Explanation of Significant Differences for Groundwater Treatment Systems Remediation Requirements

Rocky Mountain Arsenal Federal Facility Site

Revision C
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U.S. Department of the Army
Shell Oil Company

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ACRONYMS AND ABBREVIATIONS

ACHD	Adams County Health Department
ARAR	Applicable or Relevant and Appropriate Requirement(s)
CBSG	Colorado Basic Standards for Groundwater
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CFS	Confined Flow System
CGTP	Consolidated Groundwater Treatment Plant
CSRG	Containment System Remediation Goal
DIMP	diisopropylmethyl phosphonate
EPA	U. S. Environmental Protection Agency
ESD	Explanation of Significant Differences
FCTS	First Creek Treatment System
FS	Feasibility Study
ICS	Irondale Containment System
IRA	Interim Response Action
JARDF	Joint Administrative Record Document Facility
LTMP	Long-Term Monitoring Plan for Groundwater and Surface Water
NBCS	North Boundary Containment System
NCP	National Contingency Plan
NDMA	n-nitrosodimethylamine
NDPA	n-nitrosodi-n-propylamine
NPL	National Priorities List
NPTS	Northern Pathway Treatment System
NWBCS	Northwest Boundary Containment System
OGITS	Off-Post Groundwater Intercept and Treatment System
OU	Operable Unit
ppt	parts per trillion
PQL	Practical Quantitation Limit
RAO	Remedial Action Objective
RMA	Rocky Mountain Arsenal
ROD	Record of Decision
RVO	Remediation Venture Office
SOP	Standard Operating Procedure
TBC	to be considered

UFS	Unconfined Flow System
µg/L	microgram(s) per liter
UV	Ultraviolet light

1.0 INTRODUCTION

This Explanation of Significant Differences (ESD) documents significant changes associated with the remedy for groundwater contamination for both the On-Post Operable Unit (OU) and the Off-Post OU at the Rocky Mountain Arsenal (RMA) Federal Facility Site. The RMA On-Post OU is a federally owned facility located in southern Adams County, Colorado, approximately 10 miles northeast of downtown Denver and west of Denver International Airport, as shown in Figure 1. The RMA On-Post OU site currently encompasses approximately 1.7 square miles and is currently on the U.S. Environmental Protection Agency (EPA) National Priorities List (NPL) for environmental cleanup because of contamination released during previous RMA operations. The Off-Post OU encompasses groundwater Containment System Remediation Goal (CSRG) exceedance areas that underlie approximately 2.4 square miles of land zoned for rural, agricultural, commercial, residential, and industrial uses north and northwest of RMA. The RMA OUs are shown in Figure 2. Note that the configuration of the Off-Post OU shown in Figure 2 is based on the extent of groundwater contamination at the time of the Record of Decision (ROD) and not the current extent of contamination.

The ROD for the On-Post OU, which describes the remedy for the entire On-Post OU of RMA, was signed by the U.S. Department of the Army (Army), the EPA, and the State of Colorado on June 11, 1996 (Foster Wheeler 1996). The selected remedy includes distinct cleanup projects for soil and structures and long-term treatment of groundwater contamination. Since the soil and structures remediation has been completed, most of the On-Post OU of RMA has become a National Wildlife Refuge, as provided for in Public Law #102-402 (Public Law 1992). The ROD for the Off-Post OU was finalized on December 19, 1995 (HLA 1995) and was also signed by the Army, the EPA, and the State of Colorado. The selected off-post remedy consists primarily of groundwater treatment and exposure control for contaminated groundwater.

The Army is the lead agency for RMA and is issuing this ESD as part of its responsibilities under Section 117 of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendment and Reauthorization Act of 1986, and pursuant to the National Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Section 300.435(c)(2)(i). The NCP requires an ESD when the remedial action taken differs significantly from the remedy selected in the ROD with respect to scope, performance or cost. Regulatory oversight is conducted by the EPA, Colorado Department of Public Health and Environment (CDPHE), and the Adams County Health Department (ACHD).

The ROD groundwater remedy for both the On-Post OU and Off-Post OU consists primarily of extraction and treatment of contaminated groundwater through continued operation of existing boundary containment systems, on-post internal treatment systems, and off-post treatment systems. In addition, there are limited areas of extraction and treatment of contaminated groundwater to mitigate contaminant sources, such as Section 36 Bedrock Ridge and Complex Army Trenches.

Due to the age of the existing boundary containment systems, replacement of the plants is necessary as the systems are expected to be operational indefinitely to achieve Remedial Action

Objectives (RAOs). Rather than constructing two new treatment plants, the existing plants are being replaced with a new on-post Consolidated Groundwater Treatment Plant (CGTP). This revision only affects the location of groundwater treatment and does not alter the ROD requirement for continued operation of the boundary treatment systems.

The RODs are also being revised to include Applicable or Relevant and Appropriate Requirements (ARAR) for emerging contaminants identified after the RODs were signed. During the 2010 and 2015 Five-Year Reviews, 1,4-dioxane and n-nitrosodi-n-propylamine (NDPA) were identified as potential new groundwater contaminants at RMA. Because no groundwater standards for 1,4-dioxane or NDPA existed when the On-Post and Off-Post RODs were completed, the RODs did not identify ARARs for either contaminant. Since the completion of the RODs, new Colorado groundwater standards for 1,4-dioxane and NDPA were also identified. This ESD documents the addition of 1,4-dioxane to the ARAR lists for the North Boundary Containment System (NBCS) and Northwest Boundary Containment System (NWBCS), and the addition of NDPA to the ARAR lists for the NBCS, NWBCS and Off-Post Groundwater Intercept and Treatment System (OGITS). The OGITS facility was replaced by two new treatment plants in 2021 - the First Creek Treatment System (FCTS) and the Northern Pathway Treatment System (NPTS), and the ARARs for the OGITS are applied to the new treatment systems.

In addition, the treatment technologies selected in the ROD are not effective for treatment of 1,4-dioxane. Therefore, at the NBCS, where 1,4-dioxane exceeds the CSRG, the treatment system is being revised to include advanced oxidation, and the design of the CGTP includes this new treatment technology. Although treatment of 1,4-dioxane is not required for the NWBCS, the CGTP design includes space that allows for the addition of advanced oxidation treatment for the NWBCS flow if influent concentrations increase above the CSRG.

Addressing these emerging contaminants is necessary to provide continued protection of human health and the environment.

These changes, while resulting in the need for an ESD, do not alter the overall hazardous waste management remedy that was selected in the RODs. This ESD will become part of the Administrative Record as required by the NCP, 40 CFR 300.825(a)(2) (EPA 1990). The Administrative Record is available to the public at the Joint Administrative Record Document Facility (JARDF), located on the RMA in Building 129. Please call 303-289-0300 or 520-725-8131 to schedule an appointment to visit the JARDF. Site information is also available on the EPA Superfund Site Profile webpage: https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0800357.

2.0 SITE HISTORY, CONTAMINATION AND SELECTED REMEDY

2.1 RMA OPERATIONAL HISTORY

Following the attack on Pearl Harbor the Army established RMA in 1942 to produce chemical warfare agents and agent-filled munitions and to produce incendiary munitions for use in World War II. Following the war and through the early 1980s, the Army continued to use these facilities

for military production and munitions storage and demilitarization. Beginning in 1946, some facilities were leased to private companies to manufacture industrial and agricultural chemicals. Shell Oil Company purchased Julius Hyman and Co., the principal lessee, and continued to manufacture primarily pesticides at RMA from 1950 to 1982. Although the Army and Shell used accepted manufacturing and disposal practices of the time, contamination of soil, sediments, structures and groundwater occurred. The principal contaminants include organochlorine pesticides, heavy metals, chemical agent-degradation products and manufacturing by-products, and chlorinated and aromatic solvents.

In 1984, the Army began a systematic investigation of site contamination in accordance with CERCLA, and the site was placed on the NPL in 1987. The NPL is a list of the nation's most contaminated sites, also known as Superfund sites. The RMA was divided into the On-Post OU and Off-Post OU. As required by CERCLA, Remedial Investigations were conducted for both OUs to determine the nature and extent of contamination (HLA 1988, Ebasco 1992). The On-Post Remedial Investigation identified contaminated soils and waste materials in manufacturing and disposal areas, including Basin A, Basin F, South Plants Central Processing Area, Shell Disposal Trenches and the Complex Army Disposal Trenches. The primary contaminants in these areas are pesticides, solvents, heavy metals and chemical agent by-products. Groundwater contamination as a result of the disposal practices was identified within the On-Post OU and was identified as the primary pathway for migration of contamination into the off-post area. Sites that posed potential immediate risks to human health and the environment were addressed through Interim Response Actions (IRAs). These IRAs included groundwater treatment for the NBCS and NWBCS.

The remedy selected in the On-Post ROD consisted primarily of on-site containment and groundwater treatment. Contaminated soils and sediments were excavated to a maximum depth of 10 feet and disposed in the on-site hazardous waste landfills or consolidated beneath soil covers. Contaminated structures were demolished and disposed in the landfills or Basin A. The groundwater remedy, which is ongoing, includes extraction of contaminated groundwater before it flows off post, treatment at on-site facilities including the NBCS and NWBCS, and reinjection of treated groundwater. All remedial actions for soil and structures required by the On-Post and Off-Post RODs have been completed (TtEC 2011); however, treatment of groundwater and maintenance of caps and covers continue as part of long-term operations and maintenance.

The remedy selected in the Off-Post ROD consisted primarily of groundwater treatment and exposure control through provision of alternate water supply and institutional controls to prevent use of contaminated groundwater. The groundwater remedy, which is ongoing, includes extraction of contaminated groundwater that migrated off post prior to completion of the boundary containment systems, treatment to meet CSRGs, and reinjection of treated groundwater. Groundwater monitoring continues as part of long-term operations and maintenance.

