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

Section 10.0
Remedial Action Objectives

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10.0 REMEDIAL ACTION OBJECTIVES

10.1 Introduction

This section identifies remedial action objectives (RAOs) and applicable or relevant and appropriate requirements (ARARs) for contaminated groundwater, surface water, and soil at the Rocky Flats Environmental Technology Site (RFETS or site) Central Operable Unit (OU) used in developing and evaluating remedial alternatives. The RAOs are contaminant-specific cleanup goals for the final comprehensive response action and are based on:

- Human and ecological receptor exposure pathway scenarios for each contaminated medium, consistent with the reasonably foreseeable future RFETS land use as a National Wildlife Refuge;[1]
- ARARs; and
- Target risk levels.

Where transport of contamination occurs between environmental media, the RAOs for each medium are interdependent and are developed with this understanding.

Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), RAOs specify the contaminants and media of concern, potential exposure pathways, and remediation goals to be considered for the final response action. Remediation goals establish acceptable exposure levels that are protective of human health and the environment. The detailed analysis of alternatives evaluates remedial action alternatives in accordance with the nine CERCLA evaluation criteria (Section 11.0). The groundwater, surface water, and soil RAOs and ARARs form the basis for demonstrating that the final remedy will meet the CERCLA evaluation threshold criteria in 40 Code of Federal Regulations (CFR) 300.430(e)(2)(i)(A).[2] Final remediation goals to be addressed and accomplished by the final remedy are proposed in the Proposed Plan for the final remedy based upon the information developed in the Remedial Investigation/Feasibility Study (RI/FS), and are incorporated into the Corrective Action Decision/Record of Decision (CAD/ROD) for the selected remedy.

The RAOs are used to develop human health preliminary remediation goals (PRGs) that correspond to acceptable risk- and health-based contaminant levels. PRGs for soil are calculated in the Comprehensive Risk Assessment (CRA) Work Plan and Methodology (CRA Methodology) (DOE 2005a), and are based on protection of the wildlife refuge

[1] The Rocky Flats Cleanup Agreement (RFCA) Parties have agreed that the reasonably maximally exposed anticipated future land user of RFETS is the wildlife refuge worker (WRW) (see the Soil Action Levels [ALs] Technical Memorandum [DOE 2003]).

[2] Preliminary remediation goals (PRGs) are used when ARARs are not available and can also be used to evaluate whether particular ARAR standards are expected to be sufficiently protective (for example, within the acceptable risk range for carcinogens and would not result in adverse effects for systemic toxicants).

worker (WRW) at 1 x 10^{-6} lifetime excess cancer risk from carcinogens and a hazard index (HI) of 0.1 from systemic toxicants. Soil RAOs are based on protecting groundwater and surface water quality so that these media achieve their RAOs, and protecting human and ecological receptors from unacceptable risks.

Groundwater RAOs are based on promulgated maximum contaminant levels (MCLs) for drinking water. They are also based on the CWQCC water quality standards for groundwater, which are the CWQCC water quality standards for surface water, and the designated beneficial use of site groundwater, which is surface water protection.

Surface water RAOs are based on the CWQCC water quality standards for surface water, which are based on the human health or ecological protection criteria, whichever are lower.

The environmental protection RAO is based on the overall Ecological Risk Assessment (ERA) risk management goal identified in the CRA Methodology, that is, "site conditions due to residual contamination should not represent significant risk of adverse ecological effects to receptors from exposure to site-related residual contamination." Note that the levels of radionuclide contaminants at the site that will meet human health PRGs are lower than the levels of these contaminants that will meet the environmental protection RAO. Thus, the human health RAOs for radionuclide contaminants achieve the environmental protection RAO. Table 10.1 presents a summary and the status of the RAOs.

