogenic Risk			
				Oral	Dermal	Inhalation	Exposure Routes Total	Oral	Dermal	Inhalation	Exposure Routes Total
Groundwater	Shallow Groundwater (0-25ft)	Drinking Water	Bromodichloromethane	NA	NA	NA	0.00E+00	NA	NA	NA	0.00E+00
			Chloroform	3.90E-12	1.40E-10	2.30E-07	2.30E-07	3.60E-08	1.30E-06	2.80E-04	2.81E-04
			Cis-1,2-DCE	NA	NA	NA	0.00E+00	8.40E-06	4.40E-04	NA	4.48E-04
			Ethylbenzene	8.60E-12	2.00E-09	1.60E-07	1.62E-07	2.20E-08	5.10E-06	1.80E-04	1.90E-04
			Methylene Chloride	NA	NA	NA	0.00E+00	NA	NA	NA	0.00E+00
			Trichloroethene	2.90E-10	1.90E-08	2.00E-06	2.02E-06	3.60E-05	2.30E-03	6.70E-01	6.72E-01
			Vinyl Chloride	3.30E-10	1.20E-08	2.30E-07	2.42E-07	4.30E-07	1.60E-05	1.40E-03	1.42E-03
						Shallow Groundwater Total =	**2.65E-06**		**Shallow Groundwater Hazard Index Total =**		**6.75E-01**

Scenario Timeframe: Current
Receptor Population: Hypothetical Future Resident Receptor for Exposures to All Groundwater Used as Potable Water

Medium	Exposure Medium	Exposure Point	Chemcial of Concern	Carcinogenic Risk Age-Specific with a Mutagenic Mode of Action							
				0-2 years				2-6 years			
				Oral	Dermal	Inhalation	Exposure Routes Total	Oral	Dermal	Inhalation	Exposure Routes Total
Groundwater	All Groundwater	Drinking Water	Bromodichloromethane	NA	NA	NA	0.00E+00	NA	NA	NA	0.00E+00
			Chloroform	NA	NA	NA	NA	NA	NA	NA	NA
			Cis-1,2-DCE	NA	NA	NA	NA	NA	NA	NA	NA
			Ethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA
			Methylene Chloride	6.80E-07	2.00E-08	3.30E-08	7.33E-07	4.10E-07	1.20E-08	2.00E-08	4.42E-07
			Trichloroethene	7.90E-06	NA	1.50E-10	7.90E-06	4.70E-06	NA	9.30E-11	4.70E-06
			Vinyl Chloride	NA	NA	NA	0.00E+00	NA	NA	NA	0.00E+00
						All Groundwater Total =	**8.63E-06**			**All Groundwater Total =**	**5.14E-06**

Scenario Timeframe: Current
Receptor Population: Hypothetical Future Resident Receptor for Exposures to All Groundwater Used as Potable Water (Continued)

Medium	Exposure Medium	Exposure Point	Chemcial of Concern	Carcinogenic Risk Age-Specific with a Mutagenic Mode of Action							
				6-16 years				16-26 years			
				Oral	Dermal	Inhalation	Exposure Routes Total	Oral	Dermal	Inhalation	Exposure Routes Total
Groundwater	All Groundwater	Drinking Water	Bromodichloromethane	NA	NA	NA	0.00E+00	NA	NA	NA	0.00E+00
			Chloroform	NA	NA	NA	NA	NA	NA	NA	NA
			Cis-1,2-DCE	NA	NA	NA	NA	NA	NA	NA	NA
			Ethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA
			Methylene Chloride	6.20E-07	2.10E-08	4.90E-08	6.90E-07	2.10E-07	7.10E-09	1.60E-08	2.33E-07
			Trichloroethene	1.10E-06	NA	2.30E-10	1.10E-06	3.70E-07	NA	7.70E-11	3.70E-07
			Vinyl Chloride	NA	NA	NA	0.00E+00	NA	NA	NA	0.00E+00
						Shallow Groundwater Total =	**1.79E-06**			**All Groundwater Total =**	**6.03E-07**

Table 2-3b

Risk Characterization Summary - Carcinogens and Non-Carcinogens in a Trench

Scenario Timeframe: Current

Receptor Population: Hypothetical Future Resident Receptor for Exposures to All Groundwater Used as Potable Water

Medium	Exposure Medium	Exposure Point	Chemcial of Concern	Carcinogenic Risk Age-Specific with a Non-Mutagenic Mode of Action Carcinogenic Constituents							
				0-6 years				6-26 years			
				Oral	Dermal	Inhalation	Exposure Routes Total	Oral	Dermal	Inhalation	Exposure Routes Total
Groundwater	All Groundwater	Drinking Water	Bromodichloromethane	1.20E-07	7.40E-09	6.80E-07	8.07E-07	2.40E-07	1.70E-08	2.30E-06	2.56E-06
			Chloroform	6.90E-08	5.50E-09	4.90E-07	NA	1.40E-07	1.30E-08	1.60E-06	NA
			Cis-1,2-DCE	NA	NA	NA	NA	NA	NA	NA	NA
			Ethylbenzene	3.20E-07	1.70E-07	7.00E-07	NA	6.40E-07	4.00E-07	2.30E-06	NA
			Methylene Chloride	NA	NA	NA	0.00E+00	NA	NA	NA	0.00E+00
			Trichloroethene	3.70E-04	5.40E-05	2.90E-04	7.14E-04	7.40E-04	1.30E-04	9.60E-04	1.83E-03
			Vinyl Chloride	2.40E-05	1.60E-06	1.40E-06	2.70E-05	4.70E-06	3.90E-07	4.60E-07	5.55E-06
						All Groundwater Total =	**7.42E-04**			**Shallow Groundwater Total =**	**1.84E-03**

Scenario Timeframe: Current

Receptor Population: Hypothetical Future Resident Receptor for Exposures to All Groundwater Used as Potable Water (Continued)

Medium	Exposure Medium	Exposure Point	Chemcial of Concern	Total Cancer Risk			
				Route Specific Risk			
				0-26 years			
				Oral	Dermal	Inhalation	Exposure Routes Total
Groundwater	All Groundwater	Drinking Water	Bromodichloromethane	3.60E-07	2.50E-08	3.00E-06	3.39E-06
			Chloroform	2.10E-07	1.80E-08	2.10E-06	NA
			Cis-1,2-DCE	NA	NA	NA	NA
			Ethylbenzene	9.60E-07	5.60E-07	3.00E-06	NA
			Methylene Chloride	1.90E-06	6.10E-08	1.20E-07	2.08E-06
			Trichloroethene	2.00E-03	3.20E-04	2.40E-03	4.72E-03
			Vinyl Chloride	2.80E-05	2.00E-06	1.90E-06	3.19E-05
						All Groundwater Total =	**4.76E-03**

Scenario Timeframe: Current

Receptor Population: Hypothetical Future Resident Receptor for Exposures to All Groundwater Used as Potable Water

Medium	Exposure Medium	Exposure Point	Chemcial of Concern	Carcinogenic Risk Age-Specific with a Non-Mutagenic Mode of Action Carcinogenic Constituents							
				0-6 years				6-26 years			
				Oral	Dermal	Inhalation	Exposure Routes Total	Oral	Dermal	Inhalation	Exposure Routes Total
Groundwater	All Groundwater	Drinking Water	Bromodichloromethane	1.10E-03	7.00E-05	NA	1.17E-03	6.70E-04	4.90E-05	NA	7.19E-04
			Chloroform	2.60E-03	2.10E-04	2.50E-03	NA	1.60E-03	1.40E-04	2.50E-03	NA
			Cis-1,2-DCE	2.10E+01	2N4E0	NA	NA	1.30E+01	1.70E+00	NA	NA
			Ethylbenzene	3.40E-03	1.80E-03	3.30E-03	NA	2.00E-03	1.30E-03	3.30E-03	NA
			Methylene Chloride	2.00E-01	5.90E-03	1.90E-02	2.25E-01	1.20E-01	4.20E-03	1.90E-02	1.43E-01
			Trichloroethene	2.30E+02	3.40E+01	5.60E+02	8.24E+02	1.40E+02	2.40E+01	5.60E+02	7.24E+02
			Vinyl Chloride	9.80E-03	6.60E-04	2.80E-03	1.33E-02	5.90E-03	4.80E-04	2.80E-03	9.18E-03
						All Groundwater HQ Total =	8.24E+02				