The EPA certified that approximately 24.9 square miles of the original On-Post OU have met cleanup requirements and have been deleted from the NPL site. These lands were deleted from the NPL in January 2003, January 2004, July 2006, and September 2010, and most of the acreage

was transferred from the Army to the U.S. Fish and Wildlife Service for inclusion in the National Wildlife Refuge System. Implementation of the remedy for the remaining approximately 1.7 square miles is ongoing. Soil, surface water, and sediment in the Off-Post OU have also been deleted. Groundwater has been deleted in the eastern and southern perimeter areas of the RMA. However, groundwater underlying the central and northwestern portions of the site, approximately 15.5 square miles, along with groundwater comprising the Off-Post OU, has not met remediation goals and remains on the NPL. Operation of existing groundwater treatment systems for both the On-Post and Off-Post OUs will continue until shut-off criteria are met.

2.2 SITE DESCRIPTION

2.2.1 Geology and Hydrogeology

The RMA is located within the Denver Basin, an asymmetrical depression approximately 300 miles long and 200 miles wide. Virtually all of RMA is covered with unconsolidated alluvial and windblown sediments underlain by the Denver and Arapahoe Formation bedrock (Ebasco 1989). The unconsolidated alluvium consists primarily of silts, sands, and gravels and is up to 100 feet thick. The thickest deposits of these alluvial sediments occur in paleochannels eroded into the underlying Denver Formation.

Groundwater flow occurring within the alluvium and the upper weathered portion of the Denver Formation is referred to as the unconfined flow system (UFS). The UFS is the principal migration route for groundwater contaminants at RMA. Where the Denver Formation is missing near the South Platte River, the weathered upper portion of the Arapahoe Formation is part of the UFS. Deeper water-bearing units within the Denver and Arapahoe Formations are separated from the UFS by low-permeability confining units and are referred to as the confined flow system (CFS). Depending on site-specific hydrological characteristics, varying degrees of hydraulic interchange are possible between surface water and groundwater and between the UFS and CFS. In general, both chemical and hydraulic data indicate little hydraulic interchange between the UFS and CFS (Navarro 2021b).

2.2.2 On-Post Boundary Containment Systems

The NBCS and NWBCS were constructed as IRAs to extract and treat contaminated alluvial groundwater plumes migrating toward the RMA boundaries. Continued operation of these treatment systems was incorporated into the final remedial action identified in the On-Post ROD. Figure 2 shows the location of current groundwater treatment facilities at RMA.

The NBCS is located immediately south of the RMA north boundary in Sections 23 and 24 and is designed to contain contaminated groundwater flowing from Basin F and the North Plants area. It was originally installed as a pilot project in 1979 and expanded to its current extent in 1981. The containment system consists of a soil bentonite barrier with alluvial extraction wells upgradient and recharge trenches downgradient of the barrier wall. A reverse hydraulic gradient is being maintained across the entire alluvial system to minimize contaminated groundwater flow across the boundary. A carbon adsorption system is used to remove organic compounds, and ultraviolet (UV) oxidation is used to treat n-nitrosodimethylamine (NDMA) prior to recharge.

The NWBCS is located along the northwest boundary of RMA in Section 22 and is designed to contain contaminated groundwater flowing from South Plants and Basin A areas. The NWBCS includes three different components: the Original System, the NWBCS Northeast Extension, and the NWBCS Southwest Extension. The Original System, installed in 1984, consists of alluvial extraction wells, recharge wells, and a soil bentonite barrier extending across a portion of the system. The recharge wells are located downgradient of the extraction wells and barrier and the system creates a reverse hydraulic gradient to contain the contaminant plumes. The NWBCS Northeast Extension, which was added in 1990, included the installation of two extraction wells and an extension of the barrier. The NWBCS Southwest Extension was installed in 1991 to capture a separate contaminant plume that extended from South Plants to the Southwest Extension of the NWBCS. The Southwest Extension consists of four extraction wells and four recharge wells. Contaminated groundwater from the combined extraction systems is treated using a carbon adsorption system prior to reinjection to the aquifer.

2.2.3 Off-Post Groundwater Intercept and Treatment System

Groundwater north and northwest (downgradient) of the RMA boundaries continues to flow north-northwest toward the South Platte River. Contaminant migration occurs along two primary pathways defined by the First Creek and Northern Pathway paleochannels. The OGITS was originally constructed in 1993 as an IRA to extract and treat contaminated alluvial groundwater plumes that had migrated north of RMA prior to construction of the NBCS. The OGITS treated contaminated alluvial groundwater extracted from two systems, the First Creek System and the Northern Pathway System. Both extraction systems are located along Highway 2 north of RMA. Continued operation of the OGITS was incorporated into the final remedial action identified in the Off-Post ROD.

In 2021, the aging OGITS facility was replaced by separate treatment plants for groundwater extracted at the First Creek System and the Northern Pathway System (Figure 3). The new treatment plants, the FCTS and NPTS, are located closer to the respective well fields and treatment of contaminated groundwater was relocated from the OGITS plant to the new plants. These minor changes to the Off-Post ROD were documented previously in Fact Sheets for the FCTS (Navarro 2021a) and NPTS (Navarro 2021c). The Off-Post ROD OGITS requirements apply to the two new treatment systems, and any changes to the OGITS requirements also apply to both the FCTS and NPTS.

2.3 SUMMARY OF THE SELECTED ON-POST REMEDY FOR GROUNDWATER

The groundwater remedy required by the 1996 ROD for the On-Post OU, as modified, includes the following elements. Significant changes are documented in previous ESDs, and minor changes are documented in Fact Sheets or other documentation included in the site file.

- Operation of the three boundary systems, the NBCS, NWBCS, and Irondale Containment System (ICS), continues. These systems include extraction and recharge systems, slurry walls (NBCS and NWBCS) for hydraulic controls, and carbon adsorption for removal of organics. The systems will be operated until shut-off criteria, as described below, are met.

Status: Treatment at the NBCS and NWBCS is ongoing. The ICS was shut down in 1997 and shut-off monitoring was completed in August 2002 (WGI 2003). A post-shut-off monitoring category was added to the Long-Term Monitoring Plan for Groundwater and Surface Water (LTMP) (TtEC 2012a) and is ongoing.

- Operation of existing on-post groundwater IRA systems continues. The Motor Pool and Rail Yard IRA systems, which pipe water to ICS for treatment, will be shut down when shut-off criteria, as described below, are met. The North of Basin F extraction system continues to extract water that is treated at the Basin A Neck system and the Basin A Neck system continues to extract and treat water from Basin A until shut-off criteria are met.

  Status: The Motor Pool Extraction System was shut off in April 1998 and shut-off monitoring was completed in November 2003 (URS 2011). The Rail Yard Extraction System was shut off in May 2016 and shut-off monitoring was completed in October 2021 (Navarro 2022). A post-shut-off monitoring category was added to the LTMP and monitoring is ongoing (TtEC 2012a). The North of Basin F IRA extraction well was shut down in 2000 after meeting IRA objectives (WGI 2005).

- A new extraction system will be installed in the Section 36 Bedrock Ridge area. Extracted water will be piped to the Basin A Neck system for treatment (e.g., by air stripping or carbon adsorption).

  Status: Construction of the Section 36 Bedrock Ridge Extraction System was completed in 2004 (WGI 2008). Operation of the system is ongoing.

- Confined aquifer wells are monitored in the South Plants, Basin A, and Basin F areas. Specific monitoring wells will be selected during remedial design.

  Status: Confined aquifer wells selected for long-term monitoring are identified in the LTMP (Navarro 2021b). Monitoring is ongoing.

- Those monitoring wells installed in the confined aquifer that may represent pathways for migration from the unconfined aquifer (approximately 30–40 wells) are closed and sealed. Replacement wells will be installed if the Parties jointly determine that specific wells to be closed are necessary for future monitoring.

  Status: Confined aquifer well closure was completed in 2000 (Dames & Moore 2000).

- The CSRGs for chloride and sulfate will be met by natural attenuation at the NBCS.

  Status: Chloride and sulfate concentrations are meeting attenuation goals in the effluent at the NBCS.

- Monitoring and assessment of NDMA contamination will be performed in support of design refinement/design characterization to achieve remediation goals specified for the boundary groundwater treatment systems.

  Status: The assessment was completed and the NBCS was modified to include treatment for NDMA (MKC 1998). The ROD preliminary remediation goal, which was a risk-based level, was replaced with the Colorado Basic Standards for Groundwater (CBSG) of

0.00069 µg/L (TtEC 2011). Currently, treatment is conducted to the Practical Quantitation Limit (PQL) of 0.009 micrograms per liter (µg/L) (TtEC 2012b).

- Groundwater mass removal within the South Tank Farm Plume and the former Section 36 Lime Basins areas. The extracted groundwater is treated at the CERCLA Wastewater Treatment Plant for recharge to the vicinity of the respective extraction well fields (TtEC 2006).

  Status: The groundwater mass removal project was completed in June 2010 (URS 2012b). The treatment of groundwater extracted at the Section 36 Lime Basins was transferred to the BANS (URS 2012a). The CERCLA Wastewater Treatment Plant was decommissioned and demolished in 2010.

- Remediation for the Section 36 Lime Basins includes a slurry wall and groundwater extraction system. Extracted water is piped to the Basin A Neck system for treatment.

  Status: Construction of the Section 36 Lime Basins slurry wall and extraction system was completed in March 2009 (TtEC 2010). Operation of the system is ongoing.

2.4 SUMMARY OF THE SELECTED OFF-POST REMEDY

The groundwater remedy required by the 1995 ROD for the Off-Post OU, as modified, includes the following elements. Significant changes are documented in previous ESDs, and minor changes are documented in Fact Sheets or other documentation included in the site file.

- Operation of the OGITS including extraction of contaminated groundwater from the UFS north of the RMA boundary in the First Creek and northern paleochannels, treatment of organic chemicals of concern using carbon adsorption, and recharge of treated groundwater to the UFS.

  Status: Treatment at the OGITS was relocated to the FCTS and NPTS in 2021 (Navarro 2021a, 2021c). ROD requirements for the OGITS apply to the FCTS and NPTS.

- Natural attenuation of inorganic chloride and sulfate concentrations to meet applicable standards for groundwater in a manner consistent with the on-post remedial action.