10.2 Groundwater

10.2.1 Groundwater Contaminants and Pathways

Complete pathways from shallow groundwater to surface water were identified for 10 groundwater analytes of interest (AOIs): uranium (sum of isotopes uranium-233/234, uranium-235, and uranium-238), cis-1,2-dichloroethene, carbon tetrachloride, tetrachloroethene, trichloroethene, chloroform, methylene chloride, nitrate/nitrite (as N), fluoride, and sulfate (see Section 8.4.4 and Table 8.11). Groundwater AOIs with complete subsurface pathways from groundwater to surface water are primarily associated with five groundwater areas. The five groundwater areas with the potential to impact surface water quality (complete pathway from groundwater to surface water) were identified because some groundwater AOIs are above surface water standards at one or more Sentinel wells (see Figure 10.1).[3] These areas are:

- North of former Building 771 (north of the Carbon Tetrachloride Plume) – Trichloroethene may exceed the surface water standards.

- Historical East Trenches area (downgradient portion between South Walnut Creek and the existing East Trenches Plume Treatment System [ETPTS]) –

[3] Sentinel wells are wells that are typically located near downgradient plume edges, in drainages, and downgradient of existing groundwater treatment systems. These wells will be monitored to identify changes in groundwater quality.

Tetrachloroethene, trichloroethene, carbon tetrachloride, chloroform, and cis-1,2-dichloroethene may exceed the surface water standards.

- Historical Mound Site/Oil Burn Pit No. 2 area (downgradient portion between South Walnut Creek and the Mound Site Plume Treatment System [MSPTS]) – Chloroform, trichloroethene, tetrachloroethene, 1,2-dichloroethene, cis-1,2-dichloroethene, 1,1-dichloroethene, and methylene chloride may exceed the surface water standards between South Walnut Creek and the MSPTS. Carbon tetrachloride, chloroform, methylene chloride, tetrachloroethene, and sulfate may exceed the surface water standards between historical Oil Burn Pit No. 2 and the MSPTS. (Contaminated groundwater from historical Oil Burn Pit No. 2 is treated at the MSPTS.)

- Historical 903 Pad/Ryan's Pit area – Tetrachloroethene, trichloroethene, carbon tetrachloride, chloroform, and cis-1,2-dichloroethene may exceed the surface water standards downgradient of the historical 903 Pad, while carbon tetrachloride, chloroform, and trichloroethene may exceed the surface water standards downgradient of historical Ryan's Pit.

- Historical Solar Evaporation Ponds (SEP) area and 700 Area Northeast area (downgradient portion of plumes between the Solar Ponds Plume Treatment System [SPPTS] and North Walnut Creek) – Nitrate and uranium at the SEP and nitrate from the 700 Area Northeast plume may exceed the surface water standards. (Contaminated groundwater from the 700 Area Northeast plume is treated at the SPPTS.)

Based on data and numerical transport modeling results, it is likely that residual volatile organic compound (VOC) sources and associated downgradient groundwater concentrations will persist in the environment for decades to hundreds of years even with the source removals that were implemented as accelerated actions (EPA, 2003). As part of the Groundwater Interim Measure/Interim Remedial Action (IM/IRA) (DOE 2005b), an alternatives analysis was conducted to evaluate other accelerated action strategies that were feasible and practicable based on the type of residual contamination in these five areas and environmental conditions (for example, distance between the existing groundwater treatment systems and adjacent stream channels). The selected alternatives were conducted as one-time enhancements to previously implemented remedial actions. The selected enhancements are detailed in the Groundwater IM/IRA and were completed in 2005. The enhancements were intended to reduce the migration of contaminated groundwater that could impact surface water quality. They are not expected to eliminate groundwater contamination in the short term, but to have a positive long-term impact on groundwater and surface water quality. At this time, no other additional actions can reasonably be taken.

The following actions have been implemented in accordance with approved Rocky Flats Cleanup Agreement (RFCA) Decision Documents to treat contaminated groundwater that could potentially impact surface water quality:

- Post-closure care and monitoring of the Present Landfill and continued operation and maintenance (O&M) of the Present Landfill seep treatment system; and

- O&M of three groundwater treatment systems and performance monitoring (ETPTS, MSPTS, and SPPTS).

Continued operation of these four systems 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.

For the groundwater AOIs, the most current data for those analytes measured in shallow groundwater show concentrations below the highest of the surface water standard, background, or PQL at all AOC wells with the exception of well 10594 (located downgradient of Pond A-1 in North Walnut Creek with sulfate results above background, which is higher than the surface water standard or PQL, in samples collected in 1995 and 1996).