Table 2-4
Ecological Exposure Pathways of Concern

Exposure Medium	Sensitive Environment Flag (Y or N)	Receptor	Endangered/Threatened Species Flag	Exposure Routes	Assessment Endpoints	Measurement Endpoints
Surface soil, sediment, surface water, and groundwater	N	Aquatic or semi-aquatic animals	N	Incedential ingestion of surface water and sediement, direct contact of surface water and sediment, and uptake through the food chain.	• Sustainability of mammal populations; • Sustainability of avian populations; • Sustainability of terrestrial plant communities; • Sustainability ofsoil invertebrate communities	•HQ is the measurment endpoint. The HQ is the ratio of the EPC of a given constituent to it's ecological screening value.
	N	Aquatic or semi-aquatic plants	N	Uptake of surface water, surface contact of surface water and seidment, and root uptake from sediment.		
	N	Terrestrial wildlife	N	Incidental ingestion of surface soil, direct contact of surface soil, and uptake through the food chain		
	N	Terrestrial soil invertebrates	N	Direct contact of surface soil, and ingestion of surface soil		
	N	Terrestrial plants	N	Contact with, and root uptake from, surface soil		

Notes:
HQ - Hazard Quotient
EPC - Exposure Point Concentration, lower of either UCL on the mean or the maximimum concentration

Table 2-5
COPC Concentrations Expected to Provide Adequate Protection of Ecological Receptors

Potentially Impacted Species	Exposure Medium	COPEC	Protective Level	Units	Basis	Assessment Endpoint
Short-Tailed Shrew	Surface Soil	High Molecular Weight PAHs	0.615 - 3.07	mg/kg	Site specific LOAEL - NOAEL	• Sustainability of mammal populations; • Sustainability of avian populations; • Sustainability of terrestrial plant communities; • Sustainability of soil invertebrate communities
		Mercury	1 - 10			
American Robin	Surface Soil	High Molecular Weight PAHs	10 - 100			
		Mercury	0.45 - 0.9			

Notes:
mg/kg: Milligrams per kilogram
PAHs - Polycyclic aromatic hydrocarbons
LOAEL - Lowest observed adverse effect level
NOAEL - No observed adverse effect level

Table 2-6a
Alternatives Summary and Evaluation – Soil
HAA-15 (MCA Barracks Site) RI/FS
Hunter Army Airfield, Georgia

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Capping - Vegetative Cover	Alternative 3 Excavation and Disposal	Alternative 4 In-Situ Phytoremediation
Threshold Criteria				
1) Overall protection of human health and the environment	Does not provide overall protection of human health or the environment. Does not minimize, reduce, or control COC impacts or associated exposure risks. Source area RAOs would not be met.	Maintaining a vegetative cover would maintain RAOs by limiting exposure to impacted soils while LUCs would also be implemented to protect against current and future human exposure to soil impacts.	Excavation and disposal would maintain RAOs by physically eliminating current and future human exposure to soil impacts.	Maintaining a vegetative cover would maintain RAOs by limiting exposure to impacted soils while LUCs would also be implemented to protect against current and future human exposure to soil impacts. Heavy metals, such as lead, would be extracted from shallow soil by vegetation.
2) Compliance with ARARs	ARARs are not met, as no remedy will be implemented.	Alternative 2 would comply with chemical-specific, location-, and action-specific ARARs for soil.	Alternative 3 would comply with chemical-specific, location-, and action-specific ARARs for soil.	Alternative 4 would comply with chemical-specific, location-, and action-specific ARARs for soil.
Balancing Criteria				
3) Long-term effectiveness and permanence	Not effective or permanent. Potential exposure risks associated with COCs would remain with no controls or long-term management plan.	Alternative 2 would achieve long-term effectiveness and permanence through the maintenance of existing vegetative cover and implementation of LUCs.	Alternative 3 would achieve long-term effectiveness and permanence through the elimination of soil COCs.	Alternative 4 would achieve long-term effectiveness and permanence through the maintenance of existing vegetative cover and implementation of LUCs. Inorganic COCs would be permanently removed from shallow soil by vegetation.
4) Reduction of mobility, toxicity, or volume	Natural attenuation processes may reduce mobility, toxicity, or volume of source area impacts, although monitoring of these processes would not be performed.	Erosion control provided by a well-maintained vegetative cover will reduce mobility of COCs. Toxicity, volume, and mass of organic COCs may naturally attenuate over time.	Mobility, toxicity, and volume of soil COCs would completely be eliminated by Alternative 3.	Erosion control provided by a well-maintained vegetative cover will reduce mobility of COCs. Toxicity, volume, and mass of organic COCs may naturally attenuate over time while inorganic COCs will be extracted by vegetation.
5) Short-term effectiveness	No activities would be implemented that would present potential short-term exposure risks to human health or the environment.	Implementation would result in minimal exposure risks to the community and workers via LUCs while an existing vegetative cover already provides protection.	Alternative 3 would achieve short-term effectiveness and permanence through the elimination of soil COCs.	Implementation would result in minimal exposure risks to the community and workers via LUCs.
6) Implementability	This alternative is technically implementable as no action would be taken.	Vegetative cover already exists and only require minimal amendments to improve to satisfactory erosion control conditions. Requires routine lawn maintenance.	While readily implementable, Alternative 3 may result in air quality effects and hazards from excavation and transportation to the community and workers.	Readily implementable. May result in air quality effects and hazards to workers during planting as soil is disturbed.
7) Cost	No cost.	$50,000	$200,000	$51,000

Notes:
All costs are estimated to an accuracy of +50 percent to -30 percent (USEPA, 2000)

Abbreviations:
ARAR = Applicable or Relevant and Appropriate Requirement
COC = Constituent of Concern
LUC = Land Use Control
MNA = Monitored Natural Attenuation
RAO = Remedial Action Objective

From Pika/Arcadis 2019

Table 2-6b
Alternatives Summary and Evaluation – Groundwater
HAA-15 (MCA Barracks Site) RI/FS
Hunter Army Airfield, Georgia

