DRAFT FINAL PROPOSED PLAN FOR MILITARY MUNITIONS RESPONSE PROGRAM SOUTHERN OPERATIONAL RANGE ASSESSMENT AREA RDX FORT JACKSON, SOUTH CAROLINA

APRIL 2023

INTRODUCTION AND PURPOSE

This Military Munitions Response Program RDX Proposed Plan provides information necessary to allow the public to participate with the United States (U.S.) Department of the Army (Army), the Lead Agency, in selecting appropriate Response Action (RA) to address the human health hazards associated with 1,3,5-trinitro-1,3,5-triazinane (RDX; also known as Royal Demolition Explosive and Research Department Explosive) that is present in groundwater downgradient of U.S. Army Garrison Fort Jackson's Southern Operational Range Assessment (ORA) Area (Southern ORA Area), east of Weston Lake Area, located in Columbia, South Carolina.

The Army is currently monitoring off-post residential wells, including private drinking water wells and public water systems, and providing an interim remedial measure. Recently, a Remedial Investigation was completed to determine whether RDX and trinitrotoluene (TNT) breakdown products are originating and migrating off-post from the Southern ORA Area.

Of particular concern are the off-post residential wells that currently, or have historically, contained RDX in excess of the U.S. Environmental Protection Agency (USEPA) Lifetime Health Advisory Level (HAL) of 2.0 micrograms per liter (µg/L). These include nine private drinking water wells serving one residence each and one public water system serving four residences (a total of 13 affected residences) located south of the Fort Jackson installation boundary, along Davis Road and Old Leesburg Road. As an interim remedial measure to ensure the protection of human health, point of use treatment systems were connected to the nine private drinking water wells and one public water system serving the affected residences.

This Proposed Plan (PP) summarizes the detailed information found in the ***Remedial Investigation*** (RI), ***Feasibility Study*** (FS), and other reports, which are available for review as part of the ***Administrative Record*** file for this site. This PP highlights the Preferred RA for the area located south of Fort Jackson's Southern ORA Area and east of Weston Lake, including the 13 affected residences (known as the Focused Area). It also outlines all RAs identified during the FS. The Preferred RA described in this Proposed Plan is:

- Alternative 4: Dynamic Groundwater Recirculation (DGR) with Operation of Point of Use Treatment Systems and Monitoring

The Army issues this PP in order to fulfill public participation requirements under Section 117(a) of the ***Comprehensive Environmental Response, Compensation, and Liability Act*** of 1980 (CERCLA), as amended by the ***Superfund Amendments and Reauthorization Act*** of 1986 (SARA) and the ***National Oil and Hazardous Substances Pollution Contingency Plan*** (NCP) Section 300.430(f)(2). The Army encourages the public to review all of the documents relevant to CERCLA activities conducted at the site in order to assist in the selection of an appropriate RA for the site.

The Army will finalize and present the selected RA for the site in a ***Record of Decision*** (ROD). The final selection will not take place until after the public comment period in order to provide for the possibility of new information or concerns that may surface during the public comment period. New information or arguments provided to the Army during the public comment period could result in the selection of a final RA that differs from the Preferred RA described herein. The public is encouraged to comment on the Preferred RA and <u>all</u> other RAs considered. Information about how to submit comments may be found in the "Community Participation" section of this Proposed Plan.

IMPORTANT DATES AND LOCATIONS

Public Comment Period:
May 8 – June 7, 2023
The Army will accept written comments on the Proposed Plan during the public comment period.

Public Meeting: May 11, 2023
The Army will hold a public meeting to explain the Proposed Plan and all Response Actions presented in the FS. Oral and written comments will also be accepted at the meeting. The meeting will be held at the **Weston Lake Community House, Hopkins, SC** at **5:30 p.m.**

The Administrative Record, containing information used in selecting the Preferred Response Action, is available for public review at the following location:

Environmental Division
2563 Essayons Way
Fort Jackson, SC 29207

Richland Library Main
1431 Assembly Street
Columbia, SC 29201

The Preferred RA presented in this PP is believed to be protective of human health and the environment, to meet the CERCLA threshold criteria, and to provide the best combination of balancing criteria when evaluated against the CERCLA requirements.

A list of acronyms, abbreviations, references and a glossary of the terms written in ***italic bold type*** are provided at the end of this PP to further define the terminology used.

RESPONSE ACTIONS

Alternative 1: No Further Action.

Alternative 2: Operation of Point of Use Treatment Systems and Monitoring.

Alternative 3: Connect 13 Affected Residences to the City Water Supply and Monitoring.

Alternative 4: Dynamic Groundwater Recirculation with Operation of Point of Use Treatment Systems and Monitoring.

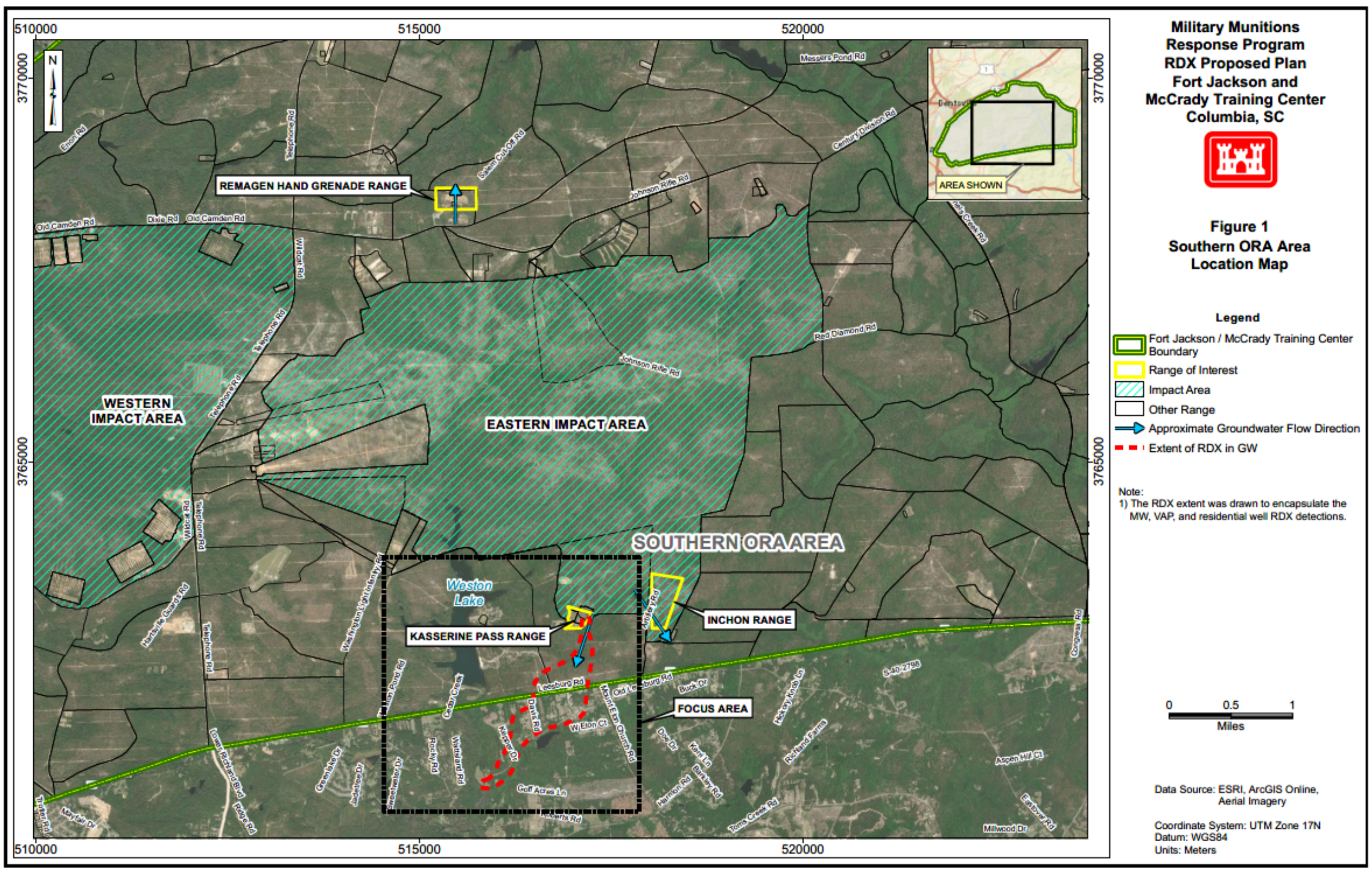
FORT JACKSON SITE BACKGROUND

Fort Jackson and the McCrady Training Center are adjoining military installations located in the eastern section of Columbia, Richland County, South Carolina, and together occupy approximately 51,316 acres. The Kasserine Pass Range is located in the south-central part of the Installation (**Figure 1**).

The Army Range Inventory Database-Geodatabase (U.S. Army, 2006a) identified 104 operational range areas at Fort Jackson encompassing a total of 29,475 acres. The operational areas support a variety of range uses, including live-fire weapons training, heavy and light maneuver exercises, impact areas, and specialty training courses.