  Status: Chloride and sulfate concentrations are meeting attenuation goals in the effluent at the FCTS and NPTS.

- Continued operation of the NBCS, NWBCS and ICS as specified in the On-Post ROD.

  Status: Treatment at the NBCS and NWBCS is ongoing. The ICS was shut down in 1997 and shut-off monitoring was completed in August 2002 (WGI 2003). A post-shut-off monitoring category was added to the LTMP, and monitoring is ongoing (TtEC 2012a).

- Improvements to the NBCS, NWBCS, ICS and OGITS as necessary.

  Status: The boundary and off-post treatment systems continue to function as intended. Minor improvements are documented in annual Operational Assessment Reports and Annual Summary Reports.

- Long-term groundwater monitoring (including monitoring after groundwater treatment has ceased) continues, to assure compliance with the CSRGs.

  Status: Long-term groundwater monitoring requirements are provided in the LTMP (Navarro 2021b).

- Exposure control through provision of alternate water supply for well owners located within the diisopropylmethyl phosphonate (DIMP) plume footprint (based on 0.392 ppb detection limit) or otherwise as described in the Off-Post ROD.

  Status: Provision for the alternate water supply was completed in 2000 (Black & Veatch 1998, Gannett Fleming 2000).

- Institutional controls to prevent the use of groundwater exceeding remediation goals.

  Status: Institutional controls required by the Off-Post ROD are being implemented to minimize potential exposure to contaminated groundwater (Navarro 2013). These controls include notices attached to new well permits issued in the groundwater contamination area and provisions for alternate water supply for wells with contaminated groundwater.

- Closure of poorly constructed wells within the Off-Post Study Area that could be acting as migration pathways for contaminants found in the Arapahoe Aquifer.

  Status: Required well closures were completed in 1998 (LATA/AG&M 1999).

- Continuation of monitoring and completion of an assessment of the NDMA plume using a 20 parts per trillion (ppt) method detection limit.

  Status: The assessment was completed and NDMA monitoring is ongoing (MKC 1998).

- Preparation of a study that supports design refinement for achieving NDMA remediation goals at the RMA boundary using a 7 ppt (0.007 µg/L) preliminary remediation goal or a certified analytical detection level readily available at a certified commercial laboratory.

  Status: The assessment was completed and the NBCS was modified to include treatment for NDMA (MKC 1998). The ROD preliminary remediation goal, which was a risk-based level, was replaced with the CBSG of 0.00069 µg/L (TtEC 2011). Currently, treatment is conducted to the PQL of 0.009 µg/L (TtEC 2012b).

2.5 TREATMENT SYSTEM SHUT-OFF

Criteria for shutting down boundary systems, internal, and off-post systems were also presented in both the On-Post and Off-Post ROD. Clarifications to the shut-off requirements were provided in a previous ESD and are summarized as follows (TtEC 2012a):

- The recommendation to initiate the shut-off process for a system or a discrete portion of a system will be based on the concentrations in the upgradient and cross-gradient water quality performance wells reported below their respective ARARs. The consultative process will be applied to decide if shut-off should proceed and if and what pre-shut-off monitoring activities should be performed before shutting the system off. When the system shut-off decision has been reached, the consultative process will be applied to

develop a shut-off monitoring program. Shut-off monitoring, which begins after the entire extraction system, or a discrete portion of an extraction system, has been shut off, will be used to confirm that the groundwater remedy goal has been successfully achieved.

- Shut off of individual wells will be addressed under the operational monitoring program for each system as described in the LTMP (Navarro 2021b) and in accordance with the *Operational Extraction Well Shut-Off Procedure* (RVO 2012). Shut-off monitoring wells for system shut-off will be selected during the consultative process from the performance, tracking and operational wells for each system. Shut-off monitoring will be performed for a minimum of five years with quarterly monitoring for the first and final years and annual monitoring for the intervening years. The duration of monitoring will be determined through the consultative process and documented in the system-specific Sampling and Analysis Plan.
- An exceedance of ARARs during the first or second year of shut-off monitoring will trigger a restart of the shut-off monitoring period. If an exceedance of ARARs occurs after the second year, the consultative process will be initiated to determine an alternate shut-off monitoring schedule. The system will be restarted if concentrations are above ARARs for two consecutive sampling years.
- Permanent system shut-off may be initiated following shut-off monitoring. After completion of the shut-off monitoring program, a post-shut-off monitoring program will be performed for a period specified for each system.

3.0 BASIS FOR THE ESD

The following sections provide a discussion of the basis for changes in treatment plant location, treatment systems ARARS, and NBCS treatment technology.

3.1 BASIS FOR CHANGE IN TREATMENT PLANT LOCATION

The On-Post ROD included continued operation of the NBCS and NWBCS. These were constructed as IRAs in the 1980s and have been operating successfully for over 40 years. However, they are reaching the end of their service life and need to be replaced with updated facilities. Rather than construct new facilities for each of the treatment systems, a new CGTP is being constructed to replace the two existing treatment plants. The CGTP will house treatment systems for each of the two extraction wellfield locations in one building. The new CGTP will be constructed near the existing NWBCS plant, approximately 0.1 miles east of Colorado State Highway 2 along East 88th Avenue, as shown in Figure 3. Although the location of the new treatment plant differs from the two systems locations shown in the ROD, it remains located on-site.

There are no changes to the extraction components for the two systems. Extracted groundwater from both the NBCS and NWBCS will be piped to CGTP for treatment. Because each influent source contains unique contaminants, separate treatment trains are maintained within the CGTP throughout the treatment and discharge process. This will prevent contamination that has not been historically seen at one location from inadvertently being introduced to the other location,

which could occur if flows were comingled or contaminants were not fully removed during treatment. Separate influent/effluent compliance monitoring will be maintained for the two systems in accordance with the LTMP.

There are no changes to the recharge components for the two systems. Treated water is returned to the system from which it was extracted and is recharged using the existing recharge wells or trenches. Overall, the change in the location of the treatment facility does not result in any changes to the ROD groundwater treatment requirements.

3.2 BASIS FOR REVISING THE TREATMENT SYSTEM ARARS

Since the RODs were signed, emerging contaminants 1,4-dioxane and NDPA were identified as potential new groundwater contaminants at RMA. Both the On-Post and Off-Post RODs included ARARs for each treatment system including NBCS, NWBCS and OGITS as well as To-Be-Considered Criteria (TBCs) for groundwater. The groundwater standards, or ARARs, designated in the ROD along with the TBCs are referred to as CSRGs. The compounds listed for each system were selected based on compounds present upgradient of the system and current or likely exceedances of applicable standards. Because there were no groundwater standards for 1,4-dioxane or NDPA when the RODs were completed, the RODs did not identify a CSRG for either compound.

During the 2010 Five-Year Review, 1,4-dioxane was identified as an emerging contaminant with the possibility that it might be present in RMA groundwater. In addition, the review identified a new CBSG for 1,4-dioxane of 6.1 µg/L that had been promulgated in 2004, which would drop to 3.2 µg/L after five years. As a result, the 2010 Five-Year Review Report (Army 2011) included a recommendation to review existing information and conduct additional groundwater monitoring to determine whether 1,4-dioxane should be added to the RMA list of ARARs. Groundwater monitoring was initiated in 2011 but was not completed by 2015 and the issue was identified again in the 2015 Five-Year Review Report (Army 2016). Also, a lower 1,4-dioxane groundwater standard of 0.35 µg/l became effective January 31, 2013. The 2015 Five-Year Review Report included a recommendation to complete the data evaluation and prepare a technical evaluation report with risk evaluation to support the ARAR determination.

Groundwater monitoring was conducted in several phases between 2011 and 2018. The objective of the sampling program was to characterize the horizontal and vertical extent of 1,4-dioxane in groundwater at the RMA and assess the concentrations in the influent and effluent at the treatment plants. Investigative samples were collected from both on-post and off-post groundwater monitoring wells. 1,4-Dioxane was detected in most monitoring wells within and downgradient of RMA source areas (Navarro 2017, 2019a). The 1,4-dioxane concentration was above the CBSG in the Basin A, South Plants, Complex Army Trenches, and Basin F source areas with contaminant plumes extending to the NBCS and NWBCS. Several wells off post in the First Creek and Northern Pathway areas also exceeded the CBSG.

The Army completed a Focused Feasibility Study (FS) in 2019 to evaluate the need for remediation of 1,4-dioxane in groundwater for each system at RMA. Recommendations in the FS included adding the 1,4-dioxane CBSG to the CSRG lists for NBCS and NWBCS (Navarro

2019a). Existing monitoring data for 1,4-dioxane has demonstrated that the analytical method for 1,4-dioxane can detect the contaminant at levels below the CBSG of 0.35 µg/L. As a result, the CBSG for 1,4-dioxane is added as a CSRG for both the NBCS and NWBCS.

During the 2015 Five-Year Review, NDPA was identified in groundwater above the CBSG of 0.005 µg/L; however, because NDPA was not part of the standard analytical reporting, further evaluation was required. Groundwater and treatment plant sampling were conducted in 2017/2018 to determine whether NDPA should be added as ARARs.

NDPA was detected in multiple monitoring wells within and downgradient of RMA source areas. The NDPA concentration was above the CBSG in the Basin A, South Plants, Complex Army Trenches, and Basin F source areas with contaminant plumes extending to the NBCS and NWBCS, indicating that RMA is a source of NDPA contamination in groundwater (Navarro 2019b). The NDPA concentration was also above the CBSG upgradient of the First Creek System and Northern Pathway System and in some Northern Pathway System extraction wells. Review of treatment plant data shows that NDPA is present above the CBSG in all plant influents at concentrations above the CBSG. Effluent concentrations at all plants are below the CBSG, indicating effective treatment from the existing systems. Review of the analytical method has determined that the CBSG of 0.005 µg/L can be used as the CSRG. Based on the monitoring data collected, the CBSG for NDPA is added as a CSRG for the NBCS, NWBCS, and OGITS, which is now comprised of the FCTS and NPTS.

