RCRA Facility Investigation – Remedial Investigation/ Corrective Measures Study – Feasibility Study Report for the Rocky Flats Environmental Technology Site

Executive Summary

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ES.1.0 INTRODUCTION

The Rocky Flats Environmental Technology Site (RFETS or site) is a 6,240-acre U.S. Department of Energy (DOE) facility owned by the United States. RFETS is located in the Denver metropolitan area approximately 16 miles northwest of Denver, Colorado, and approximately 10 miles south of Boulder, Colorado (Figure ES.1).

This Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation/Feasibility Study (RI/FS) Report for RFETS was prepared in accordance with the Final Work Plan for the Development of the Remedial Investigation and Feasibility Study Report (RI/FS Work Plan). Because remedial activities at RFETS are also being conducted under the Resource Conservation and Recovery Act (RCRA) and the Colorado Hazardous Waste Act (CHWA), this RI/FS Report also meets RCRA/CHWA requirements for a RCRA Facility Investigation/ Corrective Measures Study (RFI/CMS) Report. References to CERCLA requirements are also intended to encompass RCRA/CHWA requirements. For simplicity, the report is hereinafter referred to as the RI/FS Report.

CERCLA response actions and RCRA/CHWA corrective and closure actions are conducted by DOE at RFETS subject to the July 19, 1996, Rocky Flats Cleanup Agreement (RFCA). The U.S. Environmental Protection Agency (EPA), Region VIII and the Colorado Department of Public Health and Environment (CDPHE) exercise their respective statutory and regulatory authorities to oversee and approve DOE's investigation and cleanup actions in accordance with RFCA. Other CERCLA and RCRA/CHWA agreements and orders between DOE, EPA, and CDPHE preceded RFCA, guiding DOE's investigation and cleanup actions since 1986.

To expedite remedial work and maximize early risk reduction, RFCA adopted an accelerated action approach to cleanup. Accelerated actions removed contaminated soils, decontaminated and demolished contaminated buildings, closed the Present and Original Landfills, and installed four systems to collect and treat contaminated groundwater.

When approved by CDPHE and EPA, the RI/FS Report will be the basis for development of a Proposed Plan that describes the preferred remedy for RFETS. The Proposed Plan is the basis for the Final Corrective Action Decision/Record of Decision (CAD/ROD).

ES.1.1 Organization of the Remedial Investigation/Feasibility Study Report

The RI/FS Report is organized as follows:

- Section 1.0 presents introductory information, including the site background, site description, history, future land use, previous investigations, and the RFCA regulatory approach for cleanup.

- Section 2.0 presents a summary of the physical characteristics of the site, including surface features, meteorology, surface water hydrology, geology, soil, hydrogeology, demography and land use, and ecology.

- Sections 3.0 through 6.0 present the nature and extent of soil, groundwater, surface water and sediment, and air contamination, respectively.
- Section 7.0 presents the summary and conclusions of the Comprehensive Risk Assessment (CRA). The CRA consists of a Human Health Risk Assessment (HHRA) and an Ecological Risk Assessment (ERA).
- Section 8.0 presents contaminant fate and transport and describes potential routes of migration based on the RFETS conceptual model, physical characteristics of the site, contaminant mobility, and environmental persistence.
- Section 9.0 presents the summary and conclusions of the RI.
- Section 10.0 presents the remedial action objectives (RAOs) for groundwater, surface water, and soil and the applicable or relevant and appropriate requirements (ARARs) used as the final remedy goals in the RI/FS.
- Section 11.0 presents a detailed analysis of final remedial alternatives.
- Appendix A contains the CRA Report (Volumes 1 through 15).
- Appendix B contains the 2005 Historical Release Report (HRR).

ES.2.0 SITE BACKGROUND

The site background and cleanup progress toward final closure of RFETS are summarized below.

ES.2.1 History

RFETS was established in 1951 primarily to manufacture plutonium pits and other components for nuclear weapons triggers from uranium and other metals including stainless steel and beryllium. This was accomplished in an approximately 300-acre industrialized area at the center of the RFETS property. The industrialized area was surrounded by a security buffer zone that contained some supporting activities, such as waste disposal, but was left mostly undisturbed.

Manufacturing activities, accidental industrial fires and spills, and support activities, including waste management, resulted in the release of CERCLA hazardous substances and RCRA/CHWA hazardous wastes and hazardous waste constituents (also defined as CERCLA hazardous substances) to air, soil, sediment, groundwater, and surface water at RFETS. Some buildings and infrastructure systems also became contaminated.

Released hazardous substances at RFETS include radionuclides, volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs), inorganic compounds, and metals. RFETS was added to the CERCLA National Priorities List (NPL) on September 21, 1989 (54 Federal Register [FR] 41015, October 4, 1989). The NPL description included RFETS and land adjacent, or off site, from RFETS.

Known or suspected release locations (primarily soil) were delineated by 183 Individual Hazardous Substance Sites (IHSSs) in 16 Operable Units (OUs), 146 Potential Areas of Concern (PACs), 31 Under Building Contamination (UBC) Sites, and 61 Potential Incidents of Concern (PICs) (totaling 421 areas). The IHSSs, PACs, UBC Sites, and PICs have been thoroughly investigated and characterized, as appropriate, and RFCA accelerated actions triggered by contamination levels have been confirmed completed.

In the mid-1990s the RFETS mission changed from production to cleanup and closure. At that time there were serious safety concerns about inventories of special nuclear materials (SNM) (plutonium and enriched uranium) and hazardous substances and previously generated process wastes contained in aging RFETS facilities and stored in temporary structures. The following major accomplishments to complete this mission have been achieved under RFCA:

Approximate amount of SNM shipped to other DOE facilities: • 21 tons plutonium • 100 tons plutonium residues • 30,000 liters SNM solutions	Over 800 structures cleaned up/removed, including more than 1 million square feet (ft^2) associated with: • 5 major plutonium facilities • 2 major uranium facilities
1,475 gloveboxes deactivated, decontaminated, removed, and size-reduced, as required, and disposed off site.	690 tanks deactivated, decontaminated, removed, and size-reduced, as required, and disposed off site.
Covers installed at the Present Landfill and Original Landfill to meet applicable or relevant and appropriate landfill regulatory closure performance criteria.	421 IHSSs, PACs, UBC Sites, and PICs investigated and dispositioned. All RFCA accelerated cleanup actions have been completed or a No Further Accelerated Action (NFAA) decision was made.
3 contaminated groundwater and one seep collection systems, and accompanying passive treatment systems installed that serve to protect surface water quality. • Over 11 million gallons of contaminated groundwater and 5 million gallons of contaminated seep water treated to date.	Cleanup and closure waste shipped off site: • Over 15,000 cubic meters (m^3) transuranic (TRU) waste (including mixed waste) • Over 500,000 m^3 low-level radioactive waste (LLW) (including mixed waste) • Over 800,000 m^3 sanitary waste • Over 4,300 m^3 hazardous waste

ES.2.2 Rocky Flats National Wildlife Refuge Future Use

After completion of cleanup and closure, RFETS will become a National Wildlife Refuge in accordance with the Rocky Flats National Wildlife Refuge Act of 2001 (Refuge Act), Public Law 107-107. The U.S. Fish and Wildlife Service (USFWS), an agency of the U.S. Department of Interior (DOI), will assume jurisdiction and control of most of the property for refuge purposes, and DOE will retain jurisdiction of real property and facilities to be used in carrying out any final response action. A Final Comprehensive Conservation Plan/Environmental Impact Statement (CCP/EIS) related to the

establishment of the Refuge has been prepared by USFWS, in consultation with the public and the local communities. The area of DOE and USFWS jurisdiction and control will be delineated in the Final CAD/ROD.

ES.2.3 Environmental Permits

After the NPL listing, RCRA/CHWA, National Pollutant Discharge Elimination System (NPDES), and Clean Air Act (CAA) permits covering RFETS operations were issued to DOE and its contractor. The RCRA/CHWA permit and RFCA requirement for corrective action were specifically coordinated under the RFCA regulatory approach. Permitted operational activities continued at RFETS during the cleanup under RFCA. Permits have been or will be terminated in accordance with the regulatory requirements for termination after permitted activities end, or upon CHWA-permitted facility closure in accordance with the CHWA permit closure plan. A CHWA post-closure permit or an order or agreement in lieu of a post-closure permit will be required.

ES.3.0 NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination evaluations considered the following environmental media: soil, groundwater, surface water, sediment, and air. These evaluations were conducted to show the types of analytes of interest (AOIs) remaining in the environmental media and their extent at RFETS following the completion of RFCA accelerated actions. The purpose of identifying AOIs was to focus the nature and extent evaluation on constituents that were detected at concentrations that may contribute to the risk to future receptors and to show the overall spatial and temporal trends of those constituents on a sitewide basis. These evaluations identified 14 AOIs for surface soil, 14 AOIs for subsurface soil, 19 AOIs for groundwater, 18 AOIs for surface water, 5 AOIs for sediment, and 5 AOIs for air.

Table ES.1 presents a summary of the RFI/RI. The first column presents the results of the nature and extent of contamination evaluations. Details on the nature and extent of contamination screening methodology, preliminary remediation goals (PRGs), standards or benchmarks used in the screen, and results for the various media are found in the following sections of the RI/FS Report: Section 3.0 for soil, Section 4.0 for groundwater, Section 5.0 for surface water and sediment, and Section 6.0 for air.