McCrady Training Center is located within the eastern portion of Fort Jackson. Leased to the South Carolina Army National Guard (SCARNG), it is the primary and largest training facility for the SCARNG, supporting federal missions and serving as a staging site for state missions (PIKA-Pirnie JV, 2014a). The SCARNG holds a nonexclusive license for training operations on approximately 15,267 acres of the eastern portion of the Installation. The Army Range Inventory Database-Geodatabase (U.S. Army, 2006b) for McCrady Training Center identified 62 operational ranges encompassing 14,895 acres. The McCrady Training Center ranges support live-fire weapons training and heavy and light maneuver exercises.

Fort Jackson was established in 1917 as an infantry training center (then known as Camp Jackson) and then was inactive from 1921 to 1925. In 1925, the Department of War decided to use the post again as a training camp for the SCARNG. From 1925 to 1939, the state controlled Fort Jackson and used it as an encampment and training area for SCARNG troops. During World War II, Fort Jackson became a permanent military installation used primarily for infantry training. Additional land was acquired on the eastern and northern sides of Fort Jackson until the acreage reached its current size. In 1943, the land for McCrady Training Center, formerly referred to as Leesburg Training Center, was licensed to the SCARNG by the Department of the Army (PIKA-Pirnie JV, 2020).



SOUTHERN ORA AREA BACKGROUND

RDX was used extensively as a propellant for artillery shells and as an explosive in projectiles. Based on the timing of when RDX became prevalent in munitions used by ground forces, only ranges and training areas at Fort Jackson in use after 1950 are considered likely to have supported training with munitions containing significant quantities of RDX. According to the 2015 Archives Search Report, known or suspected historical munitions used at Fort Jackson that include RDX high explosive charges are hand grenades, rifle grenades, rockets, mortars, artillery (Howitzers and Guns), and recoilless rifles (U.S. Army Corps of Engineers [USACE] St. Louis District ,2015).

Based on the RI, Kasserine Pass Range was identified as the likely historical source of RDX for the Focused Area. Other explosive compounds were detected during the RI activities, including 1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX; also known as High Melting Explosive) and TNT breakdown products. Production-grade RDX generally contains significant amounts (approximately 10 percent) of HMX (USEPA, 2014). HMX is also used as a propellant and an explosive. Therefore, HMX can be present as an impurity of RDX or from munitions manufactured that use HMX as an explosive or propellant. However, HMX and TNT are not considered compounds of potential concern (COPC) as they are below their respective USEPA Regional Screening Levels (RSL). For the purposes of this PP, RDX is the only COPC. Alternatives in this PP focus on the mitigation of RDX in groundwater associated with the Kasserine Pass Range.

SOUTHERN ORA AREA SITE CHARACTERISTICS

Regional Geology

The Installation lies on the northwestern edge of the Coastal Plain physiographic province, a region of low to moderate relief and gently rolling plains, known as the Sand Hills. The Installation sits directly on the unnamed sediments of Tertiary age and the upper Coastal Plain portion of the Cretaceous-aged Middendorf Formation (Kite 1988; U.S. Geological Survey [USGS] 1994, 1996). The majority of the Installation sits directly on the Middendorf Formation, with Tertiary age sediments locally capping uplands in the southern half of the Installation. The Middendorf Formation (also referred to as the Tuscaloosa Formation) consists of deltaic deposits of light-colored sands and kaolin clays. The Middendorf Formation thickens considerably to the southeast, sitting on top of crystalline bedrock that dips to the southeast at approximately 25 feet per mile. The thickness of the unconsolidated sediments varies considerably across the Installation depending on distance from the fall line and the local topography. The total thickness of unconsolidated sediments of the Tertiary units and Middendorf Formation vary from approximately 300 feet in the northwestern portion of the Installation to approximately 500 feet in the southwestern corner of the Installation (PIKA-Pirnie JV, 2014a).

Regional Hydrogeology

Two types of aquifers are encountered in the region:

- *Sedimentary aquifer*. The Middendorf aquifer entirely coincident with the Middendorf Formation. The Middendorf aquifer constitutes the primary aquifer used as a groundwater supply in the area with half of the residential wells being less than 100 feet deep. The majority of the residential wells directly south of the Installation are screened at an elevation of 175 feet above mean sea level or higher within the Middendorf aquifer.
- *Bedrock aquifers*. Residential wells located several miles north of the Installation extract groundwater from bedrock aquifers. Very few supply wells on the Installation or residential wells directly south of the Installation extract groundwater from the bedrock aquifers due to the great depths to bedrock (and associated cost of well installation) (PIKA-Pirnie JV, 2020).

PREVIOUS ENVIRONMENTAL INVESTIGATION AND REMEDIAL ACTIVITIES

Investigations have been ongoing at the Installation since 2009 and include:

1. Phase I and Phase II ORAs (PIKA-Pirnie JV, 2014a; PIKA-Pirnie JV, 2014b)
2. Fort Jackson residential well water studies (off Post) (Alion, 2016a; Alion, 2016b; Weston, 2017)
3. Remagen Hand Grenade Range investigation (USACE Savannah District, 2015)
4. Fort Jackson RDX archives search (USACE St. Louis District, 2015)
5. Investigation of the southern portion of the Installation (USACE Savannah District, 2015; USACE St. Louis District, 2016)
6. RDX RI (PIKA-Pirnie JV, 2020) and RDX FS (PIKA-Pirnie JV, 2021)

The investigations are summarized below.

IDENTIFICATION OF ENVIRONMENTAL CONTAMINATION

During the Phase I ORA, the historical and current range layouts and munition use were evaluated. The results of the Phase I ORA indicated the need for a quantitative evaluation of the potentially complete munitions constituent pathways in a Phase II ORA. During the Phase II ORA, both the surface water and groundwater pathways were evaluated. While the surface water investigation included sampling all the watersheds, the groundwater investigation focused on the areas with the heaviest munitions use. The Phase II ORA identified RDX in groundwater samples exceeding the applicable former project action level of 0.61 µg/L that was related to the previous USEPA Tapwater RSL. Based on the results of the Phase II ORA, sampling of the downgradient groundwater wells located south of the Installation began in December 2013. Since January 2014, the Army has been monitoring residential wells annually and, for a subset of wells, semiannually.

The 2014 to 2015 sampling events confirmed that four residential wells supplying groundwater to residences contained RDX concentrations greater than the lifetime HAL and posed health hazards to the human receptors consuming it. Bottled water for drinking and cooking were provided to the residents until Fort Jackson installed point of use treatment systems. Fort Jackson began whole house filtration unit installation in December 2014 (two wells), February 2015 (one well), and July 2015 (one well).

The most recent RI focused on determination of the RDX plume source and delineation of the RDX plume, and it included the installation of permanent groundwater monitoring wells to assess the distribution of RDX. The RI included vertical aquifer profile soil and grab groundwater sampling, groundwater monitoring well installation, site-side groundwater monitoring well network sampling, surface and sub-surface soil sampling, and an instrument-aided visual survey to locate surficial RDX-containing munitions and explosives of concern. The nature and extent of other explosive compounds were also investigated.

The groundwater monitoring well network is further described below and includes wells installed during previous investigations:

- Twenty-nine monitoring wells located on the Installation:
- *Downgradient of Inchon Range*. Six well locations (MW-RS-02 through MW-RS-07) were installed using Rotosonic® drilling. All six locations consist of a pair of shallow and deep wells.
- *Southern-central border of the Installation*. Fifteen well locations (MW-01 through MW-15); all 15 locations consist of a pair of shallow and deeper wells. The wells are located in three areas:
- West of the Focused Area (MW-01 to MW-07) crossgradient from Kasserine Pass Range.
- Within the Focused Area (MW-08 to MW-10) downgradient from Kasserine Pass Range.
- East of the Focused Area (MW-11 to MW-15) crossgradient from Kasserine Pass Range.
- *Remagen Hand Grenade Range*. Five well locations (REM-MW-01 through REM-MW-05), including three locations consisting of a pair of shallow and deeper wells (REM-MW-01 through REM-MW-03).
- *Kasserine Pass Range*. Three well locations (MW-KP-16 through MW-KP-18).
- Seven monitoring wells located off-Installation (off-post [OP]) (MW-OP-01 through MW-OP-05, MW-OP-07 and MW-OP-08), including three locations consisting of a pair of shallow and deeper wells (MW-OP-01, MW-OP-05 and MW-OP-08).

The residential well network includes private drinking water wells (domestic wells) and public water systems supplying several residences (supply wells). Approximately 141 residential wells are owned and operated by approximately 120 private residents to the south of the Installation. Residential wells sampled during each monitoring event depend on access granted by the private owners. During 2019, 101 residential wells were sampled as part of the annual sampling program. The location and results cannot be shown due to privacy issues; however, the extent of RDX shown on **Figure 1** takes into account the results from these residential wells. Additionally, semiannual sampling is being conducted where RDX concentrations exceed the USEPA Tapwater RSL of 0.97 µg/L (USEPA, 2019), but are less than the USEPA lifetime HAL of 2.0 µg/L. In 2019, only three wells without treatment systems exceeded the RDX RSL. None of the wells without treatment systems exceeded the RDX HAL.