Evaluation Criteria		**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
		No Action	MNA and LUCs	ERD	ISCO
Threshold Criteria					
1)	Overall protection of human health and the environment	Does not provide overall protection of human health or the environment. Does not minimize, reduce, or control COC impacts or associated exposure risks. Source area RAOs would not be met.	Natural attenuation processes would be monitored while institutional controls would protect against human exposure to impacted groundwater.	ERD will enhance the rate of COC plume degradation while LUCs would protect against human exposure to groundwater impacts. Groundwater monitoring via MNA would be used to assess achievement of RAOs.	ISCO will enhance the rate of COC plume degradation while LUCs would protect against human exposure to groundwater impacts. Groundwater monitoring via MNA would be used to assess achievement of RAOs.
2)	Compliance with ARARs	ARARs are not met with the No Action alternative as no remedy will be implemented	Natural attenuation would occur within an acceptable timeframe to achieve chemical-specific ARARs and would comply with location- and action-specific ARARs.	Natural attenuation and ERD treatment of COCs would occur within an acceptable timeframe to achieve chemical-specific ARARs and would comply with location- and action-specific ARARs	Natural attenuation and ISCO treatment of COCs would occur within an acceptable timeframe to achieve chemical-specific ARARs and would comply with location- and action-specific ARARs
Balancing Criteria					
3)	Long-term effectiveness and permanence	Not effective or permanent. Potential exposure risks associated with COCs would remain with no controls or long-term management plan.	MNA and institutional controls would provide adequate and reliable long-term controls to assure exposure does not occur and would quantify the rate of the natural attenuation processes occurring at the site.	Effective in protecting human health and the environment as long as IRZ is well established and LUCs are maintained.	ISCO will treat mass flux of COC plume. As determined by MNA, a second ISCO injection may be necessary to achieve source reduction.
4)	Reduction of mobility, toxicity, or volume	Natural attenuation processes may reduce mobility, toxicity, or volume of source area impacts, although monitoring of these processes would not be performed.	Reduces mobility, toxicity, and volume of VOCs in source area groundwater.	Permanently reduces mobility, toxicity, and volume of COCs via ERD and natural attentuation processes.	Permanently reduces mobility, toxicity, and volume of COCs via ISCO and natural attentuation processes.
5)	Short-term effectiveness	No activities would be implemented that would present potential short-term exposure risks to human health or the environment.	Would result in minimal exposure risks to the community and workers via institutional controls while MNA will track plume migration and ensure that the remedy is protective of potential receptors in the short term.	Substrate injection wells and additional monitoring wells will be needed to monitor IRZ performance. EVO as the substrate injection compound for ERD will not result in additional risks to the community, workers, and the environment. MNA in will track plume migration in the short term. Potential risks are limited to onsite populations.	Requires use of hazardous chemicals that would result in moderate risks to the community, workers, and the environment. This approach would result in rapid oxidation of dissolved phase COCs.
6)	Implementability	This alternative is technically implementable as no action would be taken.	Technically and administratively feasible, as site-wide monitoring well network already exists.	Technically and administratively feasible. Well installation and injection tasks would not interfere with ongoing operations at HAAF.	Technically and administratively feasible. Well installation and injection tasks would not interfere with ongoing operations at HAAF.
7)	Cost	No cost.	$1,500,000	$1,900,000	$1,900,000

Notes:
All costs are estimated to an accuracy of +50 percent to -30 percent (per the USEPA Guide to Developing and Documenting Cost Estimates During the Feasibility Study, dated July 2000).

Abbreviations:
ARAR = Applicable or Relevant and Appropriate Requirement
COC = Constituent of Concern
ERD = Enhanced Reductive Dechlorination
EVO = Emulsified Vegetable Oil
IRZ = In-Situ Reactive Zone
ISCO = In-Situ Chemical Oxidation
LUC = Land Use Control
MNA = Monitored Natural Attenuation
RAO = Remedial Action Objective

From Pika/Arcadis 2019

Table 2-7a
Comparative Analysis Score – Soil
HAA-15 (MCA Barracks Site) RI/FS
Hunter Army Airfield, Georgia

Alternative No.		Alternative 1	Alternative 3
Remedial Timeframes and Lifecycle Costs (1)			
1)	Remedy Name	No Action	Excavation and Disposal
2)	Estimated Remedial Timeframe	30 years	1 year
3)	Estimated Lifecycle Costs	None	$ 200,000
Remedy Performance Evaluation Ranking (2)			
1)	Overall protection of human health and the environment	**4**	**2**
2)	Compliance with applicable regulations	**4**	**2**
3)	Long-term effectiveness and permanence	**4**	**1**
4)	Reduction of toxicity, mobility, and volume	**4**	**1**
5)	Short-term effectiveness	**4**	**1**
6)	Implementability	**4**	**2**
7)	Relative Cost	**1**	**2**
8)	Community Acceptance	**4**	**3**
	Total Ranking Score (Lowest score is the best performing)	**29**	**14**
	Average Score (Lowest score is the best performing)	**3.6**	**1.8**

Notes:
(1) Includes an opinion of probable cost for capital expenses related to system installation, operations and maintenance, and management for the project lifecycle.
(2) Performance Ranking Scale:
1 = Most Favorable
4 = Least Favorable

From Pika/Arcadis 2019

Table 2-7b
Comparative Analysis Score – Groundwater
HAA-15 (MCA Barracks Site) RI/FS
Hunter Army Airfield, Georgia

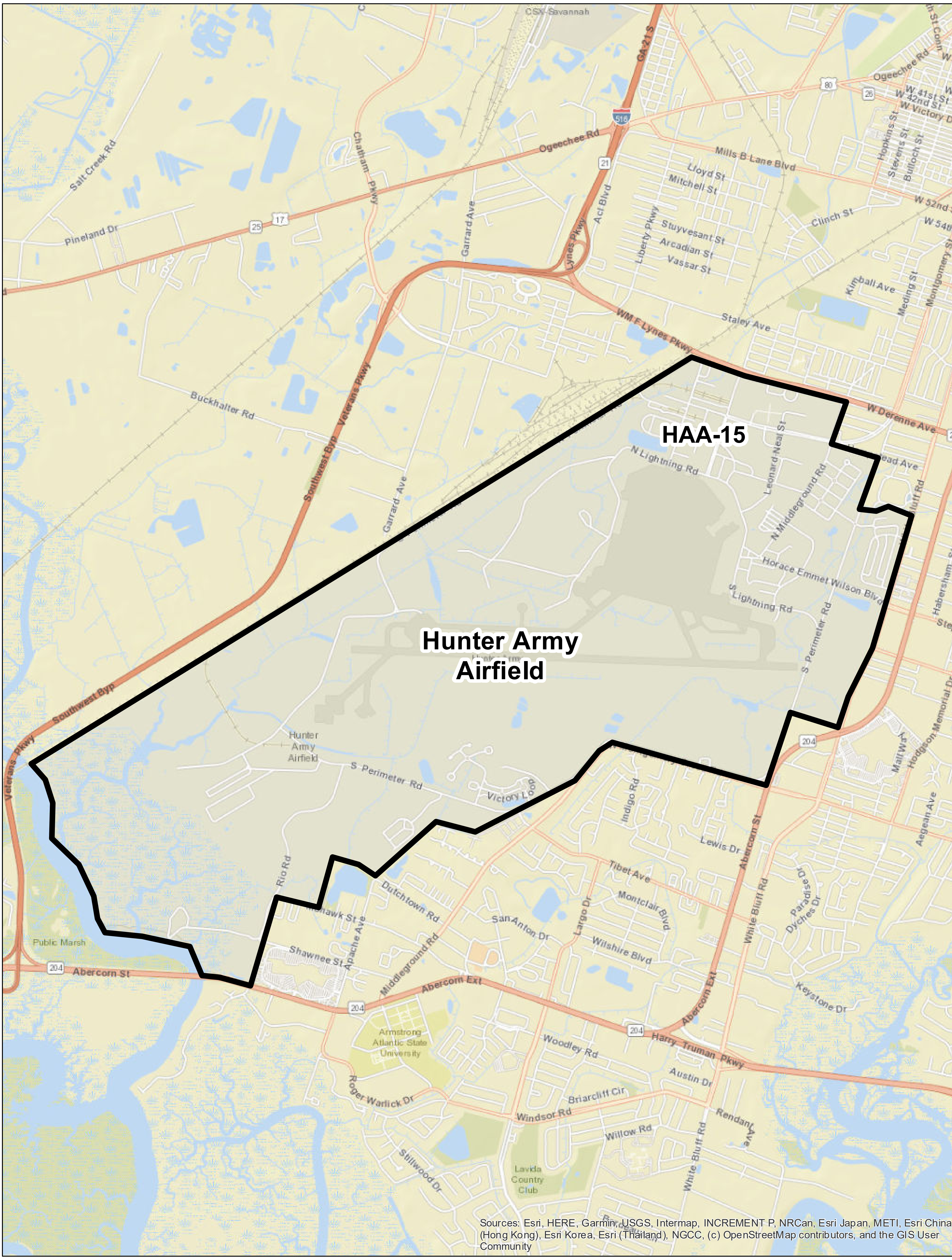
	Alternative No.	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Remedial Timeframes and Lifecycle Costs (1)					
1)	Remedy Name	No Action	MNA and LUCs	ERD in source area with downgradient MNA and onsite LUCs	ISCO in source area with downgradient MNA and onsite LUCs
2)	Estimated Remedial Timeframe	30 years	10 years	5 years	5 years
3)	Estimated Lifecycle Costs	None	$ 1,500,000	$ 1,900,000	$ 1,900,000
Remedy Performance Evaluation Ranking (2)					
1)	Overall protection of human health and the environment	**4**	**1**	**1**	**1**
2)	Compliance with applicable regulations	**4**	**2**	**2**	**2**
3)	Long-term effectiveness and permanence	**4**	**3**	**1**	**2**
4)	Reduction of toxicity, mobility, and volume	**4**	**4**	**1**	**1**
5)	Short-term effectiveness	**4**	**3**	**2**	**1**
6)	Implementability	**4**	**2**	**2**	**3**
7)	Relative Cost	**1**	**2**	**3**	**3**
8)	Community Acceptance	**4**	**2**	**1**	**1**
	Total Ranking Score (Lowest score is the best performing)	**29**	**19**	**13**	**14**
	Average Score (Lowest score is the best performing)	**3.6**	**2.4**	**1.6**	**1.8**