The revised CSRGs for the NBCS, NWBCS and OGITS are provided in Tables 2, 3, and 4, respectively. Treatment plant influent and effluent sampling continues, along with system-related groundwater monitoring, to provide data to evaluate long-term concentration trends and allow continued evaluation of the overall RMA remedy effectiveness.

3.3 BASIS FOR REVISING THE NBCS TREATMENT SYSTEM TECHNOLOGY

The ROD includes a description of the selected treatment technology for each groundwater treatment system. For the boundary containment systems, the treatment technology component of the selected remedy includes carbon adsorption for removal of organic contaminants. At the NBCS, UV oxidation is also used to treat NDMA. 1,4-dioxane is not effectively treated by the existing treatment technologies.

As part of the FS completed in 2019, 1,4-dioxane concentrations in groundwater monitoring wells and treatment plant influent were evaluated to determine whether treatment for 1,4-dioxane was necessary. The RAOs for on-post groundwater identified in the On-Post ROD provide the objectives for capture and treatment of contaminated groundwater:

Human Health

- Ensure that the boundary containment and treatment systems protect groundwater quality off post by treating groundwater flowing off RMA to the specific remediation goals identified for each of the boundary systems.

- Develop on-post groundwater extraction/treatment alternatives that establish hydrologic conditions consistent with the preferred soil alternatives and also provide long-term improvement in the performance of the boundary control systems.

Environmental Protection

- Ensure that biota (wildlife) are not exposed to biota contaminants of concern in surface water in concentrations capable of causing acute or chronic toxicity.

Based on the data review presented in the FS, treatment for 1,4-dioxane was recommended for the NBCS to meet RAOs. An evaluation of treatment alternatives resulted in the selection of advanced oxidation as an addition to the treatment process at the NBCS. A subsequent treatability study identified UV/hydrogen peroxide as an advanced oxidation process for treatment of 1,4-dioxane (Calgon 2021). The design of the CGTP includes an advanced oxidation system for treatment of 1,4-dioxane for the NBCS groundwater.

Concentrations of 1,4-dioxane at the NWBCS are below the CSRG and no treatment is required. However, the CGTP design includes space that allows for the addition of advanced oxidation treatment for the NWBCS flow if influent concentrations increase above the CSRG.

4.0 DESCRIPTION OF SIGNIFICANT DIFFERENCES

The following sections summarize the changes to the ROD-identified groundwater remedy requirements and discuss the cost impact of the revised remedy. The changes described do not alter the hazardous waste management remedy selected in the ROD and the remedy remains protective of human health and the environment.

4.1 SUMMARY OF CHANGES TO REMEDY

The changes to the groundwater remedy consist of changes in on-post boundary containment system treatment plant location, revising the treatment system ARARs, and adding a new treatment technology to the NBCS. A summary of the modifications to the groundwater remedy is presented in Table 1.

Table 1. Changes to the Groundwater Remedy

ROD-Prescribed Remedy	Modification
Continued operation of the Boundary Treatment Systems (On-Post and Off-Post ROD)	**Minor Change for Treatment Plant Location.** The NBCS and NWBCS treatment plants are being replaced by a new treatment plant, the CGTP, which is located on-post and will contain separate treatment systems for the NBCS and NWBCS. Treatment continues at the new plant location in accordance with the On-Post ROD until shut-off criteria are met.
Continued operation of the Off-Post Groundwater Intercept and Treatment System (Off-Post ROD)	**Minor Change for Treatment Plant Location.** The OGITS treatment plant was replaced by separate treatment plants for groundwater extracted at the Northern Pathway System and the First Creek System. Treatment continues at the new plant locations in accordance with the Off-Post ROD until shut-off criteria are met.
Groundwater Treatment ARARs (On-Post and Off-Post ROD)	**Addition.** Treatment system ARARs for the NBCS and NWBCS are revised to include CSRGs for emerging contaminants 1,4-dioxane and NDPA. ARARs for the OGITS, comprised of the FCTS and NPTS, are revised to include the CSRG for NDPA. See attached tables for complete revised ARARs/CSRG lists.
Treatment of groundwater at the NBCS (On-Post ROD)	**Addition.** The NBCS treatment is revised to include advanced oxidation for treatment of emerging contaminant 1,4-dioxane. This is being implemented in the design/construction of the CGTP.

4.2 SUMMARY OF COST CHANGE

The estimated capital cost for construction of the CGTP is $40.5 million. This includes plant construction costs of approximately $35.5 million, design cost of $4.4 million, and $600,000 in pre-construction cost for pipeline installation. This represents a significant cost change compared to the ROD-estimated cost. The ROD included cost for continued operation of the NBCS and NWBCS but did not include capital cost for eventual replacement of the facilities. Due to the age of the existing treatment plants, recapitalization and replacement of the plants is necessary, as the systems are expected to require operation indefinitely. Consolidation of the NBCS and NWBCS into a single facility does represent cost savings compared to the cost for replacing the existing systems with two separate facilities.

Operating costs for the CGTP are not expected to be significantly different than the combined operating costs for the NBCS and NWBCS, which were approximately $938,600 last year, because there are no changes to the extraction and recharge systems, or the volume of groundwater treated. In addition, the primary treatment technology, carbon adsorption, is unchanged. Operating costs will increase slightly due to the addition of advanced oxidation for treatment of 1,4-dioxane. The annual operating cost for the advanced oxidation system is estimated at $7,335. This represents only a 0.8 percent increase in operating costs. Consolidation

of the two treatment systems into one facility is expected to provide some operational efficiency and cost savings.

For plant monitoring, the addition of 1,4-dioxane requires an additional analytical method for quarterly influent/effluent monitoring. The annual cost for quarterly 1,4-dioxane monitoring is estimated at $7,200, which represents a 1.5 percent increase over previous annual influent/effluent monitoring costs. NDPA is reported under the analytical method already being run for NDMA and does not result in increased analytical cost. In total, the annual operating cost for the CGTP is expected to be similar to the combined cost for operation of the NBCS and NWBCS, or slightly lower.

Overall, capital costs are increased by the CGTP design/construction cost, $40.5 million, and operating costs are expected to remain at current levels or decrease slightly due to the consolidation of facilities.

5.0 SUPPORT AGENCY COMMENTS

The EPA, CDPHE, and ACHD have reviewed this ESD. Comments from these agencies have been incorporated into the document. See Appendix A for regulatory agency comments and Army responses to those comments.

6.0 PUBLIC PARTICIPATION COMPLIANCE

The Army published a public notice in the Denver Post on **TBD**, making this draft ESD available for public review and comment. Notices were also published in the Brighton Blade and Commerce City Sentinel-Express. The public comment period closes on **TBD**. Upon completion of the comment period, the Army, in consultation with the EPA and the State of Colorado, will evaluate each comment and any significant new data received before issuing a final report documenting the project changes.

This ESD and all site documents that support the changes are part of the Administrative Record and are available to the public at the JARDF, located on the RMA in Building 129. Please call 303-289-0300 or 520-725-8131 to schedule an appointment to visit the JARDF.
Site information is also available on the EPA Superfund Site Profile webpage:
https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0800357.

7.0 STATUTORY DETERMINATIONS

Considering the new information presented in this ESD, the Army, in consultation with EPA and CDPHE, believes that the groundwater remedy, with the modifications described, satisfies the requirements of CERCLA Section 121 and is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, uses a permanent solution through extraction and treatment of contaminated groundwater, and is cost effective.

Signatures

For U.S. Environmental Protection Agency

_____ Date _____

Cyrus Western
Regional Administrator

For U.S. Department of the Army

_____ Date _____

TBD

For State of Colorado

_____ Date _____

TBD
Colorado Department of Public Health and Environment

8.0 REFERENCES

Army (U.S. Department of the Army)

2016 (Sept.) *Final 2015 Five-Year Review Report for Rocky Mountain Arsenal Commerce City Adams County, Colorado. Volumes I and II.*

2011 (Sept.) *Final 2010 Five-Year Review Report for Rocky Mountain Arsenal Commerce City Adams County, Colorado. Volumes I, II and II.*

2001 (Nov.) *Explanation of Significant Difference for Endrin Containment System Remediation Goal in On- and Off-Post Records of Decision for Rocky Mountain Arsenal Federal Facility Site.* Final.

Black & Veatch

1998 (Dec. 20) *South Adams County Water and Sanitation District Henderson Pipeline Construction Completion Report*.

Calgon (Calgon Carbon UV Technologies)

2021 (Jan. 27) *Design Test Report for Advanced Oxidation Treatment of 1,4-Dioxane*.

Dames & Moore

2000 (June 15) *Final Confined Flow System Well Closure Construction Completion Report*.

Ebasco (Ebasco Services Incorporated)

1992 (Jan.) *Remedial Investigation Summary Report*. Version 3.2.

1989 (July) *Water Remedial Investigation Report*. Version 3.3.

EPA (U.S. Environmental Protection Agency)

1990 (Mar. 8) *National Oil and Hazardous Substances Pollution Contingency Plan.* Final Rule. 40 CFR Part 300. Federal Register 55 (46): 8666-8865.

Foster Wheeler (Foster Wheeler Environmental Corporation)

1996 (June 11) *Record of Decision for the On-Post Operable Unit*. Version 3.1. (3 v).

Gannett Fleming (Gannett Fleming, Inc.)

2000 (Sept.) *Final Acquisition and Delivery of 4,000 Acre-Feet Potable Water Supply, Completion Report*.

HLA (Harding Lawson Associates)

1995 (Dec. 19) *Rocky Mountain Arsenal Offpost Operable Unit Final Record of Decision.*

1988 (Dec. 31) *Offost Operable Unit Remedial Investigation and Specific Applicable or Relevant and Appropriate Requirements.* Final Report. Version 3.1. (3 v).

LATA/AG&M (Los Alamos Technical Associates/Arcadis Geraghty & Miller)

1999 (July 9) *Final RMA Off-Post Well Abandonment Construction Completion Report*.