ES.4.0 CONCLUSIONS OF THE COMPREHENSIVE RISK ASSESSMENT

The CRA consists of two parts: an HHRA and an ERA. A risk assessment is an evaluation of potential adverse impacts to human health and the environment that may exist from contaminated environmental media associated with site-related activities. The CRA was designed to provide information to decision makers to help determine the final remedy that is adequately protective of human health and the environment. The entire details of the CRA are found in Appendix A of this report. The results of the CRA are summarized in Section 7.0, and the conclusions of the CRA are summarized in Table ES.1, Column 2.

Under the CERCLA, EPA considers environmental concentrations corresponding to a 10^{-6} to 10^{-4} cancer risk range and a total noncancer hazard index (HI) less than or equal to 1 to be adequately protective of human health (NCP 1990 and EPA 1989, respectively).

CDPHE defines acceptable human health risk as a lifetime excess cancer risk less than 1 x 10^{-6} from exposure to carcinogenic compounds and/or a hazard quotient (HQ) less than 1.0 for noncarcinogenic compounds (CDPHE 1994).

The overall risk management goal identified for use in the ERA is the following:

> *Site conditions due to residual contamination should not represent significant risk of adverse ecological effects to receptors from exposure to site-related residual contamination.*

The ERA was designed and implemented to determine whether site conditions meet the defined goal.

Contaminants of concern (COCs) and ecological chemicals of potential concern (ECOPCs) were identified for the CRA on an Exposure Unit (EU) or Aquatic EU (AEU) basis using the processes outlined in the CRA Methodology (see Section 7.0 for more information).[1] Quantitative risk characterization was then performed for the EUs and AEUs that had COCs and/or ECOPCs identified.

ES.4.1 Human Health Risk Assessment

An HHRA was conducted separately for each of the 12 EUs identified for RFETS. COCs were quantitatively evaluated in the HHRA for the wildlife refuge worker (WRW) and wildlife refuge visitor (WRV) consistent with the anticipated future land use of RFETS as a wildlife refuge.

ES.4.1.1 Soil and Sediment

Based on the steps of the COC identification process, no COCs were identified for subsurface soil/subsurface sediment in the HHRA for any of the EUs. The process identified 5 COCs for surface soil/surface sediment distributed in 5 of the 12 EUs as listed below:

- Upper Woman Drainage EU (UWOEU) (benzo[a]pyrene and dioxins);
- Industrial Area (IA) EU (IAEU) (arsenic and benzo[a]pyrene);

[1] CDPHE guidance requires evaluation of contaminant concentrations on a Solid Waste Management Unit (SWMU) or release site basis. As discussed in Section 1.2.3, this was implemented at RFETS on an IHSS-by-IHSS basis during the accelerated action process. As noted in Section 1.4.3, by addressing cumulative impacts from multiple release sites, the CRA's EU approach complements, but does not supplant, CHWA's emphasis on individual release sites. Because the parties had anticipated using institutional controls consistent with the anticipated future use of the site, CDPHE determined that a post-remediation analysis of residual risk on a release site basis was not necessary.

- Upper Walnut Drainage EU (UWNEU) (benzo[a]pyrene);
- Wind Blown Area EU (WBEU) (arsenic and plutonium-239/240); and
- No Name Gulch Drainage EU (NNEU) (vanadium).

The COCs have been quantitatively evaluated for the WRW and WRV receptor. Cancer risks, noncancer health effects, and radiation doses have been calculated and are summarized in Section 7.0. The cancer risk estimates for the five EUs listed above are at the low end of EPA's 1×10^{-6} to 1×10^{-4} risk range (that is, less than 1×10^{-5}). The noncancer health effects estimates (HIs) are all below 1, indicating noncancer health effects are unlikely. Radiological dose estimates are less than 1 millirem per year (mrem/yr). From a risk management perspective, only one COC requires further evaluation in the FS. The surface soil COC for the WBEU is plutonium-239/240 with an estimated cancer risk of 2×10^{-6}. For the seven EUs that do not have COCs, risks are expected to be similar to those associated with background conditions.

ES.4.1.2 Surface Water

Potential exposure to surface water by WRW or WRV receptors was evaluated in the CRA on a sitewide basis (see Appendix A, Volume 2). For this sitewide evaluation, surface water concentrations were compared to WRW PRGs.[2] Exceedances of surface water PRGs occurred within three EUs: the IAEU, UWNEU, and UWOEU. Several organics, inorganics, and radionuclides in surface water exceeded their PRGs. Further analyses for each analyte indicated that (1) the exceedances were generally slight and infrequent, and (2) the exceedances were in data from 1998 or older, whereas no exceedances occurred in the more recent data. The more recent data are more representative of current conditions at the site than the older data. For these reasons, significant exposure from the surface water pathway for the WRW or WRV is not expected.

In some areas of the site, groundwater surfaces in seeps. Contact with groundwater in these seeps is theoretically possible for the WRW and WRV. However, because the chemical concentrations in the seeps are low and any contact with water in the seeps is expected to be infrequent and of short duration, the groundwater-to-surface water migration pathway is not considered significant.

Surface water and sediment were evaluated in the ERA portion of the CRA on an AEU basis.

[2] Surface water PRGs developed for the CRA Methodology are not the standards specified in the Colorado Water Quality Control Commission (CWQCC), which are ARARs for surface water. This evaluation is to determine whether surface water contamination may pose a significant risk.

ES.4.1.3 Groundwater

As described in Appendix A, Volume 2, the RFCA Vision states that on-site groundwater will not be used for any purposes unrelated to RFETS cleanup activities. Therefore, the pathway for direct ingestion of groundwater is incomplete.

ES.4.1.4 Indoor Air Pathway

The indoor air pathway was evaluated on a sitewide basis. Volatile chemicals have been detected in the subsurface in some subsurface soil and groundwater sampling locations of the site. In these locations, the indoor air inhalation pathway is potentially significant if buildings were constructed there. In locations where there are no exceedances of the volatilization PRGs, the indoor air inhalation pathway is assumed to be insignificant. The results of this evaluation will be further evaluated in the FS.

ES.4.2 Ecological Risk Assessment

A variety of ecological receptors of concern for the ERA were identified in the CRA Methodology, including the Preble's meadow jumping mouse (PMJM), a federally listed threatened species present at RFETS. The ERA was designed and implemented to determine whether site conditions meet the defined risk management goal of identifying adverse ecological effects. The overall conclusions from the ERA indicate there is no significant risk of adverse ecological effects to receptors from exposure to site-related residual contamination. However, additional surface water, sediment, and ecological monitoring is included in the FS to address uncertainties identified in the ERA.

ES.5.0 CONTAMINANT FATE AND TRANSPORT

The contaminant fate and transport evaluation used information about the site physical characteristics, contaminant source characteristics, and contaminant distribution across the site to develop a conceptual understanding of the dominant transport processes that affect the migration of different contaminants in various RFETS environmental media. The primary focus, consistent with the RFCA objectives, is evaluating the potential for contaminants from any medium to impact surface water quality. Evaluation of a contaminant's fate and transport is based upon two criteria: (1) does a complete migration pathway exist based on an evaluation of contaminant transport in each environmental medium; and (2) is there a potential impact to surface water quality based on an evaluation of data at representative groundwater and surface water monitoring locations in the creek drainages.

The third column in Table ES.1 presents the results of the evaluation of contaminant fate and transport. Details of the contaminant fate and transport evaluation can be found in Section 8.0 of this RI/FS Report.

ES.6.0 RECONFIGURATION AND RENAMING OF THE OPERABLE UNITS

Results of the RI analysis have identified the area of RFETS impacted by DOE activities. For purposes of this RI/FS Report, the OU boundaries are reconfigured to consolidate all areas of the site that may require final remedial actions into a final reconfigured OU. The boundary of this new "Central OU" also considers conveniences and practicalities of future land management. The remaining portions of the site have been consolidated into the reconfigured "Peripheral OU" (Figure ES.2).

The Peripheral OU has been determined to be unimpacted by site activities from a hazardous waste perspective. That is, no hazardous wastes or constituents have been placed in or migrated to the Peripheral OU.

A small portion of the Peripheral OU was impacted by site activities from a radiological perspective. For example, plutonium-239/240 exists above background in surface soil in the WBEU within the Peripheral OU. A few sampling locations for plutonium-239/240 within the Peripheral OU exceed a level of 9.8 picocuries per gram (pCi/g),[3] which corresponds to a 1×10^{-6} risk level for a WRW. Of these few sampling locations, the highest result is approximately 20 pCi/g. If the highest concentration of 20 pCi/g was considered the average concentration over an appropriate EU, it would correspond to a risk of approximately 1×10^{-5} for a rural resident, which would be in the middle of the CERCLA risk range (10^{-6} to 10^{-4}). These levels of radioactivity are also far below the 231 pCi/g activity level for an adult rural resident,[4] which equates to the 25-mrem/yr dose criterion specified in the Colorado Standards for Protection Against Radiation. Therefore, no action is required in the Peripheral OU, and the Peripheral OU is determined to be acceptable for all uses from a radiological perspective.

The Central OU boundary has not been finalized and may be refined throughout the CAD/ROD process.

ES.7.0 CONCLUSIONS OF THE REMEDIAL INVESTIGATION

Based on the results of the RI, an FS is not required for the Peripheral OU. The RFCA Parties will propose a No Action CAD/ROD for the Peripheral OU.