Groundwater contamination above MCLs exists in some sampling locations at RFETS (Figure 10.2).

The indoor air pathway was evaluated on a sitewide basis in the CRA (see Appendix A, Volume 2). Volatile chemicals have been detected in the subsurface in some groundwater sampling locations of the site. If a building is erected over these groundwater sampling locations in the future, the volatile chemicals may migrate through the building foundation indoors and be subsequently inhaled by people. In the CRA, the evaluation for the indoor air inhalation pathway was performed by comparing the maximum detected concentration (MDC) of VOCs in groundwater to PRGs for indoor air. Where there are no exceedances of the volatilization PRGs, the indoor air inhalation pathway is assumed to be insignificant (Figure 10.3). Where there are exceedances of the volatilization PRGs, the indoor air inhalation pathway is potentially significant if buildings were constructed over these locations. Results of the evaluation are included in Soil RAO 3 (Section 10.4.2.3) in order to prevent exposures that result in unacceptable risk to WRW.

Per the RFCA Vision,

> *. . . there is no current use of groundwater onsite, and there is no anticipated use of groundwater after accelerated actions are completed unrelated to RFETS final site cleanup activities.*

Groundwater at RFETS is not hydraulically connected to any groundwater drinking water supply (Hurr 1976; RMRS 1996). Shallow (UHSU) groundwater impacted by site activities discharges to surface water upgradient of the site boundary. This impacted groundwater emanates from the former industrial area and discharges to surface water in the drainages upgradient of the terminal ponds. (Section 2.0). The hydrogeology of RFETS has been thoroughly studied (EG&G 1995), and focused groundwater modeling

activities supported evaluation and implementation of accelerated actions and the assessment and conclusions summarized in the RI/FS Report (K-H 2002, 2005a).

Based on the foregoing, there are three main potential problems to human health and the environment from groundwater contamination within the Central OU:

- Groundwater contamination may migrate within the groundwater environment.[4]
- Some contaminated groundwater may discharge to surface discharge areas (seeps, ponds, and streams) or may discharge directly to surface water as baseflow.
- Contaminated groundwater may be used.

Groundwater RAOs are developed to address these problems.

10.2.2 Groundwater Remedial Action Objectives

This section describes the three groundwater RAOs.[5] Results of the RI are compared to the RAOs to determine whether remedial action is needed to meet the RAOs within the Central OU.

10.2.2.1 Contaminated Groundwater Migration RAO

Groundwater RAO 1 is:

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

Groundwater RAO 1 is met. Surface water protection is the site-specific groundwater classification[6] for the RFETS "specified area" groundwater pursuant to CWQCC Regulation No. 42, Site Specific Water Quality Classifications and Standards for Groundwater (CWQCC Reg. 42), at CWQCC Reg. 42.7(1)(b). The "specified area" is defined as all unconfined groundwater within the upper hydrostratigraphic unit (UHSU),[7,8] the Arapahoe and Upper Laramie aquifers not hydraulically connected to the

[4] VOCs may volatilize as contaminated groundwater discharges at surface seeps. The main subsurface volatile organic pathway is by emanation through the soil. This pathway is addressed by soil RAOs.

[5] See the Soil and Groundwater RAO Technical Memorandum (DOE 2005c).

[6] See CWQCC Reg. 41.4.B(3). This classification shall be applied when "a proposed or existing activity does or will impact groundwaters such that water quality standards of classified surface water bodies within the specified area will be exceeded."

[7] Pursuant to CWQCC Reg. 42.5 (7), the UHSU is the uppermost layer of groundwater incorporating any aquifer or other zone of groundwater occurrence which is the first encountered beneath the ground surface and includes all saturated geologic formations, unconsolidated alluvium and colluvium, and hydraulically connected zones in bedrock. See Reg. 42 1996 Revisions Statement of Basis and Purpose discussion regarding use of the UHSU as the "specified area" to protect quality in groundwater that does not meet the useable quantity expectations associated with the use of the term "aquifer."

UHSU, and the Laramie-Fox Hills aquifer within the area specified in CWQCC Reg. 42 Figure 1 (which coincides with the RFETS property boundary). The Upper Laramie and Laramie-Fox Hills aquifers are not impacted by RFETS contamination in the UHSU (Hurr 1976; RMRS 1996).