Notes:
(1) Includes an opinion of probable cost for capital expenses related to system installation, operations and maintenance, and management for the project lifecycle.
(2) Performance Ranking Scale:
1 = Most Favorable
4 = Least Favorable

Abbreviations:
ERD = Enhanced Reductive Dechlorination
ISCO = In Situ Chemical Oxidation
LUC = Land Use Control
MNA = Monitored Natural Attenuation

From Pika/Arcadis 2019

Figures



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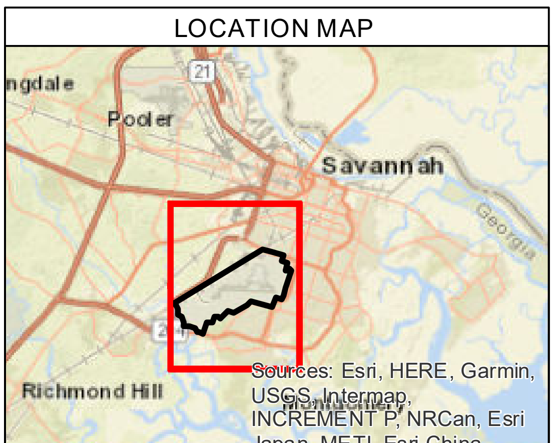

0 2,000 4,000

Feet

NOTES & SOURCES

Map Coordinates: WGS 1984, UTM Zone 17 N (feet)

LEGEND

Installation Boundary

TITLE

Hunter Army Airfield
MCA Barracks Site HAA-15
Site Location Map

KEMRON ENVIRONMENTAL SERVICES Hunter Army Airfield

PROJECT: U.S. Army Garrison Hunter Army Airfield
Directorate of Public Works, Building 615
Stephen Douglas Street
Hunter Army Airfield, Georgia 31409

DRAWING DATE: 7/24/2020

Drawn by:	Reviewed by:
CJ	MSC

N

FIGURE

2-1

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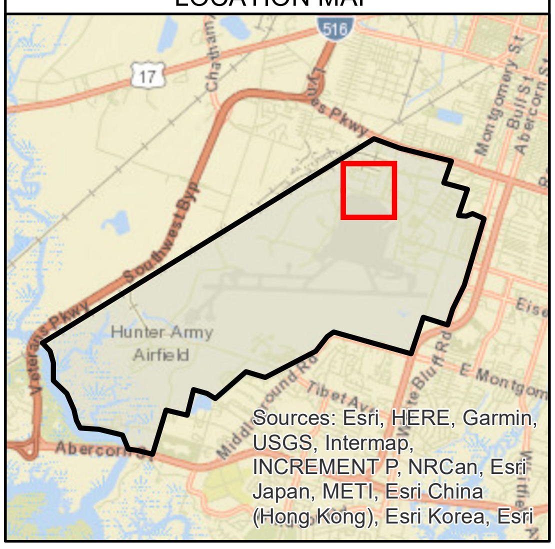
LOCATION MAP



NOTES & SOURCES

Map Coordinates: WGS 1984, UTM Zone 17 N (feet)

LEGEND

Installation Boundary

0 400 800

Feet

TITLE

Hunter Army Airfield
MCA Barracks Site HAA-15
Site Layout

KEMRON ENVIRONMENTAL SERVICES Hunter Army Airfield

PROJECT: U.S. Army Garrison Hunter Army Airfield
Directorate of Public Works, Building 615
Stephen Douglas Street
Hunter Army Airfield, Georgia 31409

DRAWING DATE: 7/21/2020

Drawn by:	Reviewed by:
CJ	MSC

N

FIGURE

2-2

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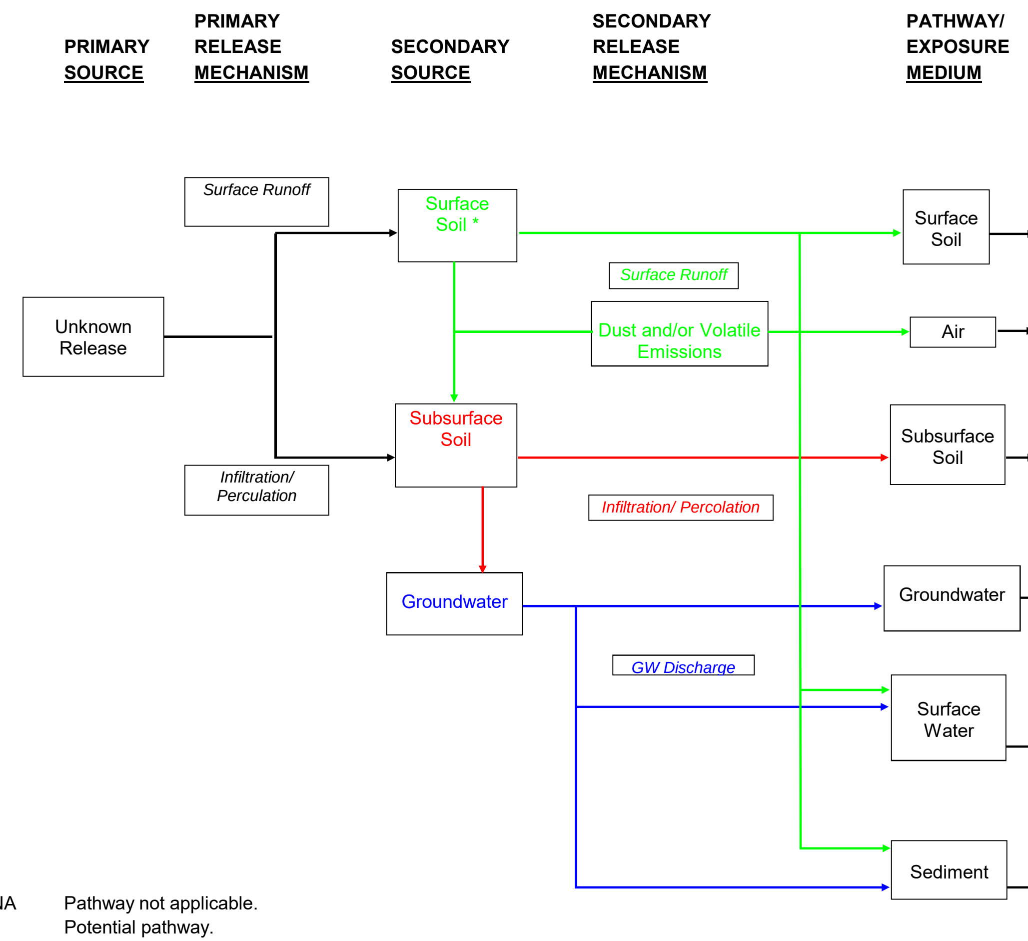