MKC (Morrison Knudsen Corporation)

1998 (June 30) *North Boundary Containment System, System Modifications for Treatment of NDMA, Construction and Startup Completion Report*.

Navaro (Program Manager Rocky Mountain Arsenal)

2022 (Feb. 24) *Railyard Containment System Shut-Off Monitoring Data Summary Report*. Revision 0.

2021a (June 7) *Minor Change to the Off-Post Record of Decision for the Off-Post Groundwater Intercept and Treatment System Modification of the First Creek System.*

2021b (May 27) *Rocky Mountain Arsenal Long-Term Monitoring Plan for Groundwater and Surface Water*. Revision 1.

2021c (Feb. 17) *Minor Change to the Off-Post Record of Decision for the Off-Post Groundwater Intercept and Treatment System Modification of the Northern Pathway System.*

2019a (Nov. 21) *Focused Feasibility Study for 1,4-Dioxane in Groundwater*. Revision 0.

2019b (Jan. 8) *Emerging Contaminants Data Summary Report*. Revision 0.

2017 (Mar. 30) *Final 1,4-Dioxane Characterization Data Summary Report*. Revision 0.

2013 (Oct. 10) *Rocky Mountain Arsenal Land Use Control Plan*. Revision 0.

Public Law (Public Law 102-402 [H.R. 1435])

1992 (Oct. 9) Rocky Mountain Arsenal National Wildlife Refuge Act of 1992.

RVO (Remediation Venture Office)

2012 (Mar.) *Operational Extraction Well Shut-Off Procedure. RVO SOP: RVOP.016.P*. Revision 1.

TtEC (Tetra Tech EC, Inc.)

2012a (July 26) *Explanation of Significant Differences for Groundwater Remediation Requirements Rocky Mountain Arsenal Federal Facility Site*.

2012b (Feb. 7) *Practical Quantitation Limit Study Report for Aldrin, Dieldrin , and n-Nitrosodimethylamine*.

2011 (Sept. 23) *Final 2010 Five-Year Review Report for Rocky Mountain Arsenal Commerce City Adams County, Colorado Review Period: April 1, 2005 – March 31, 2010*. Revision 0.

2010 (Aug. 18) *Section 36 Lime Basins Soil Remediation Project Slurry/Barrier Wall Construction, Construction completion Report*. Revision 0.

2006 (Mar. 31) *Explanation of Significant Differences for Groundwater Remediation and Revegetation Requirements*. Revision 0.

URS (URS Corporation)

2012a (Mar. 30) *Lime Basins Groundwater Treatment Relocation Project Construction Completion Report*. Revision 0.

2012b (Mar. 29) *Groundwater Mass Removal Project Construction Completion Report*. Revision 0.

2011 (Sept. 15) *Motor Pool Extraction Component of the Irondale Containment System 5-Year Shut-Off Monitoring Project Construction Completion Report*. Final.

WGI (Washington Group International, Inc.)

2008 (Mar. 2) *Section 36 Bedrock Ridge Groundwater Plume Extraction System Construction Completion Report*. Revision 6.

2005 (Sept. 21) *Termination of Operations at the Groundwater Intercept and Treatment System North of Basin F Well Construction Completion Report*. Final.

2003 (Apr. 8) *Irondale Containment System, Shut-Down for the Irondale Extraction System, Final Construction Completion Report*. Revision 0.

TABLES

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Table 2. Chemical-Specific ARARs and TBCs - CSRGs for NBCS

Chemical Group/Compound	ROD Containment System Remediation Goals (µg/l)[1]	Revised Containment System Remediation Goals (µg/l)[1]
Volatile Halogenated Organics		
1,2-Dichloroethane	0.4	0.4
1,2-Dichloroethylene	70	70
Carbon tetrachloride	0.3	0.3
Chloroform	6	6
Methylene Chloride	5	5
Tetrachloroethylene	5	5
Trichloroethylene	3[2]	3[2]
Volatile Hydrocarbon Compounds		
Dicyclopentadiene	46[2]	46[2]
Volatile Aromatic Organics		
Benzene	3[2]	3[2]
Xylenes	1,000[2]	1,000[2]
Toluene	1,000	1,000
Organosulfur Compounds; Mustard Agent Related		
1,4-Oxathiane	160[2]	160[2]
Dithiane	18[2]	18[2]
Organosulfur Compounds; Herbicide Related		
Chlorophenylmethylsulfide	30[3]	30[3]
Chlorophenylmethylsulfone	36[3]	36[3]
Chlorophenylmethylsulfoxide	36[3]	36[3]
Organophosphorus Compounds; GB Agent Related		
Diisopropylmethyl phosphonate (DIMP)	8	8
Organophosphorus Compounds; Pesticide Related		
Atrazine	3	3
Malathion	100[2]	100[2]
Organochlorine Pesticides		
Aldrin	0.002 (0.05[3])	0.002 (0.014[4])
Dieldrin	0.002 (0.05[3])	0.002 (0.013[4])
Endrin	0.2	2[6]
Isodrin	0.06[2]	0.06[2]
Other Organics		
Dibromochloropropane	0.2	0.2
n-Nitrosodimethylamine	0.007[5] (0.033[3])	0.00069 (0.009[4])
1,4-Dioxane	--	0.35[7]
n-Nitrosodi-n-propylamine	--	0.005[7]
Arsenic	2.35[2]	2.35[2]

Table 2. Chemical-Specific ARARs and TBCs - CSRGs for NBCS

Chemical Group/Compound	ROD Containment System Remediation Goals (µg/l)[1]	Revised Containment System Remediation Goals (µg/l)[1]
Anions		
Fluoride	2,000	2,000
Chloride	250,000	250,000
Sulfate	540,000[8]	540,000[8]

[1] Colorado Basic Standards for Groundwater unless otherwise noted, 5 Code of Colorado Regulations 1002-8, Section 3.11 (1996).
[2] Health-based value from the ROD for the Off-Post Operable Unit (HLA 1995).
[3] EPA Region VIII Health Advisory value.
[4] Practical quantitation limit for compliance monitoring.
[5] Risk-based value from the Integrated Risk Information System (EPA 1995).
[6] The ARAR for endrin was revised in 2001 based on revision to the CBSG (Army 2001).
[7] Colorado promulgated this standard subsequent to the ROD. No ROD CSRG was identified. Colorado Basic Standards for Groundwater, 5 Code of Colorado Regulations 1002-41 (2016).
[8] Inorganic CSRG for sulfate may be natural background concentration.

Table 3. Chemical-Specific ARARs and TBCs - CSRGs for NWBCS

Chemical Group/Compound	ROD Containment System Remediation Goals (µg/l)[1]	Revised Containment System Remediation Goals (µg/l)[1]
Volatile Halogenated Organics		
Chloroform	6	6
Trichloroethylene	3[2]	3[2]
Organophosphorus Compounds; GB Agent Related		
Diisopropylmethyl phosphonate (DIMP)	8	8
Organochlorine Pesticides		
Dieldrin	0.002 (0.05[3])	0.002 (0.013[3])
Endrin	0.2	2[5]
Isodrin	0.06[2]	0.06[2]
Other Organics		
n-Nitrosodimethylamine	0.007[4] (0.033[3])	0.00069 (0.009[3])
1,4-Dioxane	--	0.35[6]
n-Nitrosodi-n-propylamine	--	0.005[6]
Arsenic	2.35[2]	2.35[2]

[1] Colorado Basic Standards for Groundwater unless otherwise noted, 5 Code of Colorado Regulations 1002-8, Section 3.11 (1996).
[2] Health-based value from the ROD for the Off-Post Operable Unit (HLA 1995).
[3] Practical quantitation limit for compliance monitoring.
[4] Risk-based level from the Integrated Risk Information System (EPA 1995).
[5] The ARAR for endrin was revised in 2001 based on revision to the CBSG (Army 2001).
[6] Colorado promulgated this standard subsequent to the ROD. No ROD CSRG was identified. Colorado Basic Standards for Groundwater, 5 Code of Colorado Regulations 1002-41 (2016).

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Table 4. Chemical-Specific ARARs and TBCs - CSRGs for OGITS (FCTS and NPTS)