Generally, at sites where contaminant concentrations fall below RSLs, no further action or study is warranted. Contaminant concentrations above the RSL would not automatically trigger an RA; however, exceeding an RSL suggests that further evaluation of the potential risks by site contaminants is appropriate. The 2021 RI suggested a distinct lack of point sources for RDX and also suggested that any dispersed RDX source mass that was historically present is likely depleted. Therefore, increasing concentrations are not expected. Groundwater samples from residential and monitoring wells have been analyzed for:

- Explosives by USEPA SW846 Method 8330A including:
- RDX
- HMX
- TNT and breakdown or related products: 2,4-dinitrotoluene, 2,6-dinitrotoluene, 2-nitrotoluene, 3-nitrotoluene, 4-nitrotoulene, 2-amino-4,6-dinitrotoluene, and 4-amino-2,6-dinitrotoluene
- Nitrobenzene: nitrobenzene, 1,3,5-trinitrobenzene, and 1,3-dinitrobenzene
- 2,4,6-trinitrophenylmethylnitramine (commonly referred to as tetryl)
- In addition, residential wells with treatment systems have been analyzed for:
- Select metals
- General chemistry, including pH

SUMMARY OF THE SITE RISKS

As part of the RI, a human health risk assessment (HHRA) was conducted for the site to determine the current and future effects of COPCs on human health and the environment. Land use activities will remain similar to the current, with industrial / military activities on-post and residential activities off-post.

Hazard Identification

During the HHRA, COPCs were identified for the sampled environmental media (groundwater) based on a comparison of the maximum detected concentration to the human health risk-based screening level. The screening levels used for COPC identification in the HHRA were the USEPA RSLs for Tapwater, which are based on a target cancer risk of 1×10^{-6} (i.e., one-in-a-million excess lifetime cancer risk) or a noncancer hazard quotient of 0.1. RDX was the only constituent detected at concentrations greater than the RSL, which for RDX is based on cancer risk, and was selected as a COPC for further evaluation in the HHRA. RSLs are generic screening values, not de facto cleanup standards. Once the HHRA was completed, a site-specific risk-based remediation goal of 2.0 µg/L was derived using the HHRA results.

Human Health Conceptual Site Model

The human health Conceptual Site Model (CSM) demonstrates the current understanding of the potential for human exposure to RDX. The CSM includes the exposure media of concern, potential human receptor populations, and pathways through which human exposure may occur. In accordance with USEPA (1989) guidance, a complete exposure pathway includes:

- Constituent source and release mechanism
- Transport or retention medium
- Exposure point where human contact with the contaminated medium may occur
- Exposure route (i.e., ingestion, dermal absorption, or inhalation) at the contact point

If any one of these elements is missing, the pathway is considered incomplete. Fort Jackson and McCrady Training Center personnel or contractors who may be exposed on the active ranges are not evaluated.

Residential exposure to groundwater via current off-post residential wells or in the future via public water systems is the only complete exposure pathway. Residential exposure to RDX in tapwater includes ingestion and dermal contact.

Source Characterization

Kasserine Pass Range has been identified as the likely historical source of RDX impacts off post. There is no known ongoing source of RDX within the Kasserine Pass Range. RDX has not been detected in the Kasserine Pass Range impact area groundwater samples. The current residual RDX soil concentrations are not expected to contribute significant RDX impacts to groundwater. While munitions containing RDX are still used at Fort Jackson, such as hand grenades at Remagen and other ranges, the use of these munition-types have been discontinued at Kasserine Pass Range and Inchon Range (inactive). No known upgradient sources of Kasserine Pass Range are contributing to the RDX plume off the Installation.

Fate and Transport of Contaminants

Generally, the majority of groundwater and contaminant transport occurs in the most permeable segments of the aquifer matrix, such as sand and gravel (i.e., transport zones). These zones will typically account for greater than 90 percent of the groundwater flow and mass flux (PIKA-Pirnie JV, 2020). Less permeable segments, like fine sand and silt or clayey sediments, are dominated by slow advection or, in the case of clays and clay mixes, may represent mass storage zones where diffusion is dominant. Because diffusion is time-dependent, soil near release locations often contains significant mass in the slow advection and storage zones, whereas at the leading edge of the plume, the mass will be present almost wholly within the transport zones. For mature plumes with constituents such as RDX (high solubilities and limited soil interaction), the mass has likely been stored in the low-permeability segments encountered along the length of the plume as well. In this case, the mass stored along the plume trajectory can behave as the source long after the original source area is depleted due to diffusion from the storage zones back to the transport zones along the trajectory of the plume (i.e., back diffusion). Sorption of dissolved RDX onto the soil results in slowing (retardation) of the contaminant relative to the groundwater flow velocity, and a reduction in dissolved concentrations of a contaminant.

The RDX distribution and groundwater elevation contour maps show flow toward Cedar Creek to the southwest. Along the core of the RDX plume, groundwater velocity is estimated to range between 25 and 300 feet per year, with the highest velocities located in the deeper soil off the Installation. Groundwater is likely in contact with surface water and potentially discharges to a portion of Cedar Creek; however, due to vertical and horizontal distances from the core of the plume to the creek and the low concentration of RDX in groundwater prior to the creek (below RSL), RDX that discharges to the creek would likely be at concentrations less than the RSL. Also, if any RDX is present in the groundwater that discharges to surface water, it quickly attenuates due to rapid degradation by photolysis in the surface water and sediments.

RDX Extent

RDX Plume Extent and Source

RDX has been detected in groundwater samples collected from residential wells, monitoring wells, and temporary soil borings immediately downgradient of Kasserine Pass Range on its southeast border and further downgradient to the south and south-southwest, including on and off-post. While residential well data is not included on figures due to privacy concerns, the data from these wells were reviewed when delineating the RDX plume. RDX concentrations greater than the RSL ranged from 1.2 µg/L to 7.2 µg/L. The highest RDX groundwater concentration in an off-post monitoring well was 5.8 µg/L in MW-OP-02 at a depth of 80 to 90 feet below ground surface. The highest concentration in a residential well was 7.2 µg/L (prior to point of use treatment system).

Kasserine Pass Range has been determined to be the likely historical source of RDX impacts off the Installation. There is no known ongoing source of RDX within the Kasserine Pass Range. RDX was detected in the Kasserine Pass Range groundwater samples and soil samples. RDX was not detected above the HAL or RSL in the groundwater monitoring well located at Kasserine Pass (MW-KP-17), but it was detected above the soil RSL in one grab soil sample and above the groundwater RSL in two grab groundwater samples. The current residual RDX soil concentrations are not expected to contribute significant RDX impacts to groundwater, and the use of munitions containing RDX at Kasserine Pass Range has been discontinued. Samples collected upgradient of Kasserine Pass Range do not indicate other sources contributing to the RDX plume off-post.

<u>Other Areas of Interest</u>

RDX was observed sporadically in the groundwater downgradient of Inchon Range at concentrations less than the RSL. These low concentrations and sporadic distribution indicate that Inchon Range is not an ongoing source of RDX. RDX was not detected north and upgradient of Inchon Range.

The groundwater flow direction at the Remagen Hand Grenade Range was identified as northerly and, therefore, is not contributing to the RDX plume off the Installation to the south. The sampling results confirmed RDX contamination at the Remagen Hand Grenade Range and downgradient migration of groundwater on the Installation to the north. Four of the five vertical aquifer profile groundwater sampling events at the Remagen Hand Grenade Range produced one or more groundwater samples containing RDX at concentrations exceeding the RSL of 0.97 µg/L (ranging from 1.0 J µg/L to 9.5 µg/L). All three shallow monitoring wells located downgradient (north) of the Remagen Hand Grenade Range and within the active operational training area also had groundwater RDX detections exceeding the RSL (concentrations ranging from 1.4 µg/L to 2.6 µg/L). RDX was also detected in REM-MW-03S located upgradient (at 12 µg/L). RDX was detected at depths varying from 60 to 120 feet below ground surface. Note that current use of RDX is ongoing at the Remagen Hand Grenade Range as part of basic training and mission readiness operations. The area is being treated with hydrated lime periodically in accordance with accepted Best Management Practices for demolition ranges to help break down RDX and prevent migration to groundwater (PIKA-Pirnie JV 2016).

BASIS FOR THE ESTABLISHMENT OF REMEDIAL ACTION OBJECTIVES

A statutory goal of the Defense Environmental Restoration Program (DERP) is for the Army to take appropriate Response Actions to investigate and, where necessary, address releases of hazardous substances or pollutants and contaminants that create an imminent and substantial danger to the public health or welfare, or to the environment. The Army is required to select remedies that attain a degree of cleanup that assures protection of human health and the environment.

It is the Army's current judgment that the Preferred RA identified in this Proposed Plan, or one of the other measures considered in the Proposed Plan, with the exception of Alternative 1, will continue to provide protection to human health and the environment from actual or threatened releases of hazardous substances into the environment.

REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives (RAOs) are based on human health and environmental factors, which are considered in the formulation and development of RAs. Such objectives are developed based on the criteria outlined in Section 300.430(e)(2) of the NCP and in Section 121 of SARA. Where there are no Applicable or Relevant and Appropriate Requirements (ARARs) that address a particular release at a CERCLA site, "information to be considered" (TBC) can be useful to develop remedies, although their use is discretionary rather than mandatory. TBCs are guidelines or advisories that are issued by the federal or state agencies and are neither legally binding nor promulgated (USEPA, 1990). However, these guidelines may be used to ensure protection of public health and the environment (USEPA, 1990).