PATHWAY/ EXPOSURE MEDIUM	EXPOSURE ROUTE	Site Worker	Construction Worker	Utility Worker	Hypothetical Futre Adult/Child Resident	Adolescent Trespasser	Terrestrial Wildlife	Soil Invertebrates	Terrestrial Plants
Surface Soil	Ingestion	x	x	x	x	x	x	x	NA
	Dermal Contact	x	x	x	x	x	x	x	NA
	Direct Contact/Uptake	NA	NA	NA	NA	NA	x	x	x
	Food Chain	NA	NA	NA	NA	NA	x	NA	NA
Air	Inhalation	x	x	x	x	x	NA	NA	NA
Subsurface Soil	Ingestion	x	x	x	x	x	NA	NA	NA
	Dermal Contact	x	x	x	x	x	NA	NA	NA
	Direct Contact/Uptake	NA	NA	NA	NA	NA	NA	NA	NA
	Food Chain	NA	NA	NA	NA	NA	NA	NA	NA
Groundwater	Ingestion	NA	x	x	x	NA	NA	NA	NA
	Dermal Contact	NA	x	x	x	NA	NA	NA	NA
	Inhalation of vapors	NA	x	x	x	NA	NA	NA	NA
	Direct Contact/Uptake	NA	NA	NA	NA	NA	x	x	x
	Food Chain	NA	NA	NA	NA	NA	x	NA	NA
Surface Water	Ingestion	NA	NA	NA	NA	x	NA	NA	NA
	Dermal Contact	NA	NA	NA	NA	x	NA	NA	NA
	Inhalation of vapors	NA	NA	NA	NA	x	NA	NA	NA
	Direct Contact/Uptake	NA	NA	NA	NA	NA	x	x	x
	Food Chain	NA	NA	NA	NA	NA	x	NA	NA
Sediment	Ingestion	NA	NA	NA	NA	x	x	x	NA
	Dermal Contact	NA	NA	NA	NA	x	x	x	NA
	Direct Contact/Uptake	NA	NA	NA	NA	NA	x	x	x
	Food Chain	NA	NA	NA	NA	NA	x	NA	NA

NA Pathway not applicable.
x Potential pathway.

* Surface soil is defined as soil in the top 2 feet of the soil column for human and ecological receptors.

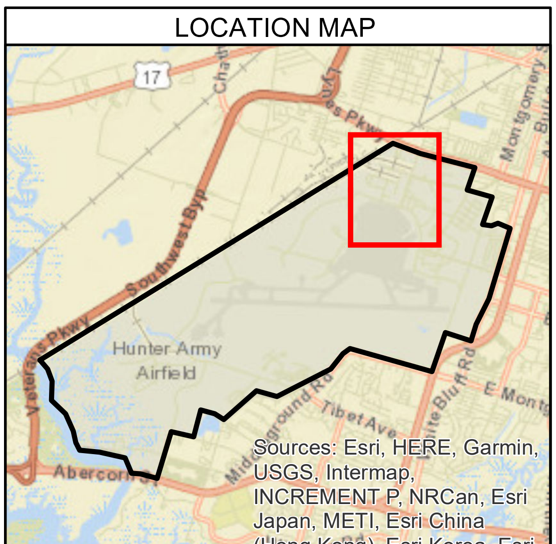
From Plka/Arcadis 2019

Conceptual Site Model for Potential Human and Ecological Receptors
HAA-15 (MCA Barracks Site)
Hunter Army Airfield - Savannah, Georgia

Figure 2-3

Notes:
All Concentrations in micrograms per liter (ug/L)
Results shown are for locations analyzed for the target compound during the December 2014 event.
Tapwater Regional Screening Level (RSL) for Trichloroethylene (TCE) is 0.49 ug/L.
Maximum Contaminant Level (MCL) for TCE is 5.0 ug/L
"J" Values are approximated
"<" Values were not detected at the Method Detection Limit (listed)
Bracketed "[ ] " concentrations represent duplicate sample results.

LOCATION MAP



LEGEND

Monitoring Well (Shallow)

1.0 TCE Concentration (ug/L)

Installation Boundary

TCE Concentration

0.49 - 4.9 ug/L (RSL - 0.49 ug/L)

5.0 ug/L - 49.9 ug/L (MCL - 5.0 ug/L)

>50 ug/L

WGS 1984, UTM Zone 17 N (feet)

0 600 1,200

Feet

TITLE

MCA Barracks Site HAA-15
Trichloroethylene in Shallow Groundwater Monitoring Wells

KEMRON ENVIRONMENTAL SERVICES Hunter Army Airfield

PROJECT: U.S. Army Garrison Hunter Army Airfield
Directorate of Public Works, Building 615
Stephen Douglas Street
Hunter Army Airfield, Georgia 31409