The groundwater quality standards adopted for the RFETS specified area groundwater classification are identified in CWQCC Reg.42.7(1)(c). The groundwater quality standards are the associated statewide or the site-specific surface water quality standards promulgated by the CWQCC.

For purposes of the FS evaluation, shallow contaminated groundwater migration will be evaluated at groundwater AOC wells. The locations of the groundwater AOC wells on Figure 10.1 are based on consideration of regulatory provisions concerning groundwater Point of Compliance (POC) locations, which are discussed below.

CWQCC Reg. 41.3(10) defines the groundwater POC as a vertical surface that is located at some specific distance hydrologically downgradient of the activity being monitored for compliance. Generally, the groundwater POC is where a facility should monitor groundwater quality and/or achieve specified cleanup levels to achieve facility-specific goals (EPA 2002). The agencies responsible for implementation of CERCLA, the Resource Conservation and Recovery Act (RCRA), and/or the Colorado Hazardous Waste Act (CHWA) have some flexibility in establishing the groundwater POC. Pursuant to CWQCC Reg. 41.5.C.5, the implementing agencies (in the case of RFETS, the Colorado Department of Public Health and Environment [CDPHE] Hazardous Materials/Waste Management Division and the U.S. Environmental Protection Agency [EPA]) may select a groundwater POC that is more or less stringent than would be achieved under the promulgated statewide or site-specific standards.

The CWQCC Reg. 42 site-specific standards do not identify any RFETS-specific groundwater POCs.[9] The CWQCC Reg. 41 statewide standards (for radionuclides) do include criteria for establishing the groundwater POC as specified in Reg. 41.6.C.1.a. The main criterion affecting the groundwater POC is whether the contamination is identified and reported to the CERCLA or RCRA/CHWA implementing agency prior to September 30, 1992. Because groundwater contamination was identified and reported prior to that date, the regulations specify that the groundwater POC is whichever of the following locations is closest to the contamination source: the site boundary or the hydrologically downgradient limit of the area in which contamination exists when identified.

At the time groundwater contamination was identified, the downgradient limit of contamination that impacted groundwater quality was not well known, but extensive

[8] Pursuant to CWQCC Reg. 42.7(1)(a), the UHSU includes the unconsolidated Quaternary and Rocky Flats alluvium, colluvium and valley fill alluvium, and weathered claystone and hydraulically connected sandstone bedrock of the Arapahoe and Upper Laramie formations.

[9] See CWQCC Reg. 42 February 4, 1991, Statement of Basis and Purpose discussion regarding not establishing a POC at that time, and essentially deferring to the agency or agencies that may have regulatory authority to implement the classifications and standards in the future. Thus, the POCs established in this FS do not depend on any POC-related rulemaking proceedings by the CWQCC.

monitoring shows that it is currently well within the site boundary. Areas of groundwater contamination also form contiguous, mappable plumes that may have formed from individual or multiple sources. During migration, some of these plumes may have coalesced to form larger plumes that are difficult to attribute to individual sources. In addition, some of the sources of contamination are historical Individual Hazardous Substance Sites (IHSSs) for which the response actions were based on the presence of RCRA/CHWA hazardous waste and/or hazardous waste constituents. While groundwater POCs for these historical IHSSs will be established pursuant to RCRA/CHWA ARARs, they are located within areas where contaminated groundwater from other sources may exist or commingle.

RCRA/CHWA provides that groundwater POCs may be established at the vertical surface of a line that circumscribes several units as an "area of concern"[10] (see 40 CFR 265.91[b][2]/6 Code of Colorado Regulations [CCR] 1007-3 Part 265.91[b][2]). Also, in recognition that groundwater contamination could be caused by releases from multiple hazardous waste management units and/or from sources other than but around hazardous management waste units, alternative groundwater monitoring points may be established (see 40 CFR 265.110[d]/6 CCR 1007-3 Part 265.110[d]).