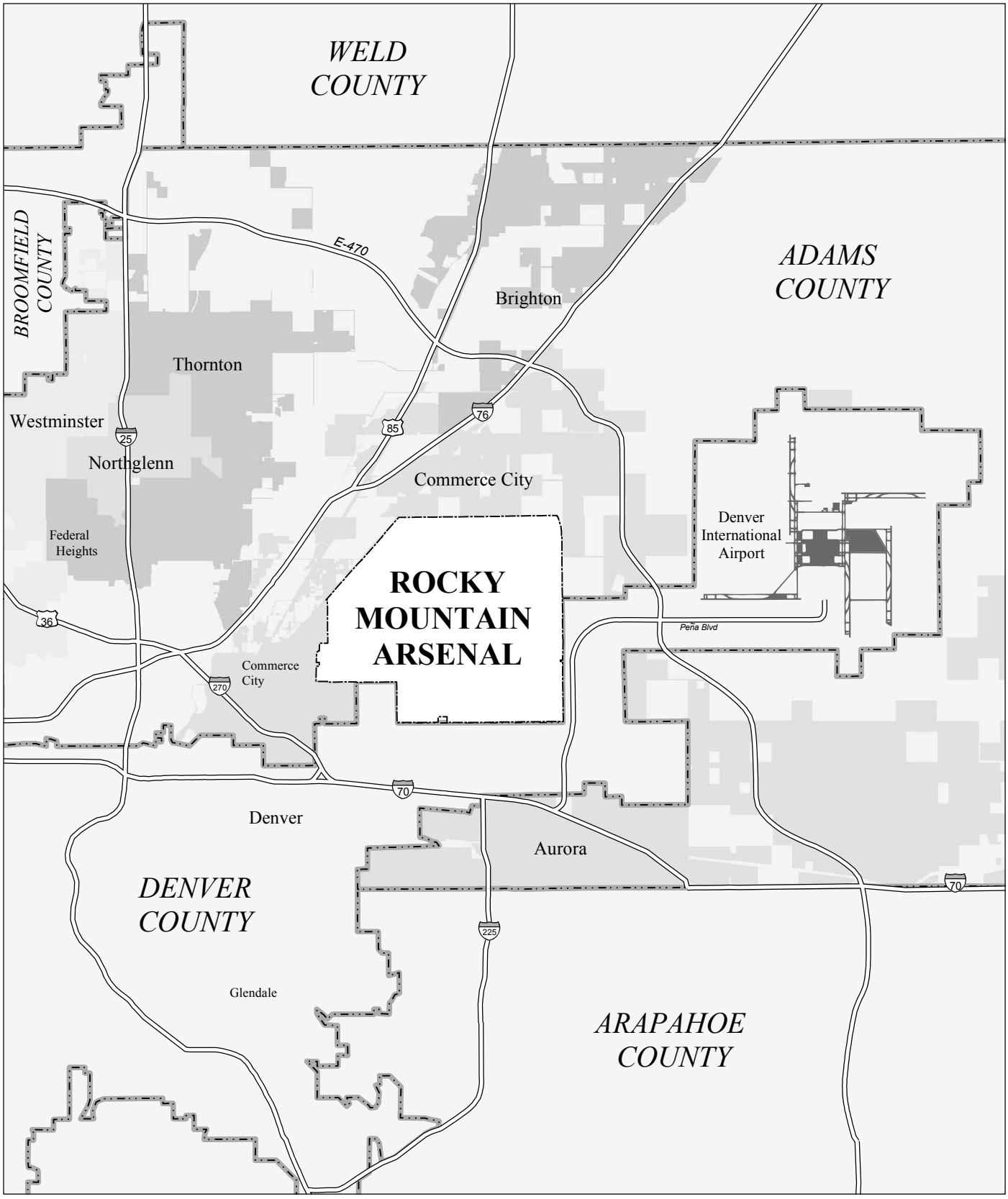
Chemical Group/Compound	ROD Containment System Remediation Goals (µg/l)[1]	Revised Containment System Remediation Goals (µg/l)[1]
Volatile Halogenated Organics		
1,2-Dichloroethane	0.4	0.4
1,3-Dichlorobenzene	6.5[2]	6.5[2]
Carbon tetrachloride	0.3	0.3
Chlorobenzene	25[2]	25[2]
Chloroform	6	6
Ethylbenzene	200[2]	200[2]
Tetrachloroethylene	5	5
Trichloroethylene	3[2]	3[2]
Volatile Hydrocarbon Compounds		
Dicyclopentadiene	46[2]	46[2]
Volatile Aromatic Organics		
Benzene	3[2]	3[2]
Xylenes	1,000[2]	1,000[2]
Toluene	1,000	1,000
Organosulfur Compounds; Mustard Agent Related		
1,4-Oxathiane	160[2]	160[2]
Dithiane	18[2]	18[2]
Organosulfur Compounds; Herbicide Related		
Chlorophenylmethylsulfide	30[2]	30[2]
Chlorophenylmethylsulfone	36[2]	36[2]
Chlorophenylmethylsulfoxide	36[2]	36[2]
Organophosphorus Compounds; GB Agent Related		
Diisopropylmethyl phosphonate (DIMP)	8	8
Organophosphorus Compounds; Pesticide Related		
Atrazine	3	3
Malathion	100[2]	100[2]
Organochlorine Pesticides		
Aldrin	0.002 (0.05[3])	0.002 (0.014[3])
Chlordane	0.03	0.03
DDE (Dichlorodiphenyltrichloroethane)	0.1	0.1
DDT (Dichlorodiphenyltrichloroethane)	0.1	0.1
Dieldrin	0.002 (0.05[3])	0.002 (0.013[3])
Endrin	0.2	2[4]
Hexachlorocyclopentadiene	0.23[2]	0.23[2]
Isodrin	0.06[2]	0.06[2]

Table 4. Chemical-Specific ARARs and TBCs - CSRGs for OGITS (FCTS and NPTS)

Chemical Group/Compound	ROD Containment System Remediation Goals (µg/l)[1]	Revised Containment System Remediation Goals (µg/l)[1]
Other Organics		
Dibromochloropropane	0.2	0.2
n-Nitrosodimethylamine	0.007[5] (0.033[3])	0.00069 (0.009[3])
n-Nitrosodi-n-propylamine	--	0.005[6]
Arsenic	2.35[2]	2.35[2]
Anions		
Fluoride	2,000	2,000
Chloride	250,000	250,000
Sulfate	250,000	540,000[7]

[1] Colorado Basic Standards for Groundwater unless otherwise noted, 5 Code of Colorado Regulations 1002-8, Section 3.11 (1996).
[2] Health-based value from the ROD for the Off-Post Operable Unit (HLA 1995).
[3] Practical quantitation limit for compliance monitoring.
[4] The ARAR for endrin was revised in 2001 based on revision to the CBSG (Army 2001).
[5] Risk-based level from the Integrated Risk Information System (EPA 1995).
[6] Colorado promulgated this standard subsequent to the ROD. No ROD CSRG was identified. Colorado Basic Standards for Groundwater, 5 Code of Colorado Regulations 1002-41 (2016).
[7] Inorganic CSRG for sulfate may be the natural background concentration.

FIGURES



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0 1 2 3 4

Miles

FIGURE 1

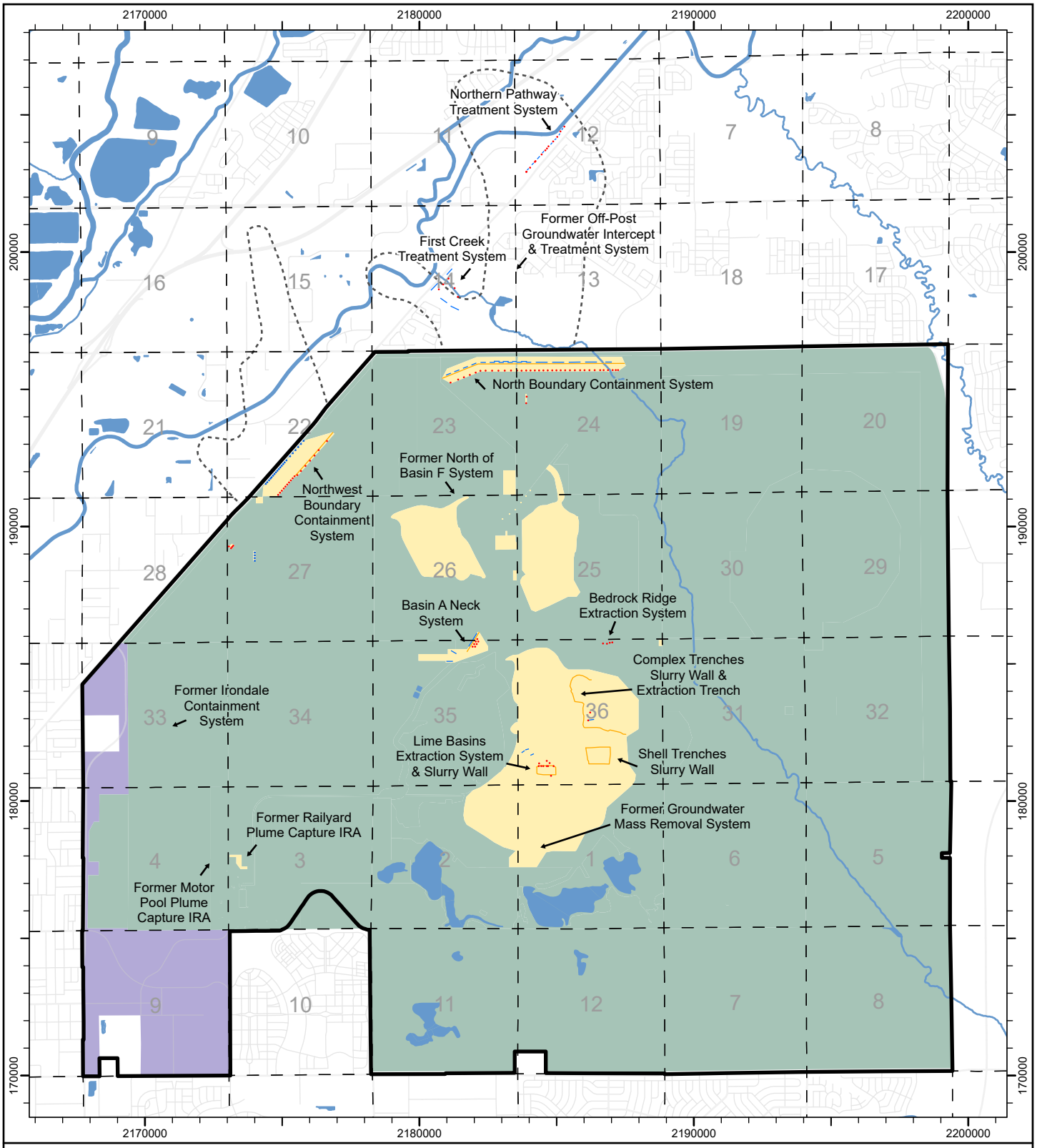
Rocky Mountain Arsenal
Regional Reference Map

State Plane Coordinate System, CO North Zone
NAD27-NGVD29 Datum, US Survey Feet

Sources: U.S. Army, RMA GIS, Navarro, Shell/AECOM, CDOT

2025-04-08

Map Document: D:/usr2/Map Documents/regional_ref-bw.mxd Printed: June 18, 2008



RMA On-Post Operable Unit
Off-Post Operable Unit (1996 Plume Extent)
PLSS Sections
U.S. Army Jurisdiction
USFWS National Wildlife Refuge
Prairie Gateway Unit Development
Surface Water
Off-Post Roads
Slurry Walls
Recharge Trenches
Extraction Wells
Recharge Wells