DRAWING DATE: 7/22/2020

Drawn by:	Reviewed by:
CJ	MSC

N

FIGURE

2-4

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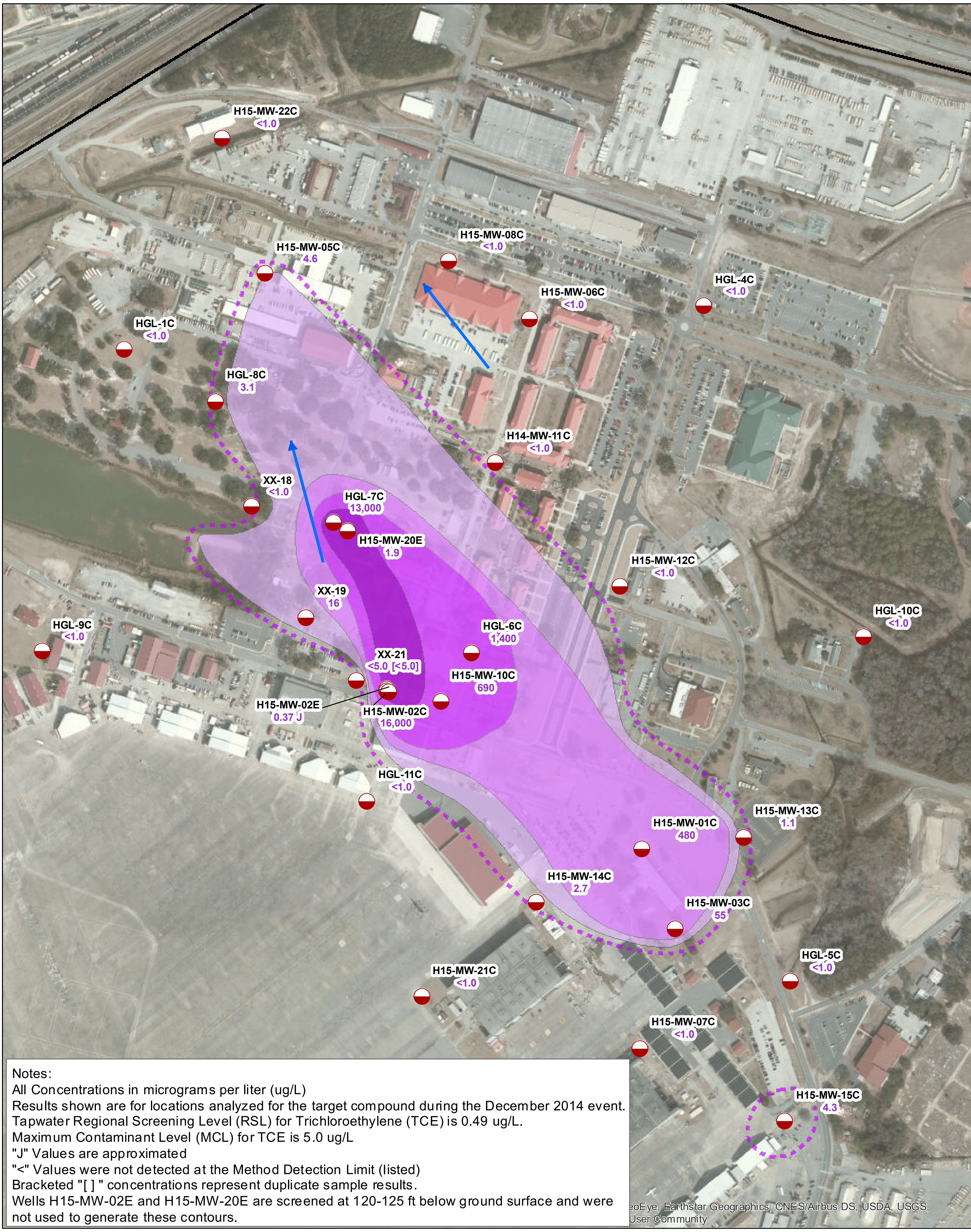
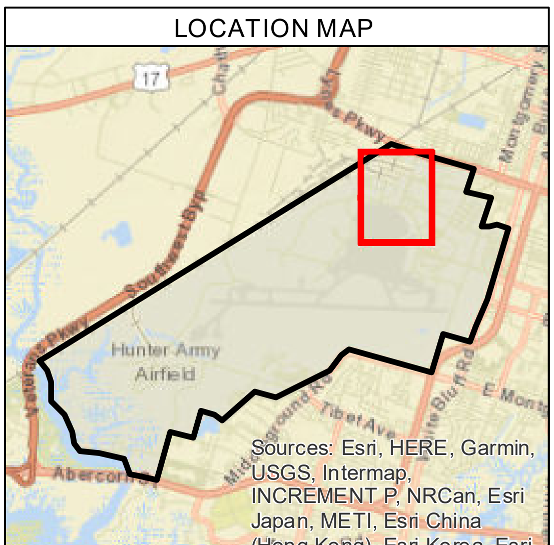


Notes:
All Concentrations in micrograms per liter (ug/L)
Results shown are for locations analyzed for the target compound during the December 2014 event.
Tapwater Regional Screening Level (RSL) for Trichloroethylene (TCE) is 0.49 ug/L.
Maximum Contaminant Level (MCL) for TCE is 5.0 ug/L
"J" Values are approximated
"<" Values were not detected at the Method Detection Limit (listed)
Bracketed "[ ]" concentrations represent duplicate sample results.
Wells H15-MW-02E and H15-MW-20E are screened at 120-125 ft below ground surface and were not used to generate these contours.

LOCATION MAP



LEGEND

Monitoring Well (Deep)

1.0 TCE Concentration (ug/L)

Groundwater Flow Direction

Installation Boundary

TCE Concentration

0.49 - 4.9 ug/L
5.0 - 49.9 ug/L
50 - 499.9 ug/L
50 - 499.9 ug/L
< 500 ug/L

WGS 1984, UTM Zone 17 N (feet)

0 600 1,200
Feet

TITLE

MCA Barracks Site HAA-15 Trichloroethylene in Deep Groundwater Monitoring Wells

KEMRON ENVIRONMENTAL SERVICES Hunter Army Airfield

PROJECT: U.S. Army Garrison Hunter Army Airfield
Directorate of Public Works, Building 615
Stephen Douglas Street
Hunter Army Airfield, Georgia 31409

DRAWING DATE: 7/24/2020

Drawn by: CJ
Reviewed by: MSC

N

FIGURE
2-5

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CITY: (KNOXVILLE) DIV/GROUP: (ENV/GIS) LD: (B.ALTOM) PIC: (T.TALELE) PM: (S.GIBBONS) TM: (D.LIPIK) BY: KIVES
PROJECT: 10153001.0001 PATH: Z:\GISPROJECTS_ENV\HAAF_PIKA\MAPDOCS\H15\2017\H15 RIFS\F3-3A H15_RIFS 201412 POT S DSIZE.MXD SAVED: 7/7/2017

PROJECTION: NAD_1983_StatePlane_Georgia_East_FIPS_1001_Feet
REFERENCE: SAGIS (2008).

LEGEND

- Monitoring Well (shallow)
- (NM) Not Measured
- (26.03) Water-Level Elevation (ft amsl) Measured December 8-9, 2014
- Groundwater Contour Line (ft amsl)
- (inferred where dashed)
- Direction of Groundwater Flow

NOTE: The shallow zone of the upper aquifer consists of wells with screened intervals between ground surface and 30 ft bgs.

HUNTER ARMY AIRFIELD, GEORGIA

MCA BARRACKS SITE (HAA-15)
REMEDIAL INVESTIGATION/FEASIBILITY STUDY

Potentiometric Surface Map for the Shallow Zone of the Upper Aquifer (December 2014)

From Pika/Arcadis 2019

FIGURE
2-6

PROJECTION: NAD_1983_StatePlane_Georgia_East_FIPS_1001_Feet
REFERENCE: SAGIS (2008).

LEGEND

- Monitoring Well (deep)
- (NM) Not Measured
- (26.03) Water-Level Elevation (ft amsl) Measured December 8-9, 2014
- (9.95*) Water-Level Elevation Not Used to Construct Contours (Well screened in different interval)
- Groundwater Contour Line (ft amsl)
- (inferred where dashed)
- Direction of Groundwater Flow

NOTE: The deep zone of the upper aquifer consists of wells with screened intervals between 30 and 50 ft bgs.