The locations of the groundwater AOC wells are based on the groundwater "areas of concern" concept. These locations approximate the hydrologically downgradient limit of the area in which groundwater contamination (contaminant plumes) may exist and at which contamination migration trending may be evaluated. These wells are monitored to determine whether the plume(s) are discharging to surface water. Figure 10.1 shows the AOC well locations. As observed on Figure 10.1, the area of concern is a small portion of the overall RFETS area and is well within the facility boundary. All AOC wells are within the Central OU.

As stated earlier, for the groundwater AOIs, 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 (Figure 10.1) with one exception. Well 10594, which is located downgradient of Pond A-1 in North Walnut Creek, has sulfate results above background, which is higher than the surface water standard or the PQL, in samples collected in 1995 and 1996. Groundwater RAO 1 is met.

Accelerated Action Performance Monitoring Points

The groundwater AOC wells identified on Figure 10.1 do not obviate any required accelerated action groundwater performance monitoring, or preclude performance monitoring associated with the final remedy.

[10] See also National Contingency Plan (NCP) Preamble at 55 Federal Register (FR) 8753-4. ". . . There may be certain circumstances where a plume of groundwater contamination is caused by releases from several distinct sources that are in close geographical proximity. In such cases, the most feasible and effective groundwater cleanup strategy may be to address the problem as a whole, rather than source-by-source, and to draw the point of compliance to encompass the sources of release."

10.2.2.2 Restoration of Usable Contaminated Groundwater to the Beneficial Use of Surface Water Protection RAO

Groundwater RAO 2 is:

> *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.*

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. Among the CERCLA expectations in developing appropriate remedial alternatives is the return of usable groundwater to beneficial uses whenever practicable (see 40 CFR 300.430[a][1][iii][f]). Historically, the vast majority of RFETS surface water volume and flow was due to imported water and runoff (from pavement) from precipitation. Now that importation of water has ceased, and the areas of impermeable surfaces no longer exist, it is anticipated that groundwater could become a larger proportionate contributor to surface water volumes and flows (K-H 2002, 2005b), not because of a significantly increased volume of groundwater, but because of the significant reduction from those other contributors. Thus, the practicability of remedial alternatives to restore groundwater beneficial use in a reasonable timeframe must be evaluated.

Sentinel wells are wells that are typically located near downgradient contaminant plume edges, in drainages, and downgradient of existing groundwater treatment systems. The Sentinel wells identified on Figure 10.1 will be used for this RAO to develop and evaluate remedial alternatives. All Sentinel well locations are within the Central OU. Groundwater AOIs with complete pathways are compared to surface water standards at each Sentinel well.

The RI evaluation identified five groundwater areas with the potential to impact surface water quality based on the complete pathway to surface water. These five areas were identified because some groundwater AOIs are above surface water standards at one or more Sentinel wells. These areas are:

- North of former Building 771 (north of the Carbon Tetrachloride Plume) – Trichloroethene may exceed the surface water standards.
- Historical East Trenches area (downgradient portion between South Walnut Creek and the existing ETPTS) – Tetrachloroethene, trichloroethene, carbon tetrachloride, chloroform, methylene chloride, and cis-1,2-dichloroethene may exceed the surface water standards.
- Historical Mound Site/Oil Burn Pit No. 2 and Historical area (downgradient portion between South Walnut Creek and the MSPTS) – Chloroform,

trichloroethene, tetrachloroethene, 1,2-dichloroethane, cis-1,2-dichloroethene, 1,1-dichloroethene, and methylene chloride may exceed the surface water standards between South Walnut Creek and the MSPTS. Carbon tetrachloride, chloroform, methylene chloride, tetrachloroethene, and sulfate may exceed the surface water standards between historical Oil Burn Pit No. 2 and the MSPTS. (Contaminated groundwater from historical Oil Burn Pit No. 2 is treated at the MSPTS.)

- Historical 903 Pad/Ryan's Pit area – Tetrachloroethene, trichloroethene, carbon tetrachloride, chloroform, and cis-1,2-dichloroethene may exceed the surface water standards downgradient of the historical 903 Pad, while carbon tetrachloride, chloroform, and trichloroethene may exceed the surface water standards downgradient of historical Ryan's Pit.

- Historical SEP area and former 700 Area Northeast area (downgradient portion of plumes between the SPPTS and North Walnut Creek) – Nitrate and uranium at the historical SEP and nitrate from the 700 Area Northeast Plume may exceed the surface water standards. Contaminated groundwater from the former 700 Area Northeast Plume is treated at the SPPTS.