0 0.5 1 Miles
1" = 2,500 FT

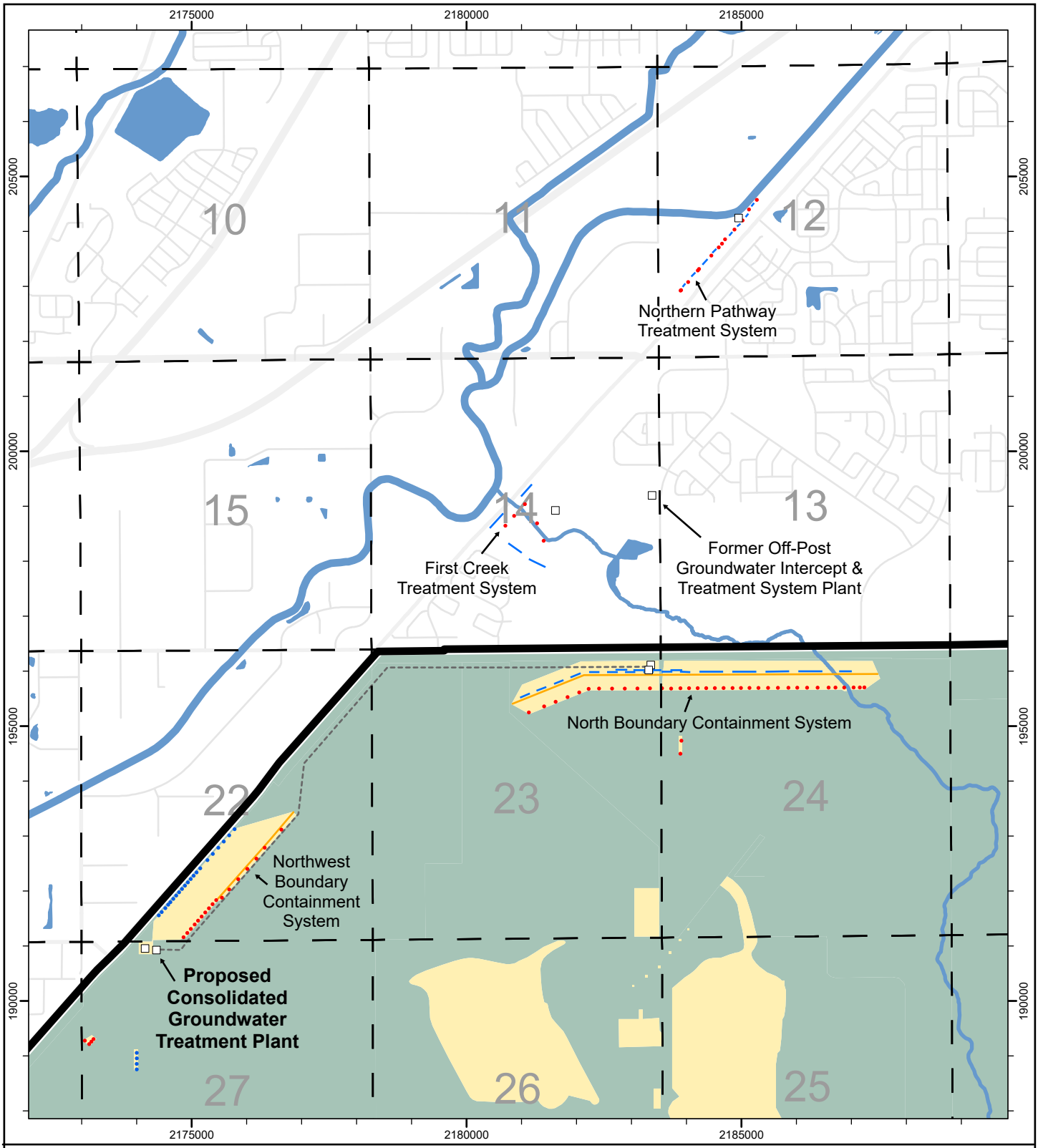
N

FIGURE 2
RMA Operable Units & Groundwater Treatment Systems

State Plane Coordinate System, CO North Zone
NAD27-NGVD29 Datum, US Survey Feet

Sources: U.S. Army, RMA GIS, Navarro, Shell/AECOM
2025-04-10

M:/PROJECTS/2025/2025_01_ESD_CGTP (FIG_2_COLOR)



RMA On-Post Operable Unit
PLSS Sections
U.S. Army Jurisdiction
USFWS National Wildlife Refuge
Surface Water
Off-Post Roads
New Conveyance Line

Slurry Walls
Recharge Trenches
Treatment Plant Buildings
Extraction Wells
Recharge Wells

0 0.25 0.5 Miles
1" = 2,500 FT

N

FIGURE 3
Consolidated Groundwater Treatment Plant Location

State Plane Coordinate System, CO North Zone
NAD27-NGVD29 Datum, US Survey Feet

Sources: U.S. Army, RMA GIS, Navarro, Shell/AECOM
2025-04-10

M:/PROJECTS/2025/2025_01_ESD_CGTP (FIG_3_COLOR)

Appendix A
Responses to Regulatory Agency Comments

U.S. Department of the Army Responses to the Environmental Protection Agency's March 24, 2025 Comments on the Explanation of Significant Differences for Groundwater Treatment Systems Remediation Requirements, dated February 15, 2025

GENERAL COMMENTS

Comment 1. Given the known presence of per- and polyfluoroalkyl substances (PFAS) compounds at the Rocky Mountain Arsenal, and the fact that the proposed treatment plant and treatment approach will treat for PFAS compounds that are known to be present in groundwater, EPA recommends that the Army include PFAS compounds as contaminants of concern (COC) in this Explanation of Significant Differences (ESD). If PFAS is not being addressed at this time, please explain how it will be addresses moving forward.

Response: Monitoring of PFAS at RMA is ongoing and a comprehensive evaluation of these emerging contaminants will be included in the upcoming Five-Year Review (draft report due in September 2025). Monitoring of treatment plant influent and effluent started in FY17 and the systems have been monitored quarterly since July 2022. Treatment plant monitoring to date has demonstrated that the existing systems are effective in removing PFAS from groundwater to levels below the National Primary Drinking Water Regulations Maximum Contaminant Levels. A summary of recent treatment plant monitoring data is attached. Monitoring of treatment system performance wells and water quality tracking wells is performed in accordance with the LTMP and results are included in the Annual Summary Reports.

Note: Based on the performance of the existing treatment plants, it is expected that the CGTP will demonstrate similar effectiveness in treating PFAS contamination.

SPECIFIC COMMENTS

Comment 1. **Section 2.1, RMA Operational History, Page 3:** The text states, "The EPA certified that approximately 24.9 square miles of the original On-Post OU have met cleanup goals and are no longer part of the NPL site." Because there are ongoing institutional controls that continue to apply sitewide, please replace "…are no longer part of the NPL site" with "have been deleted from the NPL site."

Response: The text has been revised as requested.

Comment 2. **Section 2.2.3, Off-Post Groundwater Intercept and Treatment System, Page 5:** Are the Fact Sheets documenting or explaining minor changes to the ROD? If so, please clarify that the Fact Sheets for the FCTS and NPTS explain and/or document minor changes to the Off-Post ROD.

Response: Yes. The text has been revised to clarify that these are minor changes to the Off-Post ROD.

Comment 3. **Section 2.4, Summary of the Selected On-Post Remedy for Groundwater, Page 5:** It appears some of the changes described were made by other means not associated with previous ESDs. Please revise the first sentence to reflect that modifications to the ROD were done by ESDs or other documentation (e.g., Memorandum to File to document minor changes) and ensure that all references to each corresponding ROD modifications are correct. If Fact Sheets are meant to document minor changes to the ROD, please state in the text.

Response: The text has been revised to clarify that significant changes to the ROD are documented in ESDs and minor changes are documented in Fact Sheets or other documentation included in the site file.

Comment 4. **Section 2.4, Summary of the Selected Off-Post Remedy, Page 6:** It appears some of the changes described were made by other means not associated with previous ESDs. Please revise the first sentence to reflect that modifications to the ROD were done by ESDs or other documentation (e.g., Memorandum to File to document minor changes) and ensure that all references to each corresponding ROD modifications are correct. If Fact Sheets are meant to document minor changes to the ROD, please state in the text.

Response: The text has been revised to clarify that significant changes to the ROD are documented in ESDs and minor changes are documented in Fact Sheets or other documentation included in the site file.

Comment 5. **Section 6, Public Participation Compliance, Page 13:** Please confirm if both a public notification and a public comment period are required and revise text if needed.

Response: 40 CFR 300.435(c)(2)(i) requires a public notification when an ESD is issued. Although a public comment period is not required, the Army is providing the opportunity for public review and comment as part of the RMA community outreach. All comments received will be considered prior to issuing the final ESD.

Comment 6. **Section 6, Public Participation Compliance, Page 13:** Does ACHD need to be included in this section?

Response: ACHD is included in Section 5 under Support Agency Comments.

Comment 7. **Section 7, Statutory Determinations, Page 15:** Please revise to list Cyrus Western as the Regional Administrator. If the Regional Administrator delegates to the Division Director, the signatory would be Aaron Urdiales. EPA will communicate any changes to the Army and the rest of the site team, as needed.

Response: The signature page has been revised as noted.

Comment 8. **Appendices:** Please include an appendix with regulator comments and responses to those comments in the Final version of the document and reference that appendix in Section 5.

Response: An appendix has been added with the appropriate reference.

MINOR COMMENTS

Comment 1. **Section 4.1, Summary of Changes to Remedy, Table 1, Changes to the Groundwater Remedy, Page 12:** The text states, "The NBCS and NWBCS treatment plants are being replaced by a new Treatment CGTP." Recommend replacing with, "The NBCS and NWBCS treatment plants are being replaced by a new treatment plant (CGTP)."

Response: Comment incorporated.

Comment 2. **Section 2.1, RMA Operational History, Page 3:** The text states, "All remedial actions required by the RODs have been completed…" Please clarify if this should only be referencing the On-Post OU ROD.

Response: The text has been revised to clarify that all remedial actions for surface media, which includes soil and structures, have been completed. This is correct for both the On-Post and Off-Post Operable Units.