Based on the results of the RI, an FS is required for the Central OU. As a general matter, the underlying assumptions used in the CRA human health calculations will be embodied in an institutional control. Further, the specific media to be evaluated in the FS are:

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[3] The value 9.8 pCi/g is the plutonium-239/240 WRW PRG and is based on a target risk of 1×10^{-6} (see the Final CRA Methodology).

[4] See the plutonium in surface soil target risk level in Table 1-1 of the radionuclide soil action levels (RSALs) Task 3 Report (EPA et al. 2002), Task 3 Report and Appendices: Calculations of Surface Radionuclide Soil Action Levels for Plutonium, Americium, and Uranium, Rocky Flats Environmental Technology Site, Golden, Colorado, September.

Groundwater

- Five upper hydrostratigraphic unit (UHSU) groundwater areas where contaminated groundwater may impact surface water;
- UHSU groundwater sampling locations where groundwater contamination exceeds maximum contaminant levels (MCLs); and
- Groundwater sampling locations where exceedances of volatilization PRGs in groundwater indicate a potential indoor air risk.

Surface Water

- Surface water upstream of the terminal ponds where some surface water monitoring results do not always meet Colorado surface water quality standards for some analytes.

Soil

- Surface soil that may contribute to intermittent exceedances of the surface water standard for americium-241 and plutonium-239/240 upstream of the terminal ponds;
- Surface soil in the WBEU where results of the CRA indicate potential risk to a WRW is 2×10^{-6} for plutonium-239/240;
- Subsurface soil sampling locations where exceedances of volatilization PRGs in subsurface soil indicate a potential indoor air risk; and
- Subsurface soil where complete pathways from subsurface soil to surface water (via groundwater) may impact surface water.

Air emissions present no health or environmental concerns at present and anticipated future levels. Air will therefore not be evaluated in the FS.

A summary of the RI results is found in Section 9.0 of this report. Column 4 of Table ES.1 presents the overall results of the RI, and Column 5 identifies the specific media to be evaluated in the FS.

ES.8.0 REMEDIAL ACTION OBJECTIVES AND APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

RAOs are contaminant-specific goals for the final comprehensive response action and are used in developing and evaluating remedial alternatives. ARARs are the promulgated media- and contaminant-specific standards that must be met and that are associated with the actions, locations, and contaminant levels associated with any remedial alternative. In some cases, the RAOs specifically include the ARAR standards. The results of the RI are compared to the RAOs to determine whether remedial action is needed to meet the

RAOs. Remedial action alternatives are evaluated in the FS, and only alternatives that comply with ARARs may be considered for the final remedy. Final remediation goals, including final ARARs, are incorporated into the CAD/ROD for the selected remedy.

ES.8.1 Remedial Action Objectives

RAOs provide the foundation upon which remedial cleanup alternatives are developed. Based on the results of the RI, RAOs were developed for groundwater, surface water, soil, and environmental protection. The RAO for environmental protection is incorporated into the RAOs for the specific medium.

Four RAOs (groundwater RAO 2, groundwater RAO 3, soil RAO 1, and soil RAO 3) are not met in the Central OU. Two RAOs (surface water RAO and soil RAO 2) are met under current site conditions; consequently, institutional controls are needed to ensure that these RAOs will continue to be met.

ES.8.1.1 Groundwater Remedial Action Objective 1

> *Meet groundwater quality standards, which are the Colorado Water Quality Control Commission (CWQCC) surface water standards, at groundwater Area of Concern (AOC) wells.*[5]

Status: Groundwater RAO 1 is met.

ES.8.1.2 Groundwater Remedial Action Objective 2

> *Restore contaminated groundwater that discharges directly to surface water as baseflow, and that is a significant source of surface water, to its beneficial use of surface water protection wherever practicable in a reasonable timeframe. This is measured at groundwater Sentinel wells. Prevent significant risk of adverse ecological effects.*

Status: The first part of groundwater RAO 2 (restore contaminated groundwater to its beneficial use) is not met at all Sentinel wells; however, at this time no other additional actions can reasonably be taken. The second part of groundwater RAO 2 (prevent significant risk of adverse ecological effects) is met.

ES.8.1.3 Groundwater Remedial Action Objective 3

> *Prevent domestic and irrigation use of groundwater contaminated at levels above MCLs.*

[5] AOC Wells – Wells that are within a drainage and downgradient of a contaminant plume or group of contaminant plumes. These wells will be monitored to determine whether the plume(s) may be discharging to surface water.
Sentinel Wells – Wells that are typically located near downgradient contaminant plume edges, in drainages, and downgradient of existing groundwater treatment systems. These wells will be monitored to identify changes in groundwater quality.

Status: This RAO is not met. There are some sampling locations within the Central OU where groundwater contamination exceeds MCLs. Specific mechanisms to prevent use of groundwater in these areas are evaluated in the FS.

ES.8.1.4 Surface Water Remedial Action Objective

Meet surface water quality standards, which are the CWQCC surface water standards.

Status: This RAO is met at all surface water Points of Compliance (POCs) because no surface water AOI exceeds the surface water standards at any surface water POC (or, for those surface water AOIs where data are not available at the surface water POC, at the surface water monitoring location immediately upstream of the surface water POC). However, surface water sample results do not always meet Colorado surface water quality standards for some analytes at some on-site monitoring locations upstream of the terminal ponds. Specific mechanisms to prevent use of surface water in these areas are evaluated in the FS.

ES.8.1.5 Soil Remedial Action Objective 1

Prevent migration of contaminants to groundwater that would result in exceedances of groundwater RAOs.

Status: This RAO is not met everywhere in the Central OU. Soil sources of groundwater contamination have been removed by accelerated actions; however, some subsurface soil AOIs with complete pathways from subsurface soil to surface water (via groundwater) may be above the surface water standard at one or more Sentinel wells. At this time no other additional actions can reasonably be taken.

ES.8.1.6 Soil Remedial Action Objective 2

Prevent migration of contaminants that would result in exceedances of surface water RAOs.

Status: This RAO is met provided residual soil contamination is not disturbed. If residual soil contamination is disturbed, the contamination could migrate to surface water via erosion which could result in some surface water sample results above surface water standards at some surface water monitoring locations. Specific mechanisms to prevent disturbance of soil are evaluated in the FS.

ES.8.1.7 Soil Remedial Action Objective 3

Prevent exposures that result in unacceptable risk to the WRW. The 10^{-6} risk level shall be used as the point of departure for determining remediation goals for alternatives when ARARs are not available or are not sufficiently protective because of the presence of multiple contaminants at the site or multiple pathways of exposure (40 Code of Federal Regulation [CFR] 300.430[e][2][i][A][2]). Prevent significant risk of adverse ecological effects.

Status: Soil RAO 3 is not met for human health, but it is met for the environment. Because the CRA does not evaluate an unrestricted scenario, but instead evaluates potential risk to the anticipated future user (WRW and WRV), the assumptions used in the CRA human health calculations, including the assumptions used in calculating WRW PRGs, need to be embodied in an institutional control.

In addition, the qualitative assessment of the indoor air volatilization pathway concludes that the indoor air inhalation pathway is potentially significant if buildings were constructed and occupied over some sampling locations on site where there are exceedances of volatilization PRGs in subsurface soil and groundwater.

The calculated risks for all surface soil/surface sediment COCs fell near the low end of the acceptable risk range. All COCs, except plutonium-239/240 in the WBEU, were either comparable to background risks or were of limited spatial extent or location. Results of the CRA indicate potential risk to a WRW is 2×10^{-6} for exposure to plutonium-239/240 in surface soil in the WBEU. While this level of residual contamination is protective of human health, Section 11.0 evaluates removal of surface soil within the EU to reduce the residual plutonium-239/240 contamination to below 9.8 pCi/g, which is the 1×10^{-6} WRW risk target concentration.

The overall conclusions from the ERA indicate that site conditions due to residual contamination do not represent significant risk of adverse ecological effects to receptors from exposure to site-related residual contamination. This RAO is met for the environment.

ES.8.2 Applicable or Relevant and Appropriate Requirements

One of the threshold criteria for the CERCLA remedy selection process is to identify ARARs. ARARs are the promulgated media- and contaminant-specific standards that must be met and that are associated with the actions, locations, and contaminant levels associated with any remedial alternative. With few exceptions, ARARs for the site have been met through the implementation of RFCA accelerated actions. Key ARARs are discussed in Section 10.5 of this RI/FS Report. The ARARs that have not been met, or that may not continue to be met if site conditions change, are summarized below.

- Colorado Basic Standards and Methodologies and Site Specific Standards for Surface Water – Surface water sample results do not always meet Colorado surface water quality standards for some analytes at some on-site monitoring locations upstream of the terminal ponds. Therefore, an institutional control will be needed to prevent use of surface water upstream of the terminal ponds. In addition, surface water standards could be exceeded if the land surface is disturbed; therefore, an institutional control to prevent such disturbance will also be needed.

- Environmental Covenant – This ARAR is met at the Present Landfill; however, the environmental covenant needs to be expanded to include the Central OU.

ES.9.0 DETAILED ANALYSIS OF ALTERNATIVES

With the experience and knowledge gained conducting RFCA accelerated actions, and from evaluation of alternatives in the preparation of accelerated action decision documents, the number of available options and alternatives to address residual contamination at RFETS are limited and well understood. Consequently, no formal screening of alternatives prior to the selection of alternatives that are evaluated in detail in the FS is deemed necessary.