Based on data and modeling results, it is likely that residual VOC sources and associated downgradient groundwater concentrations will persist in the environment for decades to hundreds of years even with the source removals that were implemented as accelerated actions. As discussed in Section 10.2.1, as part of the Groundwater IM/IRA (DOE 2005b), an alternatives analysis was conducted to evaluate other accelerated action strategies that were feasible and practicable based on the type of residual contamination in these five plume areas and environmental conditions (for example, distance between existing treatment systems and adjacent stream channels). The selected alternatives were conducted as one-time enhancements to previously implemented accelerated actions. The selected enhancements were detailed in the Groundwater IM/IRA and were completed in 2005. The enhancements were intended to reduce the migration of contaminated groundwater that could impact surface water quality. They are not expected to eliminate groundwater contamination in the short term, but to have a positive long-term impact on groundwater and surface water quality.

Three groundwater treatment systems have been installed at RFETS as accelerated actions to treat contaminated groundwater that could potentially impact surface water quality. These systems are:

- Historical East Trenches – The ETPTS removes VOCs in groundwater prior to its discharging to South Walnut Creek. A phytoremediation project was implemented downgradient of the ETPTS (along South Walnut Creek) to reduce the migration of contaminated groundwater that could impact surface water quality.

- Historical Mound Site – The MSPTS removes VOCs in groundwater prior to its discharge to South Walnut Creek.

- Historical SEP – The SPPTS removes uranium and nitrate in groundwater prior to its discharge to North Walnut Creek. A phytoremediation project was implemented downgradient of the SPPTS (along North Walnut Creek) to reduce the migration of contaminated groundwater that could impact surface water quality.

Continued operation of these three groundwater systems 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. These groundwater remedial actions will remain in operation and will be included in the No Further Action (NFA) alternative.

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. 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.

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.

10.2.2.3 Contaminated Groundwater RAO

Groundwater RAO 3 is:

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

Groundwater RAO 3 is not met. The RFCA Vision states that

> *. . . groundwater quality in the outer Buffer Zone (BZ) and off site will support all uses. On-site groundwater will not be used for any purpose unrelated to RFETS cleanup activities.*

It is important to understand the boundary between the outer BZ and on-site groundwater to understand whether the RFCA Vision was met, and where, if any, institutional controls for groundwater are needed. Therefore, where groundwater is contaminated above an MCL, the RAO is to prevent drinking water and irrigation use of this groundwater. MCLs are considered in the screening process for the nature and extent of groundwater contamination. Figure 10.2 presents the UHSU groundwater sampling locations where composite MCLs were exceeded. “Composite MCL” means that all groundwater AOIs above an MCL are presented on one figure, including VOCs and inorganics. The detailed

analysis of alternatives will evaluate mechanisms to prevent domestic and irrigation use of groundwater contaminated at levels above the MCLs to meet groundwater RAO 3.

Groundwater Alternate Concentration Limits and Temporary Modifications to Surface Water Standards

While the foregoing RAOs form the basis for alternatives evaluated in the detailed analysis of alternatives, they are not intended to preclude the development of alternate concentration limits (ACLs) for monitoring criteria at groundwater AOC or Sentinel wells in the Proposed Plan or as part of final remedial objectives. In addition, the RAOs do not preclude retaining temporary modifications to surface water standards that apply to RFETS, or petitioning to obtain approval of future temporary modifications in accordance with the CWQCC regulations. The ACLs and temporary modifications may enhance the final remedy selection process by serving to establish goals that are adequately protective while allowing reasonable timeframes to determine that a selected remedy is performing as anticipated. ACLs and temporary modifications are subject to regulatory approval.

10.3 Surface Water

Surface water exists in creeks and ponds on RFETS as well as immediately off-site (Figure 2-15) (5 CCR 1002-38).