Two chemical specific TBCs were identified for RDX contaminated groundwater as follows:

- *USEPA HAL*. USEPA HALs provide information on contaminants that can cause human health effects and are known or anticipated to occur in drinking water. The USEPA HALs are non-enforceable and provide technical guidance to state agencies and other public health officials on health effects, analytical methodologies, and treatment technologies associated with unregulated drinking water contaminants. The HAL for RDX in drinking water is 2 µg/L, assuming a 70-kilogram (154-pound) adult who drinks 2 liters per day (USEPA, 2018b).

WHAT IS RISK AND HOW IS IT CALCULATED?

A Superfund baseline human health risk assessment is an analysis of the potential adverse health effects caused by hazardous substance releases from a site in the absence of any actions to control or mitigate these under current- and future-land uses. A four-step process is utilized for assessing site-related human health risks for reasonable maximum exposure scenarios.

Hazard Identification: In this step, the contaminants of concern at the site in various media (i.e., soil, groundwater, surface water, and air) are identified based on such factors as toxicity, frequency of occurrence, and fate and transport of the contaminants in the environment, concentrations of the contaminants in specific media, mobility, persistence, and bioaccumulation.

Exposure Assessment: In this step, the different exposure pathways through which people might be exposed to the contaminants identified in the previous step are evaluated. Examples of exposure pathways include incidental ingestion of and dermal contact with contaminated soil. Factors relating to the exposure assessment include, but are not limited to, the concentrations that people might be exposed to and the potential frequency and duration of exposure. Using these factors, a reasonable maximum exposure scenario, which portrays the highest level of human exposure that could reasonably be expected to occur, is calculated.

Toxicity Assessment: In this step, the types of adverse health effects associated with chemical exposures, and the relationship between magnitude of exposure (dose) and severity of adverse effects (response) are determined. Potential health effects are chemical-specific and may include the risk of developing cancer over a lifetime or other non-cancer health effects, such as changes in the normal functions of organs within the body (e.g., changes in the effectiveness of the immune system). Some chemicals are capable of causing both cancer and non-cancer health effects.

Risk Characterization: This step summarizes and combines exposure information and toxicity assessments to provide a quantitative assessment of site risks. Exposures are evaluated based on the potential risk of developing cancer and the potential for non-cancer health hazards. The likelihood of an individual developing cancer is expressed as a probability. For example, a 10^{-4} cancer risk means a one-in-ten-thousand excess cancer risk; or one additional cancer may be seen in a population of 10,000 people as a result of exposure to site contaminants under the conditions explained in the Exposure Assessment. Current Superfund guidelines for acceptable exposures are an individual lifetime excess cancer risk in the range of 10^{-4} to 10^{-6} (corresponding to a one-in-ten-thousand to a one-in-a-million excess cancer risk). For non-cancer health effects, a hazard index (HI) is calculated. A HI represents the sum of the individual exposure levels compared to their corresponding reference doses. The key concept for a non-cancer HI is that a threshold level (measured as a HI of less than 1) exists below which non-cancer health effects are not expected.

- *USEPA RSL*. USEPA RSLs are generic screening levels developed using risk assessment guidance from the USEPA Superfund Program. RSLs are considered to be protective of humans for a lifetime, but do not address non-human health endpoints and are calculated without site-specific information. The Tapwater RSL published by USEPA for RDX is 0.97 µg/L (USEPA, 2021a). For off-post residential wells with groundwater containing RDX, this PP uses the HAL as both the exposure limit and level down to which groundwater is monitored. The RSL was used as a screening level during the RI and is currently used as a trigger to increase residential well sampling frequency to semi-annual in order to monitor wells more closely near the HAL.

- The risk assessment conducted during the RI evaluated potential exposure of residents to explosives in groundwater in the Southern ORA Area when used as a potable water supply. The calculated lifetime cancer risk of 3×10^{-6} was greater than the 1×10^{-6} South Carolina Department of Health and Environmental Control (SCDHEC) benchmark and the target risk level used by USEPA Region 4 (2018a) to identify constituents for further evaluation and potential remediation. RDX was the only COPC and, therefore, represents 100 percent of the excess lifetime cancer risk estimate. Given the existing potable use exposure pathway, RDX is considered a constituent of concern for remedial measures.

- Remedial Goal Options (RGOs) consist of the TBCs identified previously. The USEPA HAL of 2.0 µg/L (USEPA, 2018b) and the USEPA Tapwater RSL of 0.97 µg/L (USEPA, 2021a) are considered potential RGOs. To be protective of exposure to multiple chemicals, risk-based RGOs are developed to be protective at target cancer risk levels between 10^{-6} and 10^{-4}; and noncarcinogens are grouped by critical effect (e.g., liver toxicity). Since RDX is the only COC, the RGOs could theoretically be set at the lower target risk-level at 10^{-4} or the target noncancer hazard quotient of 1. These values, based on current toxicity values, would be sufficiently protective under the NCP. The potential risk based RGOs for RDX are shown in **Table 1** below.

Table 1: Evaluation of Human Health Risk-Based Remedial Goal Options for RDX

USEPA Cancer-Based Tapwater RSL (TCR=1×10^{-6})	USEPA Cancer-Based Tapwater RSL (TCR=1×10^{-5})	USEPA Cancer-Based Tapwater RSL (TCR=1×10^{-4})	USEPA Noncancer-Based Tapwater RSL (THQ=1)	USEPA HAL
0.97 µg/L	9.7 µg/L	97 µg/L	80 µg/L	2 µg/L

Notes: TCR=Target cancer risk; THQ= target hazard quotient

- The USEPA's Office of Water publishes concentrations of drinking water contaminants at a target cancer risk of 10^{-4} and concentrations of drinking water contaminants at which noncancer related adverse health effects are not anticipated to occur over specific exposure durations - One-day, Ten-day, and Lifetime - in the *Drinking Water Standards and Health Advisories* tables (USEPA, 2018b). The 2012 tables were updated and published in March 2018 to fix typographical errors and to add health advisories published after 2012. In August 2018, USEPA released the Final Toxicological Review of RDX (USEPA, 2018c). The Final Toxicological Review indicates RDX is almost three times less potent of a carcinogen than previously thought.

- While risk-based concentrations at a target cancer risk of 1×10^{-4} (97 µg/L) or target noncancer hazard of 1 (80 µg/L) could defensibly be used as RGOs, the Army is selecting the more conservative HAL of 2 µg/L as the remedial goal to be consistent with interim remedial measures taken to date and to be conservatively protective. In addition, the Army will continue to monitor RDX concentrations in residential wells to the preliminary remedial goal (i.e., USEPA HAL) of 2.0 µg/L.
- The RAOs were developed based on the criteria outlined in Section 300.430(e)(2) of the NCP (USEPA, 1990) with the objective to protect human health. Based on the RGOs presented above, the RAOs for this PP are as follows:

- *Primary RAO* – To prevent contact with and ingestion of groundwater with RDX concentrations exceeding the HAL of 2.0 µg/L. The exposure area containing average RDX concentrations above the exposure limit of 2.0 µg/L includes nine individual private drinking water wells and one public water system at the 13 affected residences located within the Focused Area downgradient of Kasserine Pass Range.
- *Secondary RAO* – To monitor RDX concentrations in residential wells to the preliminary remedial goal of 2.0 µg/L.

- The overall remedial action goal for this project is to achieve the RAOs in the most effective, implementable, and cost-effective manner.

SUMMARY OF RESPONSE ACTIONS

The Southern ORA Area has undergone an RI and FS in accordance with the CERCLA process. Response Actions for groundwater at the site were developed and evaluated in the FS (PIKA-Arcadis, 2021).

The types of remedial measures considered for the Southern ORA Area included:

- No action;
- Land Use Controls (LUC);
- Long-Term Monitoring (LTM);
- Point-of-use treatment systems;
- Connection to city water; and,
- DGR.

These measures were then further refined into the four RAs listed below with their respective estimated ***Capital Cost***, estimated cost for ***Operations and Maintenance*** **(O&M)** activities, and an estimate of the ***Present Worth Cost*** for the RA. Alternative 4: DGR with Operation of Point of Use Treatment Systems and Monitoring is the Preferred RA in this PP.

<u>Alternative 1:</u> No Further Action

Estimated Capital Cost: $45,460
Estimated O&M Cost Over 30 Years: $0
Estimated Present Worth Cost: $45,460

As previously noted, CERCLA and the NCP require that a No Further Action alternative be evaluated at every site to establish a baseline for the comparison of other RAs. Under this alternative, no remedial action would take place.

<u>Alternative 2:</u> Operation of Point of Use Treatment Systems and Monitoring

Estimated Capital Cost: $0
Estimated Annual O&M Cost (30 Years): $334,475
Estimated Present Worth Cost: $8,305,780

(Estimated present worth was calculated using a 1.5% discount rate).

Alternative 2 would continue the current O&M of the ten interim remedial measure point of use treatment systems installed at the nine private drinking water wells and one public water system. These point of use treatment systems mitigate human health exposure to RDX in groundwater. The treated water from these systems is being used for non-potable and potable purposes. The O&M monitoring program is designed for 30 years and includes quarterly sampling in the first year followed by semiannual sampling for the remaining 29 years. Field parameters, including pH, are collected and documented for each sample. Samples are sent for laboratory analysis by the following USEPA methods: explosives (Method 8330A), metals (Methods 200.7 and 200.8), alkalinity (Method SM 2320B-2011), hardness (Method SM 2340C-2011), turbidity (Method 180.1), specific conductance (Method SM 2510B-2011), total coliform (Method SM 9223B-2004), and fecal coliform (Method SM 9222D-2006).