Three alternatives for the Central OU were developed and evaluated in detail in accordance with the nine CERCLA evaluation criteria found in Section 11.0 of this RI/FS Report. The alternatives were analyzed individually against each evaluation criterion. The three alternatives were then compared to each other in regard to each criterion.

The following approved completed accelerated actions that include post-closure continued maintenance and monitoring requirements are not reevaluated in the alternatives analysis, however, the costs for these activities are included because they will continue to operate in each alternative:

- Post-closure care and monitoring of the Present Landfill and continued operation and maintenance (O&M) of the Present Landfill seep treatment system;
- Post-closure care and monitoring of the Original Landfill; and
- O&M and performance monitoring of the East Trenches Plume Treatment System (ETPTS), Mound Site Plume Treatment System (MSPTS), and Solar Ponds Plume Treatment System (SPPTS), which are operating as designed.

The passive treatment system for the Present Landfill seep is operating as designed, and a system to monitor groundwater upgradient and downgradient of both landfills is in place.

The other actions involve groundwater remediation. Results of the RI indicate that continued operation of these three groundwater actions serves to protect surface water quality over short- and intermediate-term periods by removing contaminant loading to surface water. This protection also serves to meet long-term goals for returning groundwater to its beneficial use of surface water protection.

ES.9.1 Alternative 1: No Further Action With Monitoring

This alternative maintains and monitors the completed actions conducted at the Present and Original Landfills and the 3 groundwater plume treatment systems. Specific monitoring and O&M requirements for these five actions will continue. Alternative 1 also includes the additional environmental monitoring for surface water and groundwater as described in the Fiscal Year (FY) 2005 Integrated Monitoring Plan (IMP), Revision 1.

ES.9.2 Alternative 2: Institutional and Physical Controls

This alternative adds the implementation of institutional and physical controls to Alternative 1. Institutional controls include legally enforceable and administrative land use restrictions and physical controls including signage or other physical features to control access and activity within the Central OU. Land use restrictions are limitations or prohibitions on specific activities within designated areas of the Central OU to ensure that the conditions remain protective for the WRW and WRV. Physical controls are items such as signage monuments along the perimeter of the Central OU to notify the WRW and WRV that they are at the boundary of the Refuge maintained by USFWS. DOE will retain jurisdiction over the engineered structures and monitoring systems associated with the completed actions. Institutional controls for the Central OU will include the following:

1. The construction and use of buildings that will be occupied on a permanent or temporary basis (such as for residences or offices) is prohibited. The construction and use of storage sheds or other nonoccupied structures is permitted, consistent with the restrictions contained in institutional controls 2 and 3 below, and provided such use does not impair any aspect of the response action at Rocky Flats.

2. Excavation, drilling, and other intrusive activities below a depth of 3 feet (ft) are prohibited, except for remedy-related purposes.

3. No grading, excavation, digging, tilling, or other disturbance of any kind of surface soils is permitted, except in accordance with an erosion control plan approved by CDPHE or EPA. Any such soil disturbance shall restore the soil surface to pre-existing grade.

4. Surface water above the terminal ponds may not be used for drinking water or agricultural purposes.

5. The construction or operation of groundwater wells is prohibited, except for remedy-related purposes.

6. Digging, drilling, tilling, grading, excavation, construction of any sort (including construction of any structures, paths, trails, or roads), and vehicular traffic are prohibited on the covers of the Present Landfill and the Original Landfill, except for authorized response actions.

7. Activities that may damage or impair the proper functioning of any engineered component of the response action, including but not limited to any treatment system, monitoring well, landfill cap, or surveyed benchmark, are prohibited.

Physical controls will consist of signage installed along the perimeter of the Central OU to notify the WRW and WRV that they are at the boundary of the refuge maintained by USFWS.

Institutional and physical controls will be inspected every 3 months. If evidence of activities that violate the restrictions or damage of the physical controls is found, a plan will be developed to correct the condition and the correction will be implemented. Inspections and corrective actions will be documented in an annual report to the regulatory agencies.

ES.9.3 Alternative 3: Targeted Surface Soil Removal

This alternative includes the implementation of the institutional and physical controls of Alternative 2. In addition, this alternative will remove the top 6 inches of soil in areas of residual surface soil contamination that have activities above the plutonium-239/240 WRW PRG (based on 1×10^{-6} target risk) concentration of 9.8 pCi/g, an area of approximately 368 acres. Note that this alternative may not completely remove all plutonium contamination within the 368 acres; however, the residual risk based on the EU is expected to be well below 1×10^{-6} if Alternative 3 is implemented. Previous excavation actions of a similar nature resulted in successful removal of contamination, as verified through post-accelerated action confirmation sampling based on a 90-percent confidence level. The removed soil would be placed in shipping containers and then shipped for disposal at a permitted LLW disposal facility.

ES.9.4 Results for Each Alternative

The results of the evaluation for each of the CERCLA criteria, except for the state and community acceptance criteria, which will be addressed in the CAD/ROD after comments on the Proposed Plan have been received, are presented in Table ES.2.

ES.9.5 Comparison of Alternatives

The following sections present the comparison between the alternatives considered.

ES.9.5.1 Overall Protection of Human Health and the Environment

Alternative 1 is protective of human health and the environment in the current site land configuration because no unacceptable risks from residual contamination exist after the completion of all planned RFCA accelerated actions. However, Alternative 1 is not the most protective of human health and the environment for the following reasons:

1. Because the CRA does not evaluate an unrestricted scenario, but instead evaluates potential risk to the anticipated future user (WRW and WRV), the assumptions used in the CRA human health calculations, including the assumptions used in calculating WRW PRGs, need to be embodied in an institutional control. The detailed analysis of alternatives will evaluate alternatives that include the underlying assumptions used in the CRA human health calculations as an institutional control.

2. Residual soil contamination exists in the Central OU. If residual soil contamination is disturbed, the contamination could migrate to surface water via erosion which could result in some surface water sample results above surface water standards at some

surface water monitoring locations. Alternative 1 does not prevent the disturbance of soil.

3. Contaminated subsurface features remain in the subsurface (Section 2.0) in the former IA. These features were not evaluated in the CRA because they are not an environmental medium and because of the exposure assumption in the CRA that there is no exposure pathway for a WRW because he or she will not be digging below 3 ft. Consequently, this CRA assumption needs to be embodied in an institutional control.

4. Subsurface soil and groundwater contamination exists above the indoor air volatilization PRGs. Alternative 1 does not actively prevent the possibility of an unacceptable risk of exposure to the WRW if a building were constructed over the area contaminated above the indoor air volatilization PRGs and the building was routinely occupied.

5. Groundwater contamination exists in the Central OU above MCLs. Alternative 1 does not actively prevent the use of this groundwater for domestic or irrigation purposes.

6. Surface water quality standards are met at the surface water POCs; however, surface water sample results do not always meet Colorado surface water standards for some analytes at some on-site surface water monitoring locations upstream of the terminal ponds. Alternative 1 does not actively prevent the use of this surface water.

7. The Present Landfill RFCA decision document requires institutional controls to be put in place at the time the post-closure period begins. However, institutional controls for the Original Landfill are not in place.

8. There are no prohibitions on activities affecting the engineered aspects of the remedy.

Alternatives 2 and 3 provide overall protection to human health and the environment. Although, Alternative 3 further reduces risk to a WRW by removing areas of residual plutonium-239/240 surface soil contamination, the short-term impact to the environment and cost of additional surface soil removal above the target risk-based concentration of 9.8 pCi/g is high.

ES.9.5.2 Compliance With Applicable or Relevant and Appropriate Requirements

Alternatives 2 and 3 meet the ARARs for RFETS through institutional controls.

ES.9.5.3 Long-Term Effectiveness and Permanence

With the completion of all accelerated actions, Alternative 1 achieves a moderate degree of long-term effectiveness and permanence. The accelerated action closures of the Present Landfill and Original Landfill, and the operation of three groundwater passive treatment systems, are designed for long-term physical integrity and use. Monitoring and maintenance plans are implemented to sustain the effectiveness and permanence of these actions. However, long-term effectiveness and permanence for Alternative 1 is compromised by the absence of institutional controls. Alternative 2 increases the

effectiveness and permanence of the actions by reducing exposures resulting in acceptable risk to the WRW through institutional controls that prohibit the construction and use of buildings and by placing restrictions on excavation or activities that cause soil disturbance. Institutional controls will prevent use of surface water, groundwater and/or pumping groundwater where the remedy may be impacted in the Central OU. Alternative 3 removes surface soil with residual contamination of plutonium-239/240 above the target risk-based concentration of 9.8 pCi/g and provides, through removal, a permanent and effective action.

In conclusion for this criterion, Alternative 3 provides the most permanent long-term action. Alternative 2 is ranked second only to Alternative 3 in long-term effectiveness.

ES.9.5.4 Reduction in Toxicity, Mobility, or Volume Through Treatment

All of the alternatives are equivalent because the only treatment considered in any of the alternatives occurs in the groundwater and Present Landfill seep treatment systems, which remain the same through all of the alternatives.

ES.9.5.5 Short-Term Effectiveness

Alternatives 1 and 2 provide a high degree of short-term effectiveness because the alternatives will not pose a risk to the workers or the public during implementation. The removal of large areas of surface soil with residual contamination as described in Alternative 3 will entail increased risks to workers from earthmoving and waste transportation activities. Risks to the public are expected to be low, although higher than from Alternatives 1 and 2. This risk is due to the large volume of soil and waste materials to be excavated and transported off site for disposal. Additionally, there will be a short-term impact to affected ecological resources that increases with the amount of sediment loading to surface water.