Comment 3. **Throughout Document:** Please revise references to on post/on-post and off post/off-post consistently throughout the document.

Response: The document was reviewed and revised as needed to provide consistent terminology. Note that the terms appear with the hyphen when they are used as a modifier, i.e., adjective or adverb.

U.S. Department of the Army Responses to the Colorado Department of Public Health and Environment's March 21, 2025 Comments on the Explanation of Significant Differences for Groundwater Treatment Systems Remediation Requirements, dated February 15, 2025

GENERAL COMMENTS

Comment 1. General. Per- and Polyfluoroalkyl Substances (PFAS) have been detected on site and up gradient from the North Boundary Containment System (NBCS) and the Northwest Boundary Containment System (NWBCS). Given the recent adoption of the Maximum Contaminant Level (MCL) for PFAS, which are much lower than the health advisory level used in the previous 2019 evaluation of potential RMA PFAS sources, CDPHE recommends a formal site wide evaluation in the 2025 Five-Year Review process to assess whether these compounds should be added to the Containment System Remediation Goals (CSRGs). Please revise this ESD to note how current and future treatment/monitoring at the boundary systems will remain effective at treating PFAS in the interim.

Response: Monitoring of PFAS at RMA is ongoing and a comprehensive evaluation of these emerging contaminants will be included in the upcoming Five-Year Review (draft report due in September 2025). Monitoring of treatment plant influent and effluent started in FY17 and the systems have been monitored quarterly since July 2022. Treatment plant monitoring to date has demonstrated that the existing systems are effective in removing PFAS from groundwater to levels below the MCL. A summary of recent treatment plant monitoring data is attached. Monitoring of treatment system performance wells and water quality tracking wells is performed in accordance with the LTMP and results are included in the Annual Summary Reports.

Note: Based on the performance of the existing treatment plants, it is expected that the CGTP will demonstrate similar effectiveness in treating PFAS contamination.

Comment 2. Section 1.0, page 2. The adoption of applicable or Relevant and Appropriate Requirements (ARARs) for emerging contaminants presented in this section should include a discussion regarding the flexibility designed into the new system that will allow for future expansion of the treatment train to treat these contaminants at RMA. Specifically, additional detail should be added to this section regarding the provision of space within the Consolidated Groundwater Treatment Plant (CGTP) to allow for an Advanced Oxidation Process for 1,4-Dioxane at the NWBCS, as well as the treatment capacity of the current system to continue to remove PFAS from the influent as necessary.

Response: The text has been revised to discuss the potential for the addition of advanced oxidation for the NWBCS should concentrations of 1,4-dioxane increase above the CSRG. Discussion for potential PFAS treatment is deferred to the upcoming Five-Year Review. See also response to comment 1.

U.S. Department of the Army Responses to the Adams County Health Department's March 21, 2025 Comments on the Explanation of Significant Differences for Groundwater Treatment Systems Remediation Requirements, dated February 15, 2025

GENERAL COMMENTS

Comment 1. Per- and Polyfluoroalkyl Substances (PFAS) have been detected on site and up gradient from the North Boundary Containment System (NBCS) and the Northwest Boundary Containment System (NWBCS). ACHD recommends evaluation to assess whether these compounds should be added to the Containment System Remediation Goals (CSRGs) due to the adoption of the Maximum Contaminant Level (MCL) for PFAS.

Response: Monitoring of PFAS at RMA is ongoing and a comprehensive evaluation of these emerging contaminants will be included in the upcoming Five-Year Review (draft report due in September 2025). Monitoring of treatment plant influent and effluent started in FY17 and the systems have been monitored quarterly since July 2022. Treatment plant monitoring to date has demonstrated that the existing systems are effective in removing PFAS from groundwater to levels below the MCL. A summary of recent treatment plant monitoring data is attached. Monitoring of treatment system performance wells and water quality tracking wells is performed in accordance with the LTMP and results are included in the Annual Summary Reports.

Note: Based on the performance of the existing treatment plants, it is expected that the CGTP will demonstrate similar effectiveness in treating PFAS contamination.

RMA Groundwater Treatment System Influent/Effluent PFAS Monitoring Results (concentrations in ng/l)

	FY24								FY25			
	Oct-23		Jan-24		Apr-24		Jul-24		Oct-23		Jan-24	
NBCS	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
HFPODA	LT 7.68	LT 7.68	LT 1.98	LT 1.79	LT 1.92	LT 1.92	LT 1.54	LT 1.54	LT 1.35	LT 1.43	LT 1.56	LT 1.56
PFBS	3	LT 1.92	2.5	LT 1.81	2	LT 1.92	2.4	LT 2.08	LT 1.8	2.9	2.3	LT 2.08
PFHxS	4.2	LT 1.92	3.2	LT 1.81	2.8	LT 1.92	3	LT 2.08	LT 1.8	2.7	2.9	LT 2.08
PFNA	LT 1.92	LT 1.92	LT 1.92	LT 1.81	LT 1.92	LT 1.92	LT 2.08	LT 2.08	LT 1.8	LT 1.9	LT 2.08	LT 2.08
PFOA	LT 1.92	LT 1.92	LT 1.92	LT 1.81	LT 1.92	LT 1.92	LT 2.08	LT 2.08	LT 1.8	LT 1.9	LT 2.08	LT 2.08
PFOS	LT 1.92	LT 1.92	LT 1.92	LT 1.81	LT 1.92	LT 1.92	LT 2.08	LT 2.08	LT 1.8	LT 1.9	LT 2.08	LT 2.08
NWBCS	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
HFPODA	LT 7.68	LT 7.68	LT 1.98	LT 1.98	LT 1.79	LT 1.98	LT 1.54	LT 1.54	LT 1.35	LT 1.35	LT 1.5	LT 1.44
PFBS	4.3	2.6	4.2	LT 2	4.6	2.6	5.3	4	5.2	3.7	4.1	2.8
PFHxS	5.2	LT 1.92	5.01	LT 2	4.7	LT 2.08	5.6	2.2	5	2.1	5.1	LT 1.92
PFNA	LT 1.92	LT 1.92	LT 2.08	LT 2	LT 1.76	LT 2.08	LT 2.08	LT 2.08	LT 1.8	LT 1.8	LT 2	LT 1.92
PFOA	2.3	LT 1.92	2.3	LT 2	2.3	LT 2.08	2.9	LT 2.08	**4.1**	2.2	3.6	LT 1.92
PFOS	2.9	LT 1.92	3.3	LT 2	2.7	LT 2.08	3.3	LT 2.08	3	LT 1.8	3.4	LT 1.92
BANS	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
HFPODA	LT 7.04	LT 7.68	LT 1.98	LT 1.98	LT 4.03	LT 1.98	LT 1.54	LT 1.54	LT 1.4	LT 1.4	LT 1.4	LT 1.41
PFBS	LT 1.76	LT 1.92	LT 2.08	LT 2.02	LT 4	LT 2.08	LT 1.92	LT 2.08	LT 1.86	LT 1.86	LT 1.9	LT 1.88
PFHxS	8.5	LT 1.92	9.3	LT 2.02	6.7	LT 2.08	6.3	LT 2.08	6.4	LT 1.86	6.5	LT 1.88
PFNA	LT 1.76	LT 1.92	LT 2.08	LT 2.02	LT 4	LT 2.08	LT 1.92	LT 2.08	LT 1.86	LT 1.86	LT 1.9	LT 1.88
PFOA	**5.1**	LT 1.92	3.41	LT 2.02	LT 4	LT 2.08	**4.1**	LT 2.08	2.7	LT 1.86	3.6	LT 1.88
PFOS	**6.2**	LT 1.92	**6.8**	LT 2.02	**5.1**	LT 2.08	**5.5**	LT 2.08	**4.7**	LT 1.86	**6.7**	LT 1.88
FCTS	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
HFPODA	LT 7.68	LT 7.04	LT 1.79	LT 1.92	LT 1.92	LT 1.98	LT 1.54	LT 1.54	LT 1.35	LT 1.4	LT 1.5	LT 1.53
PFBS	7.7	2.81	6.8	1.9	6.6	3.2	8	2.2	8.2	4.5	7.2	3.9
PFHxS	2	LT 1.76	1.9	LT 1.89	LT 1.92	LT 2.08	2.4	LT 2.08	LT 1.8	LT 1.86	LT 1.9	LT 2.04
PFNA	LT 1.92	LT 1.76	LT 1.76	LT 1.89	LT 1.92	LT 2.08	LT 2.08	LT 2.08	LT 1.8	LT 1.86	LT 1.9	LT 2.04
PFOA	**4.5**	LT 1.76	2.3	LT 1.89	LT 1.92	LT 2.08	3.9	LT 2.08	3	2.2	2.2	LT 2.04
PFOS	LT 1.92	LT 1.76	LT 1.92	LT 1.89	LT 1.92	LT 2.08	LT 2.08	LT 2.08	LT 1.8	LT 1.86	LT 1.9	LT 2.04
NPTS	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
HFPODA	LT 7.68	LT 7.68	LT 1.79	LT 1.92	LT 1.79	LT 1.98	LT 1.47	LT 1.54	LT 1.43	LT 1.47	LT 1.32	LT 1.41
PFBS	7.4	7.6	5.9	2.08	6.2	4.9	6.9	LT 2.08	7.8	5.3	8	6.5
PFHxS	3.2	2.6	3	LT 1.9	2.6	LT 2.08	3.2	LT 2.08	3.8	LT 1.96	3.6	2
PFNA	LT 1.92	LT 1.92	LT 1.76	LT 1.9	LT 1.76	LT 2.08	LT 1.92	LT 2.08	LT 1.9	LT 1.96	LT 1.76	LT 1.88
PFOA	3.6	3	3.5	LT 1.9	2.8	LT 2.08	3.6	LT 2.08	3.5	LT 1.96	3.2	2.4
PFOS	2.6	LT 1.92	3.4	LT 1.9	3	LT 2.08	2.7	LT 2.08	2.3	LT 1.96	2.2	LT 1.88

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Appendix B
Public Comments Received and Responses to Comments

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