This Alternative would also sample up to 20 groundwater monitoring wells including MW-OP-03, MW-OP-02, MW-OP-01S/D, MW-OP-04, MW-OP-05S/D, MW-07S/D, MW-08S/D, MW-09S/D, MW-10S/D, MW-11S/D, MW-KP-16, MW-KP-17, MW-KP-18.

This Alternative would also continue the annual / semiannual off-post residential well sampling program for private drinking water wells and public water systems in the Focused Area to monitor downgradient RDX groundwater contamination from Kasserine Pass Range. The groundwater monitoring program includes the annual sampling of approximately 75 wells (additional wells may be added if warranted). The program also includes semiannual sampling of approximately three wells where

RDX concentrations exceed the RSL but are less than the Lifetime HAL. All annual and semiannual groundwater samples are analyzed for explosives via USEPA Method 8330A.

Annual notification letters will be sent to off-post residents and property owners within the area impacted by RDX concentrations greater than the RSL of 0.97 µg/L for as long as groundwater in the plume is above the preliminary remedial goal of 2.0 µg/L. Annual notification letters will notify property owners and residents of the RDX in groundwater, request permission to monitor existing potable wells, and request notification to the Army of any new wells. When the remedial goal is met, notifications will be terminated. Annual well surveys in the area over the RDX RSL will be conducted to identify any new wells.

LUCs for on-post portions of the Site will be applicable to the installations planning process.

<u>Alternative 3:</u> Connect 13 Affected Residences to the City Water Supply and Monitoring

Estimated Capital Cost: $2,376,455
Estimated Annual O&M Cost (30 years): $113,947
Estimated Present Worth Cost: $5,112,993

(Estimated present worth was calculated using a 1.5% discount rate).

Alternative 3 includes the installation of water mains in the residential neighborhood south of Fort Jackson to give residences currently using private drinking water wells and public water systems along Davis Road and Old Leesburg Road the ability to connect to the City of Columbia water supply. Fort Jackson will be responsible for connecting the 13 affected residences with RDX detections above the HAL to the City water supply. All other residences, including those with RDX detections below the HAL will have the option to connect to the City water supply at their expense. Connecting the 13 affected residences to the City water supply will require the following steps:

1. Install 10,500 feet (approximately 2 miles) of water main line along the right-of-way from the nearest tie-in point of the existing 10- x 6-inch City of Columbia water main (located more than 1 mile from the study area on Old Leesburg Road), along Old Leesburg Road to Davis Road, and then north on Davis Road to the northern-most point of use treatment system.
2. The City of Columbia will tap the newly installed water main line and run individual service lines from the tap to the property line of each of the 13 affected residences with a point of use treatment system. A water meter will be installed at the end of each service line for each residence.
3. A contractor will install a ¾-inch distribution line from the meter to the home's existing plumbing system to complete the connection to the City water supply.
4. Prior to establishing full connection to the City water supply, a contractor will flush all pipes within each residence with chlorine. Flushing the line with chlorine is a precautionary measure required to ensure any existing water within the residential pipes cannot backflow into the City's water supply, in accordance with International Plumbing Code 610.1 (International Code Council, 2017).
5. A contractor will install a dual-check valve or backflow preventer as a secondary precaution to prevent backflow from the residential lines to the City's water supply.
6. The point of use treatment systems will be removed from the treatment sheds; however, the treatment sheds will be left in place.
7. The private groundwater supply wells will be plugged and abandoned at the discretion of the owner, in accordance with SCDHEC R.61-71, Well Standards (SCDHEC, 2016). Property owners will be responsible for the abandonment.

In addition to connecting the affected residences to the City of Columbia water supply, the current annual/semi-annual off-post residential well sampling program, annual sampling of groundwater monitoring wells, on-post LUCs, and off-post annual notification letters and well surveys will continue as described in Alternative 2. Monitoring will continue for 30 years.

Currently unaffected wells may become impacted in the future. If this condition is detected during the residential well sampling, these residences will be connected to the City water supply. These costs are not considered due to being unable to accurately quantify that potential.

<u>Alternative 4:</u> DGR with Operation of Point of Use Treatment Systems and Monitoring

Estimated Capital Cost: $4,568,895
Estimated Annual O&M Cost (10 Years): $681,064
Estimated Abandonment Cost After 10 Years: $18,710
Estimated Present Worth Cost: $11,011,444

(Estimated present worth was calculated using a 1.4% discount rate for a 10-year period).

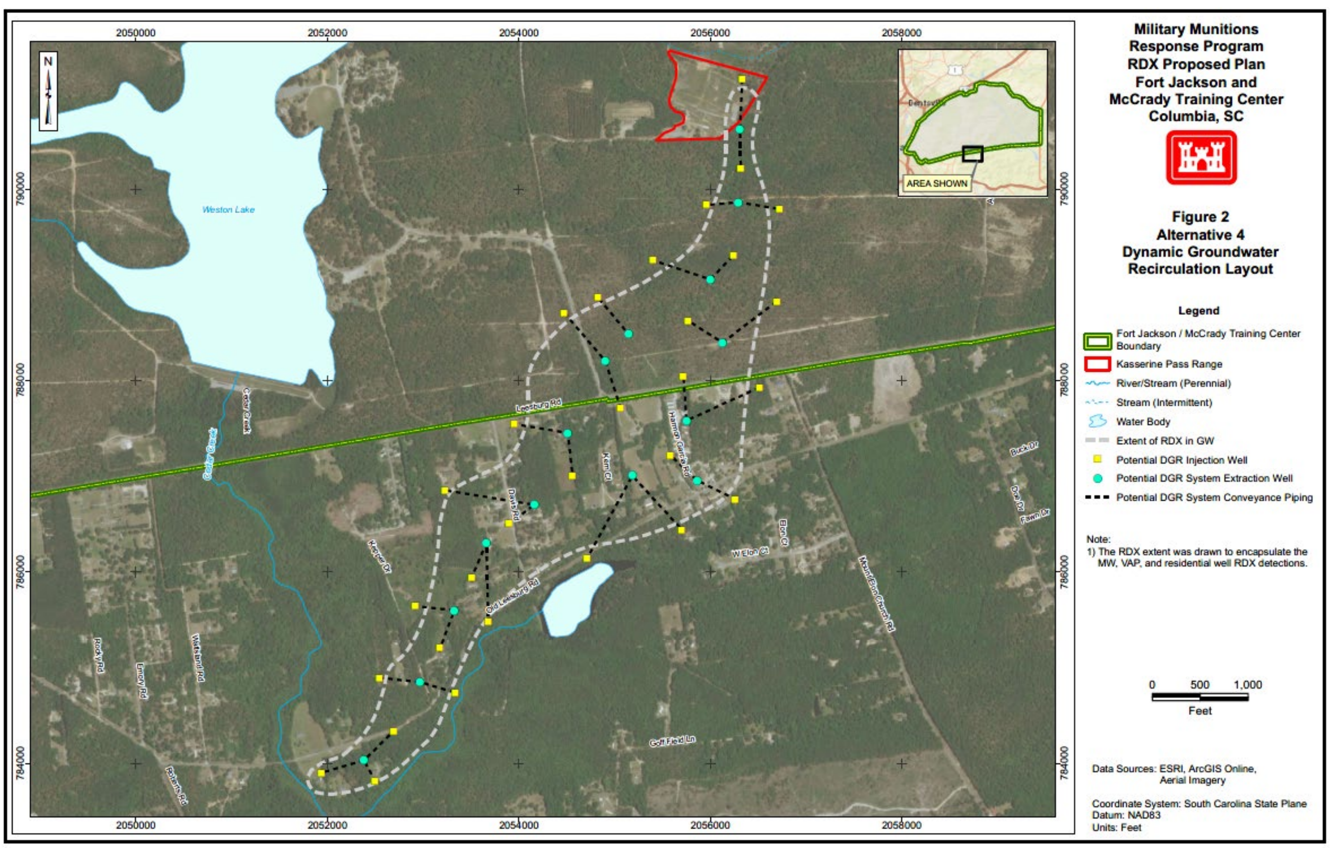
Alternative 4 uses the DGR remediation technique to treat the groundwater throughout the RDX plume on and off post. During the operation of the DGR system, the current O&M sampling of interim remedial measure point of use treatment systems will continue. DGR is a remedial approach that focuses on increasing groundwater movement through an aquifer. The outcome is controlled pore flushing to achieve remedial goals at an accelerated pace. A key design element includes the strategic placement of injection and extraction wells based on the distribution of contaminants and the site geology. The dynamic nature of this technology incorporates variations in pumping and injection to enhance flushing the plume from the aquifer or the uniform delivery of reagents to address contaminants in situ. The result is faster cleanup compared with traditional pump and treat systems.

The preliminary DGR design for the remediation of the RDX plume associated with the Kasserine Pass Range was assessed by estimating the volume of impacted groundwater (684 million gallons) and determining the number of pore flushes (1.1) necessary to reduce the average RDX plume concentrations to less than the preliminary remedial goal of 2.0 µg/L. For the initial assessment, the targeted closure period was defined as 10 years with estimated individual sustainable extraction rates of 10 to 15 gallons per minute (gpm) and sustainable injection rates of 5 gpm. Based on these criteria and the initial plume distribution, the DGR design to achieve remedial goals will require 15 extraction wells and 30 injection wells operating at a total rate of 150 gpm for 10 years. Limited sustainable injection and extraction rate data are available within the plume and will need to be further investigated prior to finalization of a full scale DGR design. For purposes of this remedial alternative, costs for full scale design include those associated with pilot testing at several locations throughout the plume.