These surface waters are part of segments 4a/4b and 5 of Big Dry Creek as follows:

- Segment 4a – Mainstem and all tributaries to Woman Creek and Walnut Creeks from the sources to Standley Lake and Great Western Reservoir, except for the specific listings in segments 4b and 5;
- Segment 4b – North and South Walnut Creek and Walnut Creek, from the outlet of Ponds A-4 and B-5 to Indiana Street; and
- Segment 5 – Mainstems of North and South Walnut Creek, including all tributaries, lakes, and reservoirs, from their sources to the outlets of Ponds A-4 and B-5 on Walnut Creek, and Pond C-2 on Woman Creek.

The CWQCC has designated the following use classifications on stream segments 4a/4b and 5 (5 CCR 1002-38):

- Water supply;
- Aquatic life – warm 2;
- Recreation 2; and
- Agricultural.

The CWQCC established numeric values, or standards, that apply throughout both stream segments and are based on these use classifications (Section 1.2.3). In general, classifications and associated standards are implemented through discharge permits unless water quality responsibilities are delegated to an implementing agency (5 CCR 1002-31.11[5]). At RFETS, the CDPHE Hazardous Materials/Waste Management Division and EPA are the implementing agencies. The surface water classifications, standards, and monitoring locations are implemented through RFCA.

10.3.1 Surface Water Contaminants

Four surface water AOIs are observed intermittently above the highest of the surface water standard, background, or PQL at representative (nonbackground) surface water locations. These AOIs are plutonium-239/240, americium-241, uranium (sum of isotopes), and nitrate/nitrite (as N). Americium-241 is observed intermittently above the surface water standard at surface water monitoring locations upstream of the terminal ponds in North Walnut Creek (SW093), South Walnut Creek (GS10), and the SID/Woman Creek drainage (GS51 and SW027). Plutonium-239/240 has been observed intermittently above the surface water standard at the same locations upstream from the terminal ponds as americium-241, as well as at station SW018 in the North Walnut Creek watershed. Uranium (sum of isotopes) was detected above the surface water standard in North Walnut Creek (GS13) and South Walnut Creek (GS10), although it is predominantly from natural uranium sources, based on analyses of uranium isotope fractions Nitrate/nitrite (as N) was observed in North Walnut Creek (GS13) above the surface water standard. All other surface water AOIs are observed infrequently or not at all at concentrations above the highest of the surface water standard, background, or PQL at representative surface water locations. No contaminants of concern (COCs) were identified in the CRA for surface water. The ERA did not identify surface water site conditions due to residual contamination as representing a 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 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 CWQCC 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.

10.3.1.1 Surface Water Quality Evaluation Locations

In accordance with RFCA Attachment 5 (RFCA Section 2.3):

> *When the Intermediate Site Condition is achieved following completion of active remediation, the surface water must be of sufficient quality to support any surface water use classification in both Segments 4a/4b and*

> *5. All final remedies must be designed to protect surface water for any use as measured at the nearest and/or most directly impacted surface water in Segments 4a/4b and 5. . . . [Points of Compliance] POCs will be at the outfalls of the terminal ponds and near where Indiana Street crosses both Walnut and Woman Creeks. If the terminal ponds are removed, new monitoring and compliance points will be designated and will consider groundwater in stream alluvium.*

The following surface water monitoring locations will be used to evaluate surface water quality in this FS:

- Segment 5 POCs – Given that the terminal ponds existed at closure, their outfalls are the RAO evaluation points because they are the last management controls in place for surface water. The outfalls of the terminal ponds, stations GS11, GS08, and GS31, are the surface water locations where segment 5 water quality will be evaluated in this FS.[11]

- Segment 5 Upstream of the Terminal Ponds – The FY2005 IMP, Revision 1 identified several surface water monitoring locations (SW018, SW093, GS51, SW027, and GS05) (K-H 2005b) as the surface water monitoring locations of the nearest and/or most impacted surface water in segment 5 from site-related activities. These are the surface water locations where segment 5 water quality upstream of the terminal ponds will be evaluated in this FS.

- Segment 4a/4b POCs – The surface water monitoring locations where Walnut Creek and Woman Creek cross Indiana Street (stations GS03 and GS01) are the surface water locations where segment 4a/4b water quality will be evaluated in this FS.

10.3.2 Surface Water Remedial Action Objectives

This section describes the surface water RAO. Results of the RI are compared to the RAO to determine whether remedial action is needed to meet the RAO.