In conclusion for this criterion, Alternatives 1 and 2 provide the most short-term effectiveness.

ES.9.5.6 Implementability

Alternative 1 is easily implemented because no further removal actions need to be conducted. In addition, the IMP and landfills and groundwater treatment monitoring systems are already in place.

Alternative 2 is easily implemented by initiating deed restrictions and limited construction work to install the physical controls (signage). These activities are not expected to entail direct exposure to residual contamination.

Alternative 3 is moderately difficult to implement. Even though standard earthmoving and transportation equipment is readily available, implementing the alternative without impacting surface water quality is difficult. The implementation of the surface soil removal is difficult due to the large extent and large volume of soil to be managed. Wind and precipitation will also increase the potential for soil erosion and sediment loads to the

RFETS drainages during the removal process. Major construction to support the long duration of the work (for example, new temporary roadways) would be required to implement Alternative 3.

In conclusion for this criterion, Alternative 1 is the most implementable alternative.

ES.9.5.7 Cost

The cost of Alternative 1 is only slightly increased by the addition of Alternative 2 (5 percent increase in present worth cost). The removal of surface soil contamination in Alternative 3 adds a large increment of cost (750 percent increase in present worth cost). Alternative 3 provides only a small incremental benefit (reducing potential risk from 2×10^{-6} to below 1×10^{-6}) and entails high costs and high short-term risks (increased worker risk and mobilization of contaminants).

In conclusion for this criterion, Alternative 2 is the most cost-effective action.

ES.9.5.8 State Acceptance

Discussion of this criterion will be provided in the CAD/ROD.

ES.9.5.9 Community Acceptance

Discussion of this criterion will be provided in the CAD/ROD.

When approved by CDPHE and EPA, the RI/FS Report will be the basis for development of a Proposed Plan that describes the preferred remedy for RFETS. The Proposed Plan is the basis for the final CAD/ROD.

TABLES

Table ES.1
Summary of the RFI/RI

1 Nature and Extent AOIs					2 Risk Management Decisions and Conclusions of the CRA	3 Results of Contaminant Fate and Transport	4 Results of RFI/RI	5 Areas in the Central OU to be Evaluated in the CMS/FS
Purpose: Characterize the nature of and threat posed by hazardous substances and hazardous materials and gather data necessary to assess the extent to which the release poses a threat to human health or the environment or to support the analysis and design of potential response actions.					**Purpose: Conduct a site-specific baseline risk assessment to characterize the current and potential threats to human health and the environment that may be posed by contaminants migrating to groundwater or surface water, releasing to air, leaching through soil, remaining in the soil, and bioaccumulating in the food chain.**			
SOIL – Screened Against WRW PRGs (Screening methodology, standards screened against, and results are discussed in Section 3.0.)					Results are discussed in Section 7.0.	Results are discussed in Section 8.0.		
Surface soil Radionuclides Americium-241 Plutonium-239/240 Uranium-233/234* Uranium-235* Uranium-238* Metals Aluminum Arsenic Chromium (Total) Vanadium* VOCs SVOCs Benzo(a)pyrene Dibenz(a,h)anthracene PCBs PCB-1254 PCB-1260 Dioxins 2,3,7,8-TCDD TEQ	**Subsurface soil (0.5-3')** Radionuclides Metals Lead* VOCs SVOCs Benzo(a)pyrene PCBs	**Subsurface soil (3-8')** Radionuclides Americium-241* Plutonium-239/240 Uranium-235* Uranium-238* Metals Chromium (Total)* Lead* VOCs Tetrachloroethene* SVOCs Benzo(a)pyrene* PCBs	**Subsurface soil (8-12')** Radionuclides Plutonium-239/240* Uranium-235* Uranium-238* Metals Chromium (Total)* VOCs Tetrachloroethene* SVOCs Benzo(a)pyrene PCBs	**Subsurface soil (12-30')** Radionuclides Metals VOCs Tetrachloroethene* Trichloroethene* 1,1,2,2-Tetrachloroethane* Carbon tetrachloride* Chloroform* Methylene chloride* SVOCs PCBs PCB-1260	There is no significant risk of adverse ecological effects to receptors from exposure to site-related residual contamination. However, additional ecological monitoring to address uncertainties identified in the ERA is needed. Plutonium-239/240 in the surface soil in the WBEU has been calculated to have a potential risk of 2 x 10^{-6} for the WRW. Some subsurface sampling locations contain a complete groundwater/ subsurface soil-to-air pathway for a WRW. See Figures 9.3 and 9.5 for possible indoor air volatilization exposure areas. The CRA does not evaluate an unrestricted scenario, but instead evaluated potential risk to the anticipated future user (WRW and WRV). Assumptions are used in calculating WRW PRGs that correspond to this restricted land use scenario.	Two landfill covers were installed as accelerated actions under individual RFCA decision documents. Complete pathways from surface soil/surface sediment to surface water were identified for two surface soil AOIs: americium-241 and plutonium-239/240 (see Section 8.3.3.1 and Tables 8.4 and 8.5). These two have been observed intermittently above the surface water standard (which is higher than background or the practical quantitation limit [PQL]) at representative surface water locations upstream of the terminal ponds in North Walnut Creek, South Walnut Creek, and the South Interceptor Ditch (SID)/Woman Creek drainage. Removal of impervious areas has decreased runoff volumes and peak discharge rates resulting in reduced soil erosion and the associated particulate transport of americium-241 and plutonium-239/240 from surface soil/surface sediment with its potential impacts on surface water quality. Consequently, if residual soil contamination is disturbed, the residual soil contamination could migrate to surface water via erosion which could result in some surface water sample results above surface water standards at some surface water monitoring locations. For surface soil/surface sediment AOIs, the most current data for those analytes measured in surface water show concentrations below the highest of the surface water standard, background, or PQL at representative surface water locations downstream of the terminal ponds in North Walnut Creek, South Walnut Creek, or the SID/Woman Creek drainage. Complete pathways from subsurface soil to surface water (via groundwater) were identified for five subsurface soil AOIs, all of which are VOCs. These AOIs include carbon tetrachloride, chloroform, methylene chloride, tetrachloroethene, and trichloroethene (see Section 8.4.2.2 and Table 8.6). Subsurface soil AOIs with complete pathways from subsurface soil to surface water (via groundwater)	The calculated risks for all surface soil/surface sediment COCs were at the low end of the acceptable risk range. All COCs, except plutonium-239/240 in the WBEU, were either comparable to background risks or were of limited spatial extent or location. Removal of impervious areas has decreased runoff volumes and peak discharge rates resulting in reduced soil erosion and the associated particulate transport of americium-241 and plutonium-239/240 from surface soil/surface sediment with its potential impacts on surface water quality. Consequently, if residual soil contamination is disturbed, the contamination could migrate to surface water via erosion which could result in some surface water sample results above surface water standards at some surface water monitoring locations. For surface soil/surface sediment AOIs, the most current data for those analytes measured in surface water show concentrations below the highest of the surface water standard, background, or PQL at representative surface water locations downstream of the terminal ponds in North Walnut Creek, South Walnut Creek, or the SID/Woman Creek drainage. Subsurface soil AOIs with complete pathways from subsurface soil to surface water (via groundwater) are associated with one or more groundwater areas. Consequently, the subsurface soil AOIs with complete pathways from subsurface soil to surface water (via groundwater) may be above the surface water standard (which is higher than background or the PQL) at one or more Sentinel wells. For the subsurface soil AOIs, the most current data for those analytes measured in groundwater show concentrations below the highest of the surface water standard, background, or PQL at all AOC wells. Because the CRA does not evaluate an unrestricted scenario, but instead	Actions at the Present Landfill and Original Landfill will not be reevaluated in the FS. An alternative analysis was included in the respective landfill Interim Measures/Interim Remedial Actions (IM/IRAs). These actions will be carried forward in a No Further Action (NFA) Alternative. The following areas/media in the Central OU will be evaluated in the CMS/FS: • Subsurface soil where complete pathways from subsurface soil to surface water (via groundwater) may impact surface water; • Surface soil that may contribute to intermittent exceedances of the surface water standard for americium-241 and plutonium-239/240 upstream of the terminal ponds; • Surface soil in the WBEU where results of the CRA indicate potential risk to a WRW is 2 x 10-6 for plutonium-239/240; • Subsurface soil sampling locations where exceedances of volatilization PRGs in subsurface soil indicate a potential indoor air risk; and • Additional ecological monitoring to address uncertainties identified in the ERA. The underlying assumptions used in the CRA human health calculations will be embodied in an institutional control.