The general approach of well placement for DGR is to focus the extraction wells toward the central higher concentration portion of the plume to maximize the mass flux removal and to place the injection wells to hydraulically contain the plume to prevent plume spreading, enhance pore flushing, and alleviate potential hydraulic stagnation points that may develop between wells. A conceptual layout of the proposed DGR well network is shown on **Figure 2**. The 15 extraction wells are located along the main axis of the RDX plume with a staggered pattern toward the central wider portion of the RDX plume. The 30 injection wells were placed along the perimeter of the plume and between the proposed extraction wells within the footprint of the plume. This conceptual layout is intended to show the relative scale and distribution of the proposed DGR network but is flexible to allow for further refinement based on land access and refinement of hydraulic parameters obtained from pilot study data.

Each injection well location will require a groundwater conveyance piping network and pre-injection treatment system to include filtration and ultraviolet (UV) treatment. Each groundwater injection carbon treatment system will treat extracted groundwater and inject into approximately 2 injection wells. Fifteen standalone injection treatment systems will be located strategically around the plume.

Prior to full scale DGR system design, a pilot study will be implemented to determine the efficacy of remediation using site specific conditions. The pilot study will determine if a full scale DGR strategy is appropriate for observed site conditions by collecting groundwater yield, injectability, and radius of influence data. If the remediation strategy is effective using site specific conditions, the data will be used in an optimized system design.



Implementation of a plume wide DGR Strategy will include the following steps:

1. Submit a full-scale design document using pilot study results, detailing the system design O&M schedule for operation over 10 years.
2. Install 30 injection wells and 15 extraction wells throughout the plume.
3. Construct the DGR treatment infrastructure using approximately 15 separate small-scale treatment systems co located at system extraction wells where groundwater will be treated through filtration and UV treatment prior to reinjection. Each DGR system will consist of down-well pumps for extraction, ex-situ treatment through filtration, and reinjection using an above grade injection pump.
4. Install approximately 13,000 linear feet of distribution piping within trenches.
5. Install approximately 9,000 linear feet of overhead power supply lines and meter drops at each pumping site.
6. O&M of the DGR system for 10 years.
7. The DGR system will be removed after the 10-year implementation period pending the efficacy of the system and monitoring results.
8. O&M of the existing point of use treatment systems.
9. Quarterly sampling throughout the operation of the DGR system for injection wells, and quarterly sampling of the potable water systems in Year 1 to 5 followed by semi-annual sampling in subsequent years.
10. Sampling of groundwater monitoring wells as described in Alternative 2; however, the sampling frequency will be increased to monitor remedial progress more closely. Instead of annually, the 20 monitoring wells will be sampled quarterly for the first year then semi-annually for the remaining years.
11. Continue ongoing off-post residential well monitoring program for private drinking water wells and public water systems, on-post LUCs, and off-post annual notification letters and well surveys as described in Alternative 2.

EVALUATION OF RESPONSE ACTIONS

Nine criteria are used to evaluate the different Response Actions individually and against one another in order to select a remedy. These criteria are as follows:

Threshold Criteria – Must be met for the RA to be eligible for selection as a remedial option.

1. Overall Protectiveness of Human Health and the Environment – Determines whether a RA eliminates, reduces, or controls threats to public health and the environment through institutional controls, engineering controls, or treatment.
2. Compliance with ARARs – Evaluates whether the RA meets Federal and State environmental statutes, regulations, and other requirements that pertain to the site, or whether a waiver is justified. Identification of ARARs is dependent on the hazardous substances present at the site, site characteristics, the site location, and the actions recommended to remediate the site. Thus, requirements may be chemical-, location-, or action-specific. Please refer to Section 3.1 of the FS (PIKA-Pirnie JV, LLC, 2021) for a more detailed discussion of ARARs.

Primary Balancing Criteria – Used to Weigh Major Trade-offs Among Response Actions

3. Long-term Effectiveness and Permanence – Considers the ability of a RA to maintain protection of human health and the environment over time.
4. Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment – Evaluates a RA's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.
5. Short-term Effectiveness – Considers the length of time needed to implement a RA and the risks the RA poses to workers, residents, and the environment during implementation.
6. Implementability – Considers the technical and administrative feasibility of implementing the RA, including factors such as the relative availability of goods and services.
7. Cost – Includes estimated capital and annual O&M costs, as well as present worth cost. Present worth cost is the total cost of a RA over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of –30 to +50 percent.

Modifying Criteria – May be considered to the extent that information is available during the FS, but it can be fully considered only after public comment on this Proposed Plan.

8. State/Support Agency Acceptance – Considers whether the State agrees with the Army's analysis and recommendations, as described in the RI/FS and PP.
9. Community Acceptance – Considers whether the local community agrees with the Army's analysis and Preferred RA. Comments received on the PP are an important indicator of community acceptance.

A detailed evaluation of RAs compared to threshold and primary balancing criteria is presented in the FS. A summary of cost for each RA is presented in **Table 2** below**.**

Table 2: Cost Comparison of Alternatives

Remedial Alternative	Estimated Capital Cost	Annual O&M Cost	Present Worth
1	$45,460	$0	$45,460
2	$0	$334,475	$8,305,780
3	$2,376,445	$113,947	$5,112,993
4	$4,568,895	$681,064	$11,011,444

COMPARATIVE ANALYSIS OF RESPONSE ACTIONS

This section summarizes the comparative analysis of RAs for the Focused Area presented in the FS.

Protection of Human Health and the Environment

Alternative 1 does not provide controls for monitoring the reduction of RDX concentrations through time, reducing exposure, or long-term management. Alternative 2 mitigates the human health exposure to RDX through continued operation and semiannual O&M sampling of groundwater point of use treatment systems serving 13 affected residences. Alternative 3 will not eliminate or reduce the volume of potentially contaminated media at the affected residences, but it will eliminate the potential exposure pathways for current or potential future human receptors to RDX and any other potentially detected explosives at these residences. Alternative 4 will reduce the volume of potentially contaminated media throughout the plume. It will eliminate the potential exposure pathways for current or potential future human receptors to RDX and any other potentially detected explosives.

Compliance with ARARs

Alternative 1 is not compliant with ARARs. Alternatives 2, 3, and 4 all comply with ARARs.

Long-Term Effectiveness

Under Alternative 1, no action will be taken to mitigate or eliminate human exposure to RDX in groundwater. Because the actions taken under Alternative 1 will be to discontinue point of use treatment system operations, O&M sampling of these treatment systems, and the groundwater monitoring program, this alternative will not reduce the toxicity, mobility, or volume of RDX in groundwater through treatment and will not provide long- or short-term effectiveness.

Alternative 2 provides a moderate level of long-term effectiveness and permanence, as it will mitigate the potential human exposure pathways for current or potential future receptors to RDX in groundwater.

Alternative 3 is an effective method for removing access and restricting potential pathways for human receptors that may be exposed to the contamination at the affected residences. This alternative is effective in the long term because access to RDX in groundwater will be permanently removed if the wells are abandoned.

Alternative 4 is effective in the long term because RDX in groundwater will be reduced down to or below the preliminary remedial goal.

Reduction in Toxicity, Mobility, or Volume through Treatment

Because the actions taken under Alternative 1 will be to discontinue point of use treatment system operations, O&M sampling of these treatment systems, and the groundwater monitoring program, this alternative will not reduce the toxicity, mobility, or volume of RDX in groundwater through treatment.

Alternative 2 mitigates but does not eliminate human exposure pathways to RDX in groundwater, as it provides no treatment of RDX in the groundwater. This alternative will not reduce the toxicity, mobility, or volume of RDX in groundwater beneath the affected properties through treatment.

Alternative 3 is a permanent solution and eliminates exposure pathways to the contamination for human receptors; however, it does not eliminate or reduce the toxicity, mobility, or volume of RDX in groundwater through treatment.

Alternative 4 is effective within a medium duration of approximately 10 years as this alternative will use treatment to reduce RDX to below drinking water standards and HALs. This alternative will reduce and ultimately eliminate the volume of RDX in groundwater above the preliminary remedial goal beneath the affected properties through treatment.

Short-term Effectiveness

Because the actions taken under Alternative 1 will be to discontinue point of use treatment system operations, O&M sampling of these treatment systems, and the groundwater monitoring program, this alternative will not reduce the toxicity, mobility, or volume of RDX in groundwater through treatment and will not provide short-term effectiveness.

Alternative 2 will have good short-term effectiveness and will mitigate the potential human exposure pathways for current or potential future receptors to RDX in groundwater.

In Alternative 3, access to RDX-contaminated groundwater, which drives the health hazard, will be removed from each affected residence. By removing access to groundwater with RDX, the future human exposure pathway will be eliminated. This alternative will pose some short-term risks to the community and site workers during the construction required to connect the affected residences to the City of Columbia water supply and during well removal. Well removal is the responsibility of the homeowner. Short-term risks will likely be attributed to typical safety hazards associated with construction.

The potential exposure and safety hazards during construction will be reduced by using personal protective clothing and equipment as well as implementing safe construction practices.