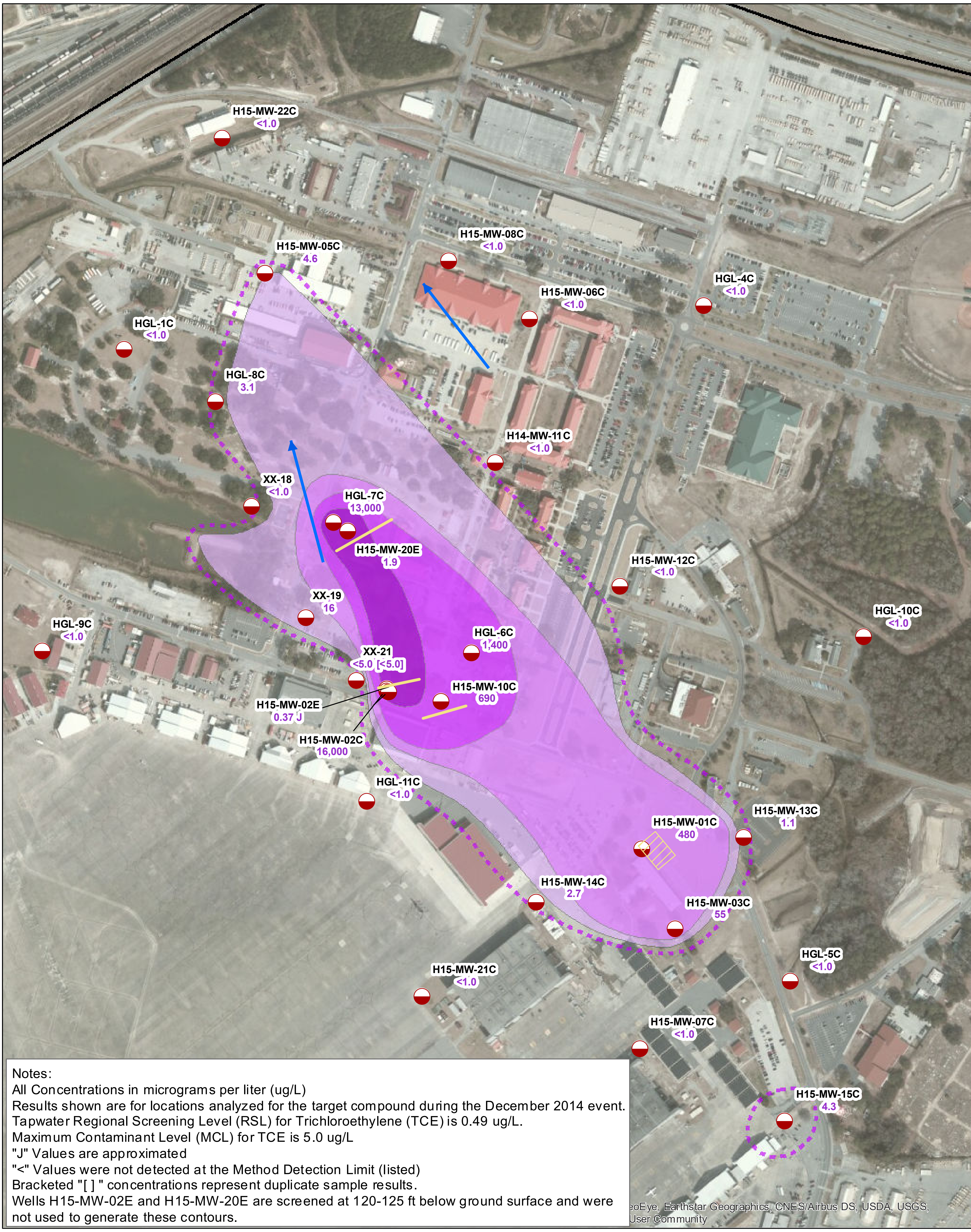
HUNTER ARMY AIRFIELD, GEORGIA

MCA BARRACKS SITE (HAA-15)
REMEDIAL INVESTIGATION/FEASIBILITY STUDY

Potentiometric Surface Map for the Deep Zone of the Upper Aquifer (December 2014)

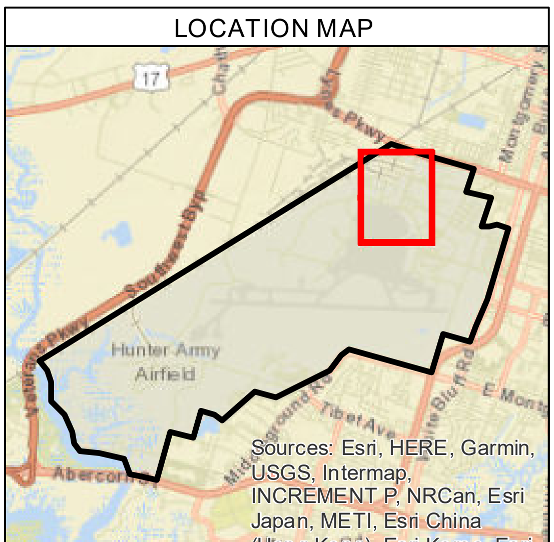
From Pika/Arcadis 2019

FIGURE
2-7



Notes:
All Concentrations in micrograms per liter (ug/L)
Results shown are for locations analyzed for the target compound during the December 2014 event.
Tapwater Regional Screening Level (RSL) for Trichloroethylene (TCE) is 0.49 ug/L.
Maximum Contaminant Level (MCL) for TCE is 5.0 ug/L
"J" Values are approximated
"<" Values were not detected at the Method Detection Limit (listed)
Bracketed "[ ]" concentrations represent duplicate sample results.
Wells H15-MW-02E and H15-MW-20E are screened at 120-125 ft below ground surface and were not used to generate these contours.

LOCATION MAP



LEGEND

Monitoring Well (Deep)
Installation Boundary
1.0 TCE Concentration (ug/L)
Groundwater Flow Direction
Proposed Injection Line
Proposed Injection Area

TCE Concentration (Deep Wells)

0.49 - 4.9 ug/L
5.0 - 49.9 ug/L
50 - 499.9 ug/L
50 - 499.9 ug/L
< 500 ug/L

WGS 1984, UTM Zone 17 N (feet)

0 600 1,200
Feet

TITLE

MCA Barracks Site HAA-15
Planned Injection Areas

KEMRON ENVIRONMENTAL SERVICES Hunter Army Airfield

PROJECT: U.S. Army Garrison Hunter Army Airfield
Directorate of Public Works, Building 615
Stephen Douglas Street
Hunter Army Airfield, Georgia 31409