Table ES.1
Summary of the RFI/RI

1 Nature and Extent AOIs					2 Risk Management Decisions and Conclusions of the CRA	3	4	5
Purpose: Characterize the nature of and threat posed by hazardous substances and hazardous materials and gather data necessary to assess the extent to which the release poses a threat to human health or the environment or to support the analysis and design of potential response actions.					**Purpose: Conduct a site-specific baseline risk assessment to characterize the current and potential threats to human health and the environment that may be posed by contaminants migrating to groundwater or surface water, releasing to air, leaching through soil, remaining in the soil, and bioaccumulating in the food chain.**	**Results of Contaminant Fate and Transport**	**Results of RFI/RI**	**Areas in the Central OU to be Evaluated in the CMS/FS**
						are associated with one or more groundwater areas. Consequently, the subsurface soil AOIs with complete pathways from subsurface soil to surface water (via groundwater) may be above the surface water standard (which is higher than background or the PQL) at one or more Sentinel wells. At this time no other additional actions can reasonably be taken. For the subsurface AOIs, the most current data for those analytes measured in groundwater show concentrations below the highest of the surface water standard, background, or PQL at all AOC wells.	evaluated potential risk to the anticipated future user (WRW and WRV), the assumptions used in the WRW PRGs that correspond to this restricted land use scenario need to be embodied in an institutional control in the Central OU. The ERA did not identify significant risk of adverse ecological effects to receptors from exposure to site-related residual contamination. However, additional ecological monitoring is required to address uncertainties identified in the ERA.	
GROUNDWATER – Screened Against Surface Water Standards (Screening methodology, surface water standards screened against, and results are discussed in Section 4.0.)					Results are discussed in Section 7.0.	Results are discussed in Section 8.0.		
UHSU Radionuclides Uranium (sum of isotopes) **LHSU** None	VOCs cis-1,2-Dichloroethene 1,2-Dichloroethane* 1,1-Dichloroethene Benzene* Carbon tetrachloride Chloroform Chloromethane* Methylene chloride Tetrachloroethene Trichloroethene Vinyl chloride	Metals Arsenic (D) Chromium (T) Nickel (D) Nickel (T)	Water Quality Parameters Fluoride Nitrate/Nitrite, as N Sulfate		While groundwater was not specifically evaluated in the ERA, the only exposure pathway for ecological receptors to groundwater is where groundwater impacts surface water. The surface water evaluation in the ERA indicated no significant impact to surface water for ecological receptors. Consequently, there are no significant impacts for ecological receptors from groundwater. Some subsurface sampling locations contain a complete groundwater/ subsurface soil-to-air pathway for a WRW. See Figures 9.3 and 9.5 for possible indoor air volatilization exposure areas.	Groundwater AOC and Sentinel wells were identified as locations to evaluate contaminated groundwater migration and the potential to impact surface water. Consequently, the Contaminant Fate and Transport section includes an evaluation of all groundwater AOIs at groundwater AOC and Sentinel wells against surface water standards. Groundwater contamination above MCLs exists in some sampling locations at RFETS (Figure 9.4). Five groundwater areas with the potential to impact surface water quality were identified because some groundwater AOIs are above surface water standards at one or more Sentinel wells: • North of former Building 771; • Historical East Trenches area (downgradient portion of plume); • Historical Solar Evaporation Ponds (SEP) area and 700 Area Northeast area (downgradient portion of plume); • Historical Mound Site and historical Oil Burn Pit No. 2 area (downgradient portion of plumes); and • Historical 903 Pad and historical Ryan's Pit area. An accelerated action and/or enhancement was completed for each of these five areas under the Groundwater IM/IRA in 2005. At this time, no additional actions can reasonably be taken.	Groundwater contamination above MCLs exists in some sampling locations at RFETS (Figure 9.4). Five groundwater areas with the potential to impact surface water quality were identified because some groundwater AOIs are above surface water standards at some Sentinel wells. As part of the Groundwater IM/IRA, an alternatives analysis was conducted to evaluate accelerated action strategies that were feasible and practicable based on the type of residual contamination in these five plume areas and environmental conditions. The selected alternatives were conducted as one-time enhancements to previously implemented remedial actions. The enhancements were intended to reduce the migration of contaminated groundwater that could impact surface water quality. At this time, no additional actions can reasonably be taken. Three groundwater treatment systems were installed as accelerated actions under individual decision documents. Continued operation of the three groundwater actions serves to protect surface water quality over short- and intermediate-term periods by removing contaminant loading to surface water. This protection also serves to meet long-term goals for returning groundwater to its beneficial use of surface water protection. Each action is under ongoing performance monitoring consistent with	The three groundwater treatment systems will not be reevaluated in the FS. These actions will be carried forward as actions in an NFA Alternative (ETPTS, SPPTS, and MSPTS). At this time, no additional actions can reasonably be taken. Several areas in the Central OU will be evaluated in the CMS/FS as follows: • Five UHSU groundwater areas where contaminated groundwater may impact surface water; • UHSU groundwater monitoring locations where groundwater contamination exceeds MCLs; and • Groundwater monitoring locations where exceedances of volatilization PRGs indicate a potential indoor air risk.

Table ES.1
Summary of the RFI/RI

1 Nature and Extent AOIs	2 Risk Management Decisions and Conclusions of the CRA	3	4	5
Purpose: Characterize the nature of and threat posed by hazardous substances and hazardous materials and gather data necessary to assess the extent to which the release poses a threat to human health or the environment or to support the analysis and design of potential response actions.	**Purpose: Conduct a site-specific baseline risk assessment to characterize the current and potential threats to human health and the environment that may be posed by contaminants migrating to groundwater or surface water, releasing to air, leaching through soil, remaining in the soil, and bioaccumulating in the food chain.**	**Results of Contaminant Fate and Transport**	**Results of RFI/RI**	**Areas in the Central OU to be Evaluated in the CMS/FS**
		Three groundwater treatment systems were installed as accelerated actions under individual decision documents (ETPTS, SPPTS, and MSPTS). Continued operation of these three groundwater actions serves to protect surface water quality over short- and intermediate-term periods by removing contaminant loading to surface water.	groundwater and surface water monitoring required by the FY2005 IMP, Revision 1. Groundwater contamination above MCLs exists in some areas of RFETS (Figure 9.4). An FS is not required for the protection of the environment due to groundwater contamination.	
SURFACE WATER – Screened Against Surface Water Standards (Screening methodology, surface water standards screened against, and results are discussed in Section 5.0.)	Results are discussed in Section 7.0.	Results are discussed in Section 8.0.		
Radionuclides Americium-241 Plutonium-239/240 Uranium (sum of isotopes) Gross alpha Gross beta VOCs cis-1,2-Dichloroethene Carbon Tetrachloride Chloroform Methylene chloride Tetrachloroethene Trichloroethene Vinyl chloride Metals Aluminum (D) Beryllium (T) Chromium (T) Lead (T) Nickel (T) Water Quality Parameters Nitrate/Nitrite, as N	There is no significant risk of adverse ecological effects to receptors from exposure to site-related residual contamination. However, additional surface water monitoring to address uncertainties identified in the ERA is needed.	For the most current data, no surface water AOIs exceed the surface water standards at any surface water POC or at the surface water monitoring location immediately upstream of the surface water POC for those surface water AOIs where data are not available at the surface water POC. However, surface water sample results do not always meet Colorado surface water quality standards for some analytes at some on-site monitoring locations upstream of the terminal ponds (see Table 8.3). Surface water leaving RFETS is acceptable for all uses.	No surface water AOIs exceed surface water standards at the surface water POCs or at the surface water monitoring location immediately upstream of the surface water POC if surface water AOI data are not available at the surface water POC. Surface water sample results do not always meet Colorado surface water standards for some analytes at some on-site monitoring locations upstream of the terminal ponds. The ERA did not identify significant risk of adverse ecological effects to receptors from exposure to site-related contamination. However, additional surface water monitoring is required to address uncertainties identified in the ERA.	The following areas/media in the Central OU will be evaluated in the CMS/FS: • Areas where surface water upstream of the terminal ponds where some surface water sample results do not always meet Colorado surface water quality standards for some analytes will be evaluated in the CMS/FS. • Additional surface water monitoring to address uncertainties identified in the ERA.
SEDIMENT – Screened Against WRW PRGs (Screening methodology, standards screened against, and results are discussed in Section 5.0.)	Results are discussed in Section 7.0.	Results are discussed in Section 8.0.		
Radionuclides Americium-241 Plutonium-239/240 Metals Arsenic Chromium SVOCs Benzo(a)pyrene	There is no significant risk of adverse ecological effects to receptors from exposure to site-related residual contamination. However, additional sediment monitoring to address uncertainties identified in the ERA is needed.	Results of the contaminant fate and transport discussion are incorporated into the soil analysis above.	For human health, see the soil analysis above. The ERA did not identify significant risk of adverse ecological effects to receptors from exposure to site-related contamination. However, additional sediment monitoring is required to address uncertainties identified in the ERA.	For human health, see the soil analysis above. Additional sediment monitoring to address uncertainties identified in the ERA.