Alternative 4 allows for an accelerated remedial timeframe by focusing on pore flushing through the plume. DGR creates hydraulic gradients and groundwater flow through an aquifer, enabling remediation of the more mobile and less mobile pore fractions of the aquifer to remove groundwater contaminant mass more rapidly. This alternative will pose some short-term risks to the community and site workers during the construction of the remediation system and during well removal. Short-term risks will likely be attributed to typical safety hazards associated with construction. The potential exposure and safety hazards during construction will be reduced by using personal protective clothing and equipment as well as implementing safe construction practices.

Implementability

Alternative 1 will not be implementable, because community, regulatory, and governmental acceptance would not be obtainable. Alternative 2 does not require implementation, because the point of use treatment systems, O&M sampling, and residential well sampling program are in place and operating currently. Alternative 3 will be implemented within a moderately reasonable time frame due to the number of steps involved in this remedial alternative. The DGR remedial strategy in Alternative 4 is applicable to a wide range of hydrogeologic settings and has been successfully applied to numerous sites. Alternative 4 will be implemented within a moderately reasonable time frame due to the number of steps involved in this remedial alternative.

Cost

Alternative 1 is the least costly and least effective option with a capital cost of $45,460. Alternative 2 has no initial startup cost due to currently being utilized at the Site, with an annual operation cost of $334,475 and an abandonment cost of $8,660. The Alternative 3 capital cost is $2,376,445, with annual operating costs of $113,947. Alternative 4 has the most expensive capital and annual operating costs of $4,568,895 and $681,064, respectively. There is also an $18,710 abandonment cost.

State Acceptance

Based upon concerns about getting all the affected residents to agree to the City water connection and its lack of reduction in Toxicity, Mobility, or Volume, Alternative 3 was determined not to be a viable Alternative. Due to these community and groundwater remediation concerns, Alternative 4 – DGR with Operation of Point of Use Treatment Systems and Monitoring was selected as the Preferred RA. State acceptance will be further evaluated in the ROD following the public comment period.

Community Acceptance

Community acceptance of the Preferred RA will be evaluated at the conclusion of the public comment period. Community acceptance will be addressed in the ***Responsiveness Summary*** prepared for the ROD.

PREFERRED RESPONSE ACTION FOR SOUTHERN ORA AREA

The Preferred RA was selected based on the best balance between the selection criteria for treatment of impacts at the Southern ORA Area Site. The Preferred RA is:

- Alternative 4 (DGR with Operation of Point of Use Treatment Systems and Monitoring) for groundwater that exceeds RDX HAL for the Southern ORA Area plume.

Alternative 4 has an advantage over Alternative 3 as the DGR remedy allows for an accelerated remedial timeframe by focusing on pore flushing through the plume. Alternative 4 is effective in the long term because RDX in groundwater will be removed down to the preliminary remedial goal, whereas Alternative 3 does not physically treat the groundwater and instead focuses on removal of access to the contaminated groundwater plume.

Alternative 4 meets threshold criteria by providing protectiveness of human health and the environment in a reasonable timeframe (within 10 years total active treatment) and meeting ARARs. Primary balancing criteria are met with the RA providing both long term and short-term effectiveness; it reduces toxicity through in-situ treatment, is readily implementable and cost effective.

It should be noted that the RAs recommended can be changed in light of new information or in response to public comment. Public comment will be received through the activities discussed in the next section.

Based on information currently available; the lead agency believes the Preferred RA meets the threshold criteria and provides the best balance of tradeoffs among the other RAs with respect to the balancing and modifying the criteria. The Army expects the Preferred RA to satisfy the following statutory requirements of CERCLA 121(b): 1) be protective of human health and the environment; 2) comply with ARARs; 3) be cost-effective; 4) utilize permanent solutions and alternative treatment technologies to the maximum extent practicable; and 5) satisfy the preference for treatment as a principal element.

RESILIENCE AND SUSTAINABILITY

Green and sustainable remediation was considered in accordance with the DERP Manual Section 6d (DoD, 2018a) and consistent with the NCP, 40 C.F.R. §300.430(e)(9)(iii)(C), (E), (G), and (I). As described above, the preferred response action for this site is DGR with Operation of Point of Use Treatment Systems and Monitoring. This remedy offered a solution that sustainably met the project needs as it protects water resources by returning extracted water to the aquifer, reduces energy use over the remedy life cycle as the hydraulic influence and destruction of mass leads to a shorter operation period compared to traditional pump and treat, and it reduces emissions through selection of a low maintenance approach that requires fewer O&M events and reduces the lifecycle resulting in fewer monitoring events. Additionally, by decentralizing the treatment, the remedy is able to more seamlessly imbed into the off-post community and will be adaptable in the future as the plume changes with treatment.

Sustainability management can be further considered and incorporated during remedy implementation through the consideration of sustainable best management practices (SBMPs) as described by USEPA guidance (USEPA, 2016 and USEPA, 2021b). Some examples of applicable SBMPs that may be considered and incorporated as applicable include the following:

- Using regenerated carbon for water treatment
- Regeneration of spent carbon instead of disposal
- Use of UV lights in the system to reduce the amount of total carbon required over the life of the system.
- Remote telemetry to reduce the number of visits to the system.
- Use of local staff for O&M activities and system installation
- Use of renewable energy
- Use of used equipment and mobile equipment structures and existing infrastructure

Resilience to extreme weather and changing climate conditions was also considered in accordance with Executive Order 14008 (Executive Order, 2021) and DoD Directive 4715.21 (DoD, 2018b). As with sustainability, SBMPs with an impact on the resilience of the remedy will be considered as part of implementation planning. Many of the measures that increase the sustainability of a remedy also make it more resilient, such as remote telemetry which allows for the safe shutdown of a system when a site cannot be reached, and renewable energy (i.e., solar panels) which reduces reliance of electrical grid in the event of a power outage (USEPA, 2019). Integrating resilience with sustainability planning and management is expected to minimize conflicts and maximize synergies when compared with separate implementation strategies.

COMMUNITY PARTICIPATION

Public participation is an important component of remedy selection. The Army is soliciting input from the community on the Preferred RA. This period includes a public meeting at which the Army will present the PP. The Army will accept both **oral and written** comments at this meeting.

Public Comment Period

The Army is providing a 30-day comment period from **May 8, 2023** to **June 7, 2023**, to provide an opportunity for public involvement in the decision-making process for the Preferred RA. If any significant new information or public comments are received during the public comment period, the Army, in consultation with SCDHEC, may modify the Preferred RA outlined in this Proposed Plan or select another RA. The public is encouraged, therefore, to review and comment on this Proposed Plan. During the public comment period, the public is encouraged to review the following documents pertinent to this site and the Superfund process:

- Military Munitions Response Program RDX Remedial Investigation, Fort Jackson, Columbia, South Carolina (PIKA-Pirnie JV, 2020)
- Military Munitions Response Program RDX Feasibility Study, Fort Jackson, Columbia, South Carolina (PIKA-Pirnie JV, 2021).
- This information is available at the Fort Jackson Environmental Division, located at 2563 Essayons Way, Fort Jackson, South Carolina. To obtain further information, the following representative may be contacted:

Ms. Barbara Williams
Chief, Environmental Division
Directorate of Public Works
2562 Essayons Way
Fort Jackson, SC 29207
(803) 751-6858

Written Comments

If the public would like to comment in writing on the PP or other relevant issues, comments should be delivered to the Army at the public meeting or mailed (postmarked no later than **June 7, 2023**) to the address above.

Public Meeting

The Army will hold a public meeting on this Proposed Plan on **May 11, 2023** at **5:30 p.m.,** at the **Weston Lake Community House, Hopkins, SC** to accept comments. This meeting will provide an opportunity for the public to comment on the Preferred RA. Comments made at the meeting will be transcribed. A copy of the transcript will be included in the ROD Responsiveness Summary and will be added to the Fort Jackson Administrative Record file.

Army's Review of Public Comments

The Army will review the public's comments as part of the process in reaching a final decision on the most appropriate RA to be taken. The Army's final choice of RA will be issued in a ROD. A Responsiveness Summary, documenting and responding to written and oral comments received from the public, will be issued with the ROD. Once community response and input are received and the Army signs the ROD, it will become part of the Administrative Record.