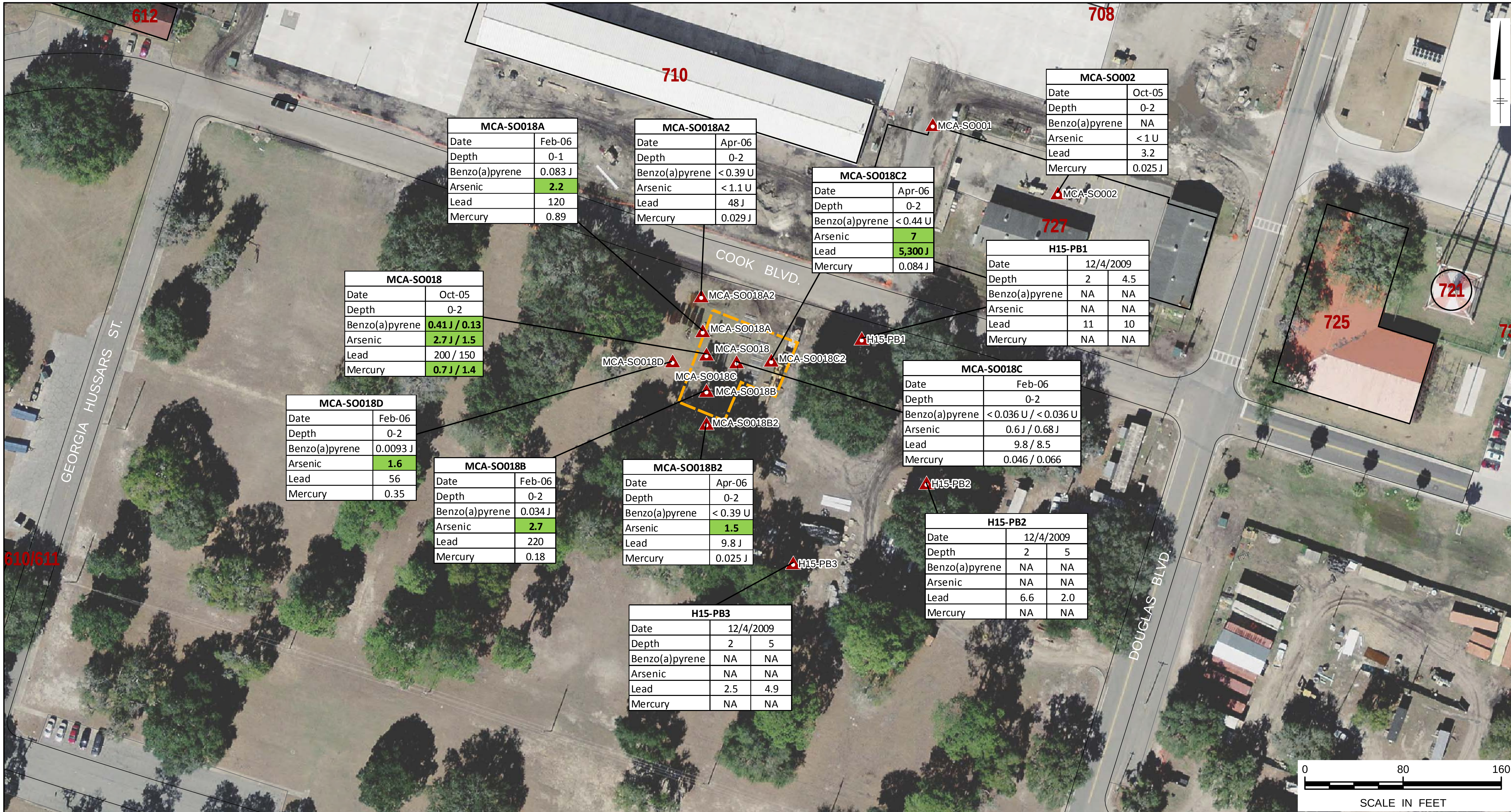
DRAWING DATE: 7/24/2020

Drawn by: CJ
Reviewed by: MSC

N

FIGURE
2-8

Document Path: L:\GIS_Databases\GIS\SH4943 - Ft Stewart Hunter Army Airfield\Hunter Army Airfield\MXDs\HAA-15\Proposed_Injection.mxd



MCA-SO018A	
Date	Feb-06
Depth	0-1
Benzo(a)pyrene	0.083 J
Arsenic	**2.2**
Lead	120
Mercury	0.89

MCA-SO018A2	
Date	Apr-06
Depth	0-2
Benzo(a)pyrene	< 0.39 U
Arsenic	< 1.1 U
Lead	48 J
Mercury	0.029 J

MCA-SO018C2	
Date	Apr-06
Depth	0-2
Benzo(a)pyrene	< 0.44 U
Arsenic	**7**
Lead	**5,300 J**
Mercury	0.084 J

MCA-SO002	
Date	Oct-05
Depth	0-2
Benzo(a)pyrene	NA
Arsenic	< 1 U
Lead	3.2
Mercury	0.025 J

H15-PB1		
Date	12/4/2009	
Depth	2	4.5
Benzo(a)pyrene	NA	NA
Arsenic	NA	NA
Lead	11	10
Mercury	NA	NA

MCA-SO018	
Date	Oct-05
Depth	0-2
Benzo(a)pyrene	**0.41 J / 0.13**
Arsenic	**2.7 J / 1.5**
Lead	200 / 150
Mercury	**0.7 J / 1.4**

MCA-SO018D	
Date	Feb-06
Depth	0-2
Benzo(a)pyrene	0.0093 J
Arsenic	**1.6**
Lead	56
Mercury	0.35

MCA-SO018C	
Date	Feb-06
Depth	0-2
Benzo(a)pyrene	< 0.036 U / < 0.036 U
Arsenic	0.6 J / 0.68 J
Lead	9.8 / 8.5
Mercury	0.046 / 0.066

MCA-SO018B	
Date	Feb-06
Depth	0-2
Benzo(a)pyrene	0.034 J
Arsenic	**2.7**
Lead	220
Mercury	0.18

MCA-SO018B2	
Date	Apr-06
Depth	0-2
Benzo(a)pyrene	< 0.39 U
Arsenic	**1.5**
Lead	9.8 J
Mercury	0.025 J

H15-PB2		
Date	12/4/2009	
Depth	2	5
Benzo(a)pyrene	NA	NA
Arsenic	NA	NA
Lead	6.6	2.0
Mercury	NA	NA

H15-PB3		
Date	12/4/2009	
Depth	2	5
Benzo(a)pyrene	NA	NA
Arsenic	NA	NA
Lead	2.5	4.9
Mercury	NA	NA

PROJECTION: NAD_1983_StatePlane_Georgia_East_FIPS_1001_Feet
REFERENCE: SAGIS (2008).

LEGEND

- ▲ Soil Boring
- Approximate Extent of Proposed Excavation
- 710 Building Number

MCA-SO018C		
Date	Feb-06	Sample Date
Depth	0-2	Sample Interval (ft bgs)
Lead	9.8 / 8.5	Lead Concentration / duplicate

(MCA-SO018C — Soil Boring ID)

NOTES:
1) All soil concentrations reported in milligrams per kilogram (mg/kg).
2) **BOLD** concentration exceeds the applicable 2018 United States Environmental Protection Agency Regional Screening Level for Residential Soil for soil samples collected between ground surface and 2 feet below grade.
3) Concentrations shown are those detected above the method detection limit (MDL).
4) J values are estimated.
5) < 1 U - constituent was not detected above the indicated MDL.
6) NA - Not Analyzed.

From Approved RI/FS, Figure 5-4, Pika/Arcadis 2019

HUNTER ARMY AIRFIELD, GEORGIA
MCA BARRACKS SITE (HAA-15)
REMEDIAL INVESTIGATION/FEASIBILITY STUDY

Old Hospital Area Concentrations in Soil

KEMRON ENVIRONMENTAL SERVICES

Planned Excavation Area

FIGURE **2-9**

CITY: Citrix DIV/GROUP: IMDV LD: (B.ALTOM) PIC: (T.TALELE) PM: (S.GIBBONS) TM: (S.BOSTIAN) BY: acarlone
PROJECT: 10153001.0001.EE015 PATH: Z:\GISProjects_ENV\PIKA\HAAF_PIKA\MapDocs\H15\2018\H15 RIFS\F5-4 H15_CAP HOSP AREA SOIL.mxd SAVED: 6/11/2018

Appendix A
GAEPD Approval Letter

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

Richard E. Dunn, Director

Land Protection Branch
2 Martin Luther King, Jr. Drive
Suite 1054, East Tower
Atlanta, Georgia 30334
404-657-8600

September 22, 2021

Mr. James L. Heidle, Public Works Director
Headquarters, 3D Infantry Division (Mechanized) and Fort Stewart
Directorate of Public Works, Building 1137
Environmental Branch
1550 Veterans Parkway
Fort Stewart, GA 31314-4927

RE: Final Proposed Plan Revised for HAA-15 (MCA Barracks Site); Hunter Army Airfield, Savannah, Georgia.

Dear Mr. Heidle:

The Land Protection Branch of the Georgia Environmental Protection Division (EPD) has reviewed the above referenced document, received on June 1, 2021. Based on that review, no major comments were generated. However, please note that on page 19, in the box that reads, "For Further Information..." please change MAA-15 to HAA-15 and change the name of the contact person from Algeana Stevenson to Tavy Wade. Please make these minor corrections prior to public review and submit a revised hard copy and electronic copy to EPD to be placed on file at our office.

Should you have any questions concerning this correspondence, please contact Sharon Priyadarshini or Mo Ghazi at (404) 657-8600.

Sincerely,

Kim B. Hembree

Kim Hembree, Manager
Department of Defense Facilities Unit
Hazardous Waste Management Program

cc: Tressa Rutland, Fort Stewart (tressa.m.rutland2.civ@mail.mil)
Tavy Wade, Fort Stewart (tavy.j.wade.civ@mail.mil)

File: Hunter Army Airfield (G)