Table ES.1
Summary of the RFI/RI

1 **Nature and Extent AOIs**	2 **Risk Management Decisions and Conclusions of the CRA**	3	4	5
Purpose: Characterize the nature of and threat posed by hazardous substances and hazardous materials and gather data necessary to assess the extent to which the release poses a threat to human health or the environment or to support the analysis and design of potential response actions.	**Purpose: Conduct a site-specific baseline risk assessment to characterize the current and potential threats to human health and the environment that may be posed by contaminants migrating to groundwater or surface water, releasing to air, leaching through soil, remaining in the soil, and bioaccumulating in the food chain.**	**Results of Contaminant Fate and Transport**	**Results of RFI/RI**	**Areas in the Central OU to be Evaluated in the CMS/FS**
AIR – Screened Against Air Emission Standards (Screening methodology, standards screened against, and results are discussed in Section 6.0.)	Results are discussed in Section 7.0.	Results are discussed in Section 8.0.		
Radionuclides Americium-241 Plutonium-239/240 Uranium-233/234 Uranium-235 Uranium-238	See soil and groundwater discussion for results of the groundwater/subsurface soil-to-air pathway analysis.	The total off-site annual effective dose equivalent (EDE) of combined radionuclides has been less than 3 percent of the allowable 10 mrem/yr standard, based on samples collected since 1999.	For human health, see the soil and groundwater analysis above. An FS is not required for the protection of the environment due to air.	None

VOCs = volatile organic compounds
SVOCs = semi-volatile organic compounds
PCBs = polychlorinated biphenyls
* = Indicates those AOIs that have a frequency of detection less than 1% above the designated standard.
T = total metal
D = dissolved metal

Table ES.2
Analysis of Alternatives for the Proposed Central OU

	No Further Action With Monitoring (Alternative 1)	Institutional and Physical Controls (Alternative 2)	Targeted Surface Soil Removal (Alternative 3)
Alternative Description	Maintains and monitors the completed actions conducted at the Present and Original Landfills and the three groundwater treatment systems. Specific monitoring and O&M requirements for these five actions will continue. Alternative 1 also includes additional surface water, sediment, and ecological monitoring based on results of the ERA and surface and groundwater monitoring as described in the FY2005 IMP, dated September 8, 2005.	Includes Alternative 1 plus institutional and physical controls. Institutional controls include legally enforceable and administrative land use restrictions. Physical controls include signs.	Includes Alternative 2 plus targeted removal of surface soil within an EU to reduce the residual plutonium-239/240 contamination to below 9.8 pCi/g, which is the 1 x 10^{-6} WRW target risk concentration.
Evaluation Criteria			
Protection of Human Health and the Environment	This alternative is protective of human health and the environment in the current site land configuration because no unacceptable risks from residual contamination exist after completion of all planned accelerated actions. • The CRA shows that the incremental risk to the WRW falls within the acceptable range of 1 x 10^{-6} to 1 x 10^{-4} cancer risks and an HI of 1 for noncarcinogenic effects. • The CRA predicts that there is no significant ecological risk from residual contamination within all environmental media across RFETS. • Actions at the Present and Original Landfills provide protection of human health and the environment. • Groundwater actions are operating as designed to remove contamination captured to meet appropriate surface water quality standards at surface water POCs. • Monitoring of groundwater, surface water, sediment, and ecology provides data to verify that RFETS continues to be protective of human health and the environment. The IMP also includes environmental monitoring of the Present and Original Landfills, the Present Landfill seep treatment system, and the three groundwater treatment systems. This alternative may not be protective of human health if the current site land configuration were to change. In particular: • Because the CRA does not evaluate an unrestricted scenario, but instead evaluates potential risk to the anticipated future user, the assumptions used in the CRA human health calculations, including the assumptions used in calculating the WRW PRGs, need to be embodied in an institutional control. • Residual soil contamination exists in the Central OU. If residual soil contamination is disturbed, the contamination could migrate to surface water via erosion which could result in some surface water sample results above surface water standards at some surface water monitoring locations. • Subsurface soil and groundwater contamination exists above the indoor air volatilization PRGs. • Groundwater contamination exists in the Central OU above MCLs. • Surface water quality standards are met at the surface water POCs. However, surface water sample results do not always meet Colorado surface water standards for some analytes at some on-site surface water monitoring locations upstream of the terminal ponds. • Institutional controls for the Original Landfill are not in place. • There are no prohibitions on affecting the engineered aspects of the remedy.	This alternative is protective of human health and the environment because: • See Alternative 1. • Alternative 2 increases the protectiveness of Alternative 1 because institutional controls will provide the following: - The construction and use of buildings that will be occupied on a permanent or temporary basis (such as for residences, offices, shops, break rooms, and so forth) is prohibited. The construction and use of storage sheds or other nonoccupied structures is permitted, consistent with the restrictions below, and provided such use does not impair any aspect of the response action at Rocky Flats. - Excavation, drilling, and other intrusive activities below a depth of 3 ft are prohibited, except for remedy-related purposes. - No grading, excavation, digging, tilling, or other disturbance of any kind of surface soils is permitted, except in accordance with an erosion control plan approved by CDPHE or EPA. Any such soil disturbance shall restore the soil surface to pre-existing grade. - Surface water above the terminal ponds may not be used for drinking water or agricultural purposes. - The construction or operation of groundwater wells is prohibited, except for remedy-related purposes. - Digging, drilling, tilling, grading, excavation, construction of any sort (including construction of any structures, paths, trails, or roads), and vehicular traffic are prohibited on the covers of the Present Landfill and the Original Landfill, except for authorized response actions. - Activities that may damage or impair the proper functioning of any engineered component of the response action, including but not limited to any treatment system, monitoring well, landfill cap, or surveyed benchmark, are prohibited. - Signs will be installed as a physical control along the perimeter of the Central OU to notify the WRW and WRV that they are at the boundary of the Refuge maintained by USFWS.	This alternative is protective of human health and the environment because: • See Alternatives 1 and 2. • Alternative 3 increases the protectiveness of Alternatives 1 and 2 because targeted surface soil removal will reduce plutonium-239/240 contamination to below 9.8 pCi/g. • Surface soil removal will result in short-term adverse impacts to ecological resources, including potential impacts to PMJM habitat. • Removal of surface soil increases the potential to mobilize residual contamination, particularly if a large area of soil is removed, or if the removal is on a steep slope or in close proximity to a stream segment. It also increases the potential for wind erosion.

Table ES.2
Analysis of Alternatives for the Proposed Central OU

	No Further Action With Monitoring (Alternative 1)		Institutional and Physical Controls (Alternative 2)		Targeted Surface Soil Removal (Alternative 3)
Compliance With ARARs and RAOs	This alternative complies with most ARARs; however, it does not meet all ARARs. This alternative does not meet all RAOs.		This alternative complies with all ARARs and meets all RAOs.		This alternative complies with all ARARs and meets all RAOs.
Long-Term Effectiveness and Permanence	• Most of the RFCA accelerated actions (except the landfills) included removal of contaminated structures and environmental media providing a high degree of long-term effectiveness and permanence. • Landfills have been closed in accordance with regulatory agency-approved closure plans as long-term solutions. • Remaining building structures either meet free release standards or have fixed contamination that is 6 ft or more below ground surface. • Groundwater treatment systems are permanent passive systems requiring limited operational attention. • Monitoring of groundwater and surface water provides additional assurance of permanence.		See Alternative 1 plus: • Institutional controls are designed to provide the mechanisms that permanently maintain the completed actions conducted at RFETS and the monitoring consistent with the requirements in all accelerated action decision documents. • In the very long term, institutional controls may fail. • An environmental covenant will increase the long-term permanence of institutional controls.		See Alternative 2 plus: • Removal of surface soil will permanently and effectively reduce plutonium-239/240 contamination to below 9.8 pCi/g. • Surface soil removal reduces remaining residual surface contamination that could be mobilized in the future if disturbed.
Reduction of Toxicity, Mobility, or Volume Through Treatment	• Groundwater treatment systems provide for a reduction of VOCs or uranium and nitrate reducing the overall volume of contaminants in the groundwater and protecting the adjacent surface water. • The Present Landfill seep treatment system provides treatment to remove the VOC contamination from the landfill seep.		See Alternative 1.		See Alternative 1.
Short-Term Effectiveness	Workers and the public are not at risk because no additional action is required in this alternative.		See Alternative 1 plus: • Institutional controls are effective immediately after the controls have been established.		See Alternative 2 plus: • Removal of surface soil will result in an incremental risk to the workers and the public through the removal and transportation operations. • Surface soil removal will result in short-term adverse impacts to ecological resources. • Removal of surface soil increases the potential to mobilize residual contamination, particularly if a large area of soil is removed, or if the removal is on a steep slope or in close proximity to a stream segment. It also increases the potential for wind erosion.
Implementability	• No further action is easily implemented because all accelerated actions are complete. • Post-accelerated action monitoring of the Present and Original Landfills is easily implemented because the monitoring systems are established. • Monitoring through the IMP is easily implemented because the monitoring network is established.		See Alternative 1 plus: • Institutional controls and an environmental covenant are easily implemented. • Physical controls, such as signage, are easily implemented.		See Alternative 2 plus: • Even though standard earthmoving and transportation equipment is readily available, implementing the alternative without impacting surface water quality is difficult. • Weather, wind, and precipitation will increase the potential for soil erosion and sediment loads to the RFETS drainages. • Major construction to support the long duration of the work would be required.

Table ES.2
Analysis of Alternatives for the Proposed Central OU

	No Further Action With Monitoring (Alternative 1)		Institutional and Physical Controls (Alternative 2)		Targeted Surface Soil Removal (Alternative 3)
Cost[a]	Capital Cost: $0 Annual O&M Cost: $2,530,000 Present Worth Cost: $41,350,000 Groundwater treatment system media replacement costs are estimated at $728,000 every 5 years. The estimated costs for preparing materials for the CERCLA periodic reviews is $153,000 every 5 years.		Capital Cost: $1,120,000 Annual O&M Cost: $45,000 (Alternative 2 only) Total Annual O&M Cost: $2,575,000 (includes Alternatives 1 and 2), less the periodic media replacement costs and CERCLA review costs Present Worth Cost: $43,170,000 (includes Alternatives 1 and 2)		Capital Cost: $222,340,000 (assumes up to approximately 368 acres for surface soil removal and disposal as low-level radionuclide-contaminated soil) Total Capital Cost: $223,460,000 (includes Alternatives 1, 2, and 3) Annual O&M Cost: Varies from $206,000 to $70,000 (Alternative 3 only) Total Annual O&M Cost: $2,781,000 to $2,645,000 (includes Alternatives 1, 2, and 3), less the periodic media replacement costs and CERCLA review costs Present Worth Cost: $265,510,000 (includes Alternatives 1, 2, and 3)
State Acceptance	Discussion of this criterion will be provided in the CAD/ROD.		Discussion of this criterion will be provided in the CAD/ROD.		Discussion of this criterion will be provided in the CAD/ROD.
Community Acceptance	Discussion of this criterion will be provided in the CAD/ROD.		Discussion of this criterion will be provided in the CAD/ROD.		Discussion of this criterion will be provided in the CAD/ROD.