ACRONYMS AND ABBREVIATIONS

µg/L .... Micrograms per Liter
ARARs........................... Applicable or Relevant and Appropriate Requirements
Army .... United States Department of the Army
CERCLA .... Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COPC .... Compound of Potential Concern
CSM............................... Conceptual Site Model
DERP .... Defense Environmental Restoration Program
DGR............................... Dynamic Groundwater Recirculation
FS .... Feasibility Study
gpm................................ Gallons per minute
HAL................................ Health Advisory Level
HHRA .... Human Health Risk Assessment
HI .... Hazard Index
HMX............................... 1,3,5,7-tetranitro-1,3,5,7-tetrazocine, also known as High Melting Explosive
ITRC .... Interstate Technology and Regulatory Council LTM Long-Term Monitoring
LUC .... Land Use Control
NCP .... National Oil and Hazardous Substances Pollution Contingency Plan
O&M .... Operation and Maintenance
ORA............................... Operational Range Assessment
PP .... Proposed Plan
RA.................................. Response Action
RAO............................... Remedial Action Objective
RDX .... 1,3,5-trinitro-1,3,5-triazinane, also known as Royal Demolition Explosive and Research Department Explosive
RI .... Remedial Investigation
ROD............................... Record of Decision
RGOs .... Remedial Goal Options
RSL................................ Regional Screening Level
SARA............................. Superfund Amendments and Reauthorization Act of 1986
SBMP .... sustainable best management practices
SCARNG .... South Carolina Army National Guard
SCDHEC .... South Carolina Department of Health and Environmental Control
Southern ORA Area ...... United States Army Garrison Fort Jackson’s Southern Operational Range Assessment Area
TBC .... To-Be-Considered
TCR .... Target Cancer Risk
THQ .... Target Hazard Quotient
TNT................................ Trinitrotoluene
U.S................................. United States
USACE .... United States Army Corps of Engineers
USEPA .... United States Environmental Protection Agency
UV.................................. Ultraviolet
USGS .... United States Geological Survey

GLOSSARY OF TERMS

Administrative Record: This is a collection of documents (including plans, correspondence and reports) generated during site investigation and remedial activities. Information in the Administrative Record is used to select the Preferred Response Action and is available for public review.

Applicable or Relevant and Appropriate Requirements (ARARs): The federal and State requirements that a selected remedy will attain. These requirements may vary among sites and RAs.

Capital Costs: This includes costs associated with construction, treatment equipment, site preparation, services, transportation, disposal, health and safety, installation and start-up, administration, legal support, engineering, and design associated with Response Actions.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): This federal law was passed in 1980 and is commonly referred to as the Superfund Program. It provides for liability, compensation, cleanup, and emergency response in connection with the cleanup of inactive hazardous waste disposal sites that endanger public health and safety or the environment.

Feasibility Study: This CERCLA document reviews the chemicals of concern at a site, and evaluates multiple remedial technologies for use at the site. It finally identifies the most feasible Response Actions.

Focused Area: The area located south of Fort Jackson's Southern ORA Area and east of Weston Lake, including the nine individual private drinking water wells and one public water system at the 13 affected residences.

National Contingency Plan (NCP): The National Oil and Hazardous Substances Pollution Contingency Plan. These CERCLA regulations provide the federal government the authority to respond to the problems of abandoned or uncontrolled hazardous waste disposal sites as well as to certain incidents involving hazardous wastes (e.g., spills).

Operation and Maintenance (O&M): Annual post-construction cost necessary to ensure the continued effectiveness of a Response Action.

Point of Use Treatment Systems: a treatment device installed to treat the water entering a house or building for the purpose of treating water distributed throughout the entire house or building. These are currently in use at the Focused Area.

Present Worth Costs: Used to evaluate expenditures that occur over different time periods by discounting all future costs to a common base year. This allows the cost of the Response Actions to be compared on the basis of a single figure representing the amount of money that would be sufficient to cover capital and O&M costs associated with each Response Action over its planned life.

Record of Decision (ROD): This legal document is signed by the Army. It provides the cleanup action or remedy selected for a site, the basis for selecting that remedy, public comments, responses to comments, and the estimated cost of the remedy.

Remedial Investigation: An investigation under CERCLA that involves sampling environmental media such as air, soil, and water to determine the nature and extent of contamination and human health and environmental risks that result from the contamination.

Response Action: A removal action, remedy, or remedial action, including enforcement activities related thereto.

Responsiveness Summary: A part of the ROD in which the Army documents and responds to written and oral comments received about the Proposed Plan.

Superfund Amendments and Reauthorization Act (SARA): A Congressional act that modified CERCLA. SARA was enacted in 1986 and again in 1990 to authorize additional funding for the Superfund Program.

To-Be-Considered: Information such as nonpromulgated criteria, advisories, guidance, and proposed standards issued by federal or state governments that may be considered in Response Actions. TBCs may be used to interpret ARARs, or to determine preliminary remediation goals when ARARs do not exist for particular contaminants.

REFERENCES

Alion, 2016a. Fort Jackson Off-Post Residential Water Study. January 2016.

Alion, 2016b. Fort Jackson Off-Post Residential Water Study. September 2016.

ASTM, 2016. E2893 Standard Guide for Greener Cleanups.

DoD, 2018a. Department of Defense Manual Number 4715.20, Defense Environmental restoration Program (DERP) Manual. March 2012. Change 31 August 2018.

DoD, 2018b. DoD Directive 4715.21, Climate Change Adaptation and Resilience. January 2016. Change 31 August 2018.

Executive Order, 2021. Executive Order 14008 Tackling the Climate Crisis at Home and Abroad. 27 January 2021.

Kite, L.E., 1988. Geologic Map of the Congaree, Eastover, Leesburg and Messers Pond 7.5-Minute Quadrangles. Open-File Report 62. South Carolina Geological Survey.

International Code Council, 2017. 2018 International Plumbing Code. August. Section 610.1.

ITRC, 2011. Green and Sustainable Remediation: A Practical Framework. November 2011.

ITRC, 2021. Sustainable Resilient Remediation SRR-1. Washington, D.C.: Interstate Technology & Regulatory Council, SRR Team. www.itrcweb.org.

PIKA-Pirnie JV, LLC, 2014a. Final Operational Range Phase II Assessment Report, United States Army Garrison Fort Jackson and McCrady Training Center, South Carolina. January 2014.

PIKA-Pirnie JV, LLC, 2014b. Final Letter Report Operational Range Additional Phase II Assessment, Off-post Private Well Sampling Results, U.S. Army Garrison Fort Jackson and McCrady Training Center, South Carolina. April 2014.

PIKA-Pirnie JV, LLC, 2016. Final Uniform Federal Policy-Quality Assurance Project Plan, Military Munitions Response Program Remedial Investigation – Fort Jackson and McCrady Training Center, Columbia, South Carolina. November 2016a.

PIKA-Pirnie JV, LLC, 2020. Military Munitions Response Program RDX Remedial Investigation, Fort Jackson, Columbia, South Carolina. July.

PIKA-Pirnie JV, LLC, 2021. Military Munitions Response Program RDX Feasibility Study, Fort Jackson, Columbia, South Carolina. September.

SCDHEC, 2016. R.61-71, Well Standards. May 27.

U.S. Army, 2006a. U.S. Army Operational Range Inventory Sustainment FY05: Draft Packet for Fort Jackson, South Carolina.

U.S. Army, 2006b. U.S. Army Operational Range Inventory Sustainment FY06: Final Packet for McCrady Training Center, South Carolina.

USACE Savannah District, 2015 Investigation Report, Explosives Groundwater Contamination.

USACE St. Louis District, 2015. Archives Search Report, RDX Potential at Fort Jackson.

USACE St. Louis District, 2016. Summary Report for Expanded Explosive Contamination, Groundwater Delineation.

USEPA, 1989. Risk Assessment Guidance for Super Fund Human Health Evaluation Manual Volume 1. Office of Emergency and Remedial Response U.S. Environmental Protection Agency, Washington, DC. December 1989.

USEPA, 1990. National Oil and Hazardous Substances Pollution Contingency Plan. Final Rule. 40 CFR Part 300.

USEPA, 2014. Technical Fact Sheet – Hexahydro-1,3,5-trinitro1,3,5-triazine (RDX). U.S. Environmental Protection Agency. January 2014.

USEPA, 2016. Consideration of Greener Cleanup Activities in the Superfund Cleanup Process. 02 August 2016.

USEPA, 2018a. Region 4 Human Health Risk Assessment Supplemental Guidance. Scientific Support Section, Superfund Division, EPA Region 4. March 2018 Update. Available at: https://www.epa.gov/risk/regional-human-health-risk-assessment-supplemental-guidance

USEPA, 2018b. 2018 Edition of the Drinking Water Standards and Health Advisories (EPA 822-F-18-001). Office of Water, U.S. Environmental Protection Agency, Washington, DC. March.

USEPA, 2018c. Toxicological Review of Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) (CASRN 121-82-4). EPA/635/R-18/211Fa. Integrated Risk Information System, National Center for Environmental Assessment, Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC. August.

USEPA, 2019. Climate Resilience Technical Fact Sheet: Groundwater Remediation Systems. Office of Superfund Remediation and Technology Innovation EPA 542-F-19-005 October 2019 Update Accessed online: https://www.epa.gov/sites/default/files/2019-12/documents/cr_groundwater_systems_fact_sheet_2019_update.pdf

USEPA, 2021a. Regional Screening Level Summary Table, November 2021. Accessed online: https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables

USEPA, 2021b. Green Remediation Best Management Practices: Pump and Treat Systems. Office of Land and Emergency Management (5203) EPA 542-F-21-029 December 2021 Update Accessed online: https://clu-in.org/PRODUCTS/grnremed5/docs/GR_fact_sheet_pump_treat.pdf

Weston, 2017. Final Report Residential Well Treatment System.

USGS, 1994. Effects of Sediment Depositional Environment and Ground-water Flow on the Quality and Geochemistry of Water in Aquifers in Sediments of Cretaceous Age in the Coastal Plain of South Carolina. By G.K. Speiran and W.R. Aucott. U.S. Geological Survey water-supply paper 2416.

USGS, 1996. Hydrology of the Southeastern Coastal Plain Aquifer System in South Carolina and Parts of Georgia and North Carolina. By W.R. Aucott. U.S. Geological Survey professional paper 1410-E.