[a] Capital costs are in 2005 dollars and O&M costs are calculated for 30 years at a discount rate of 5 percent.

FIGURES

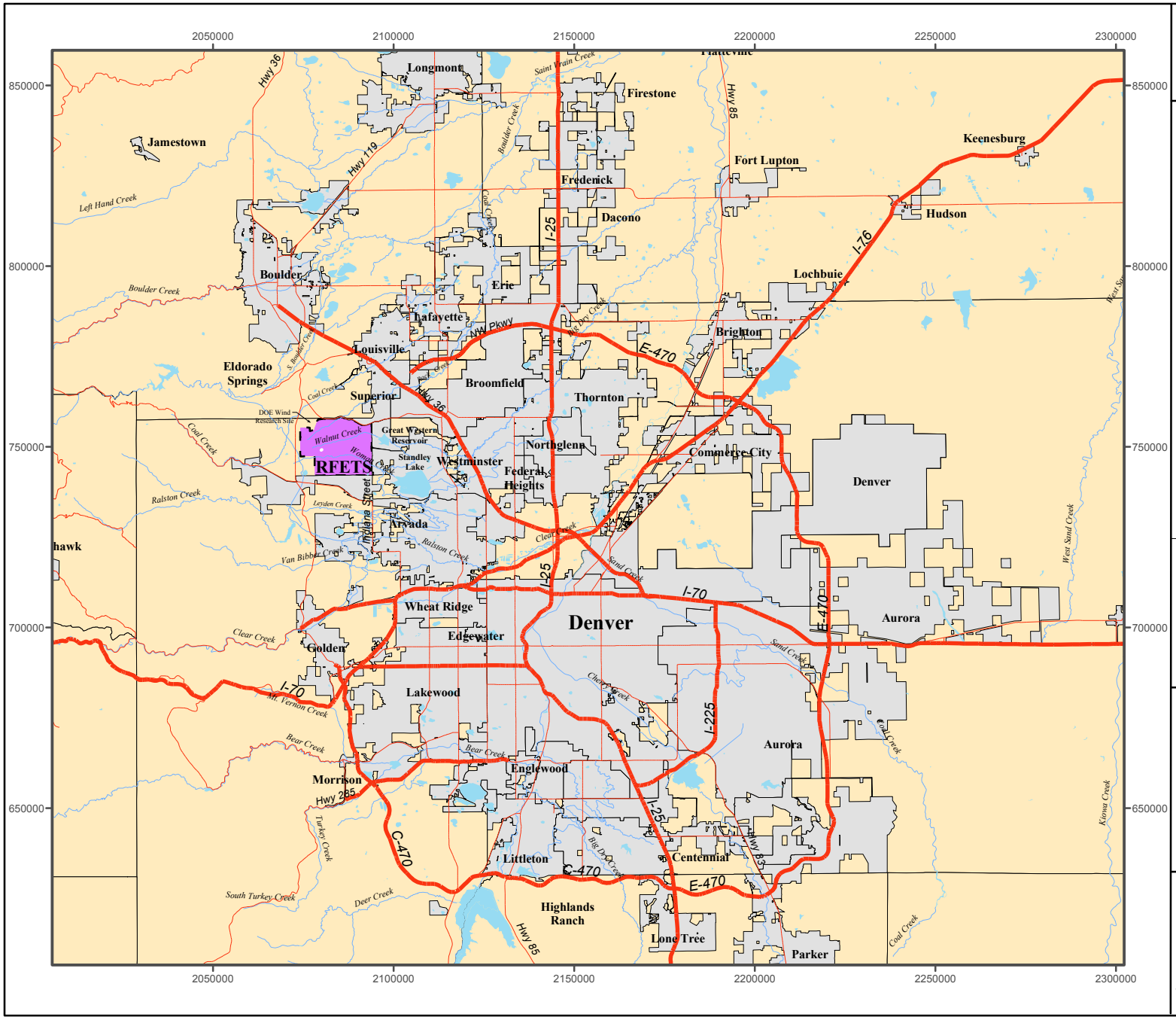
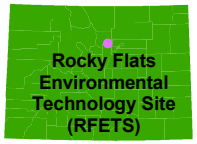


Figure ES.1
Location of
Rocky Flats Environmental
Technology Site (RFETS)

KEY

- Highway
- Interstate
- Lakes and ponds
- Streams
- City boundary
- Site boundary
- County boundary



Colorado

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Scale 1:480,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental
Technology Site

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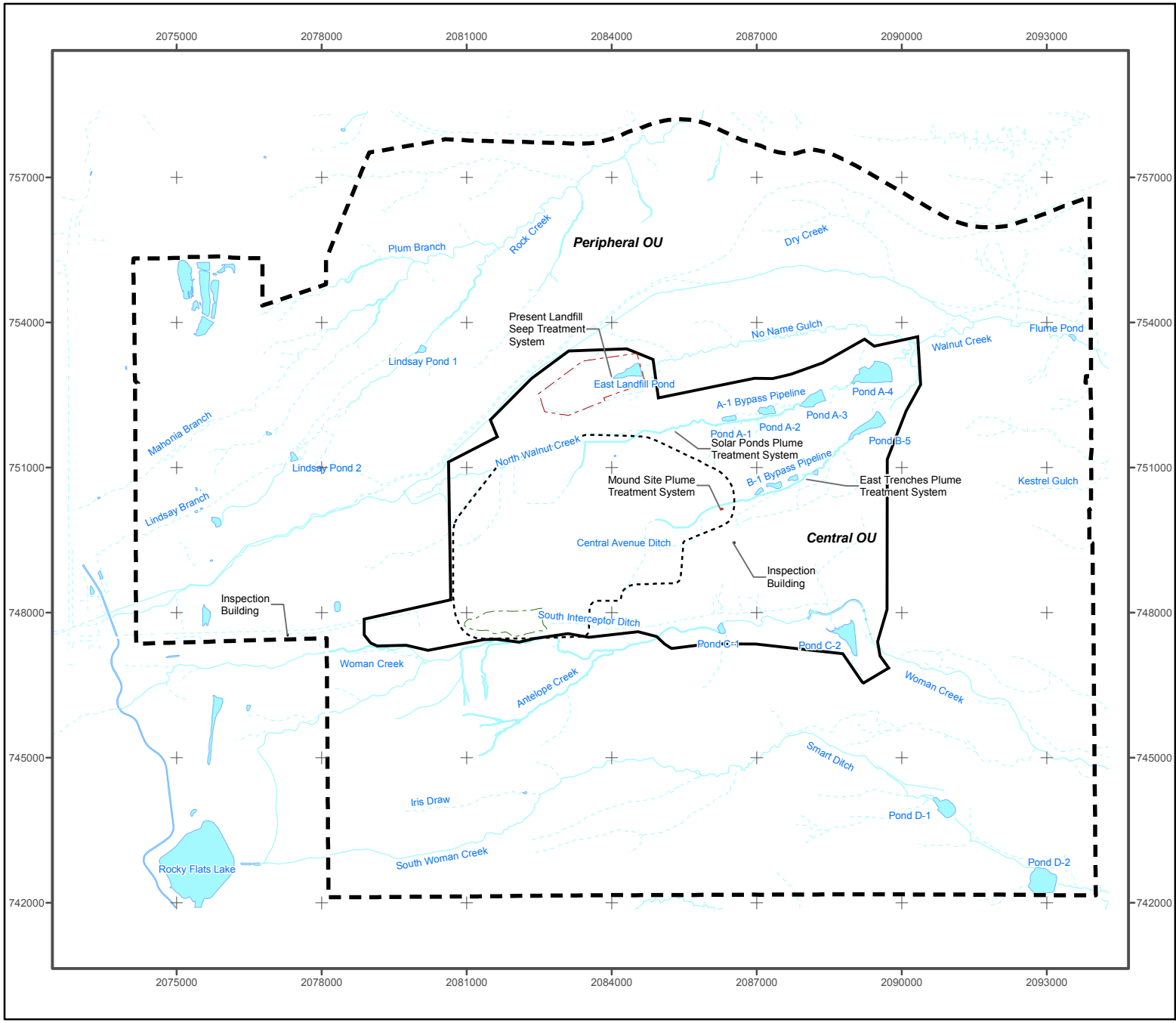

Figure ES.2

Reconfiguration of the RFETS OUs

KEY

- Original landfill IHSS boundary
- Present landfill IHSS boundary
- Site boundary
- Historical IA OU boundary
- Central OU boundary

Standard Map Features

- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream

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S

0 1,500 3,000 Feet

Scale 1:36,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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