10.3.2.1 Contaminated Surface Water RAO

The surface water RAO is:

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

The surface water RAO is met at all surface water POCs; 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. In Section 8.0, surface water AOIs were evaluated at the surface water POCs and the identified surface water monitoring locations upstream of the terminal ponds. No surface water AOIs exceed the surface water standards at any surface water POC or the surface water monitoring

[11] See the Surface Water RAO Technical Memorandum (DOE 2002).

location immediately upstream of the surface water POC for those surface water AOIs where data are not available at the surface water POC. However, as stated, 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. An institutional control will be needed to prevent use of surface water upstream of the terminal ponds.

The ERA evaluation concluded that there is no significant risk of adverse ecological effects; however, additional surface water monitoring to address uncertainties identified in the ERA will be evaluated in Section 11.0.

10.4 Soil

10.4.1 Soil Contaminants and Pathways

Complete pathways from surface soil/surface sediment to surface water were identified for two surface soil AOIs: americium-241 and plutonium-239/240 (see Sections 8.3.3.1 and 8.3.5.1 and Tables 8.4 and 8.5). These two analytes have been observed intermittently above the surface water standard (which is higher than background or the PQL) at representative surface water locations upstream of the terminal ponds in North Walnut Creek, South Walnut Creek, and the 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 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 analytes, the most current surface water data 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, and the SID/Woman Creek drainage.

Complete pathways from subsurface soil to surface water (via groundwater) were identified in Section 8.0 for five subsurface soil analytes, all of which are VOCs. These analytes include carbon tetrachloride, chloroform, methylene chloride, tetrachloroethene, and trichloroethene (see Section 8.4.2.2 and Table 8.6). Subsurface soil analytes with complete pathways from subsurface soil to surface water (via groundwater) are associated with one or more groundwater areas, as addressed in Section 10.2.1. Consequently, the subsurface soil analytes 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 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.

The indoor air pathway was evaluated on a sitewide basis in the CRA (see Appendix A, Volume 2). Volatile chemicals have been detected in the subsurface in some subsurface soil sampling locations of the site. If a building is erected over these subsurface soil sampling locations in the future, the volatile chemicals may migrate through the building foundation indoors and be subsequently inhaled by people. In the CRA, the evaluation for the indoor air inhalation pathway was performed by comparing the MDC of VOCs in subsurface soil and subsurface sediment to PRGs for indoor air. Where there are no exceedances of the volatilization PRGs, the indoor air inhalation pathway is assumed to be insignificant (Figure 10.3). Where there are exceedances of the volatilization PRGs, the potential for an exposure resulting in unacceptable risk to the WRW is assumed to exist.

Results of the CRA indicate potential risk to a WRW is estimated to be 2×10^{-6} for exposure to plutonium-239/240 in surface soil in the Wind Blown Area Exposure Unit (EU) (WBEU). A review of the RFETS data indicates that residual plutonium-239/240 surface soil contamination exceeds the WRW PRG (based on a 1×10^{-6} target risk) of 9.8 picocuries per gram (pCi/g) at some locations in the WBEU.

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 soil contamination. However, additional ecological and sediment monitoring to address uncertainties identified in the ERA is needed.

The primary exposure pathways for soil contamination are direct contact with surface and near-surface soil, erosion of soil into surface water and air, and precipitation infiltration and dissolved groundwater transport of the contaminants.

The soil RAOs are based on adequate protection of human health and the environment through the direct and indirect human and flora and fauna contact with the soil medium, and release of VOCs and radionuclides from the soil matrix into the water and air. Whether areas of soil contamination are sources of contamination that actually or potentially impact groundwater or surface water quality was evaluated in the RI (Section 8.0).

10.4.2 Soil Remedial Action Objectives

This section describes the three soil RAOs.[12] Results of the RI are compared to the RAOs to determine whether remedial action is needed to meet the RAOs.

10.4.2.1 Source of Groundwater Contamination RAO

Soil RAO 1 is:

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

[12] See the Soil and Groundwater RAO Technical Memorandum (DOE 2005c).

Soil RAO 1 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 dissolved transport) may be above the surface water standard at one or more Sentinel wells. At this time no other additional actions can reasonably be taken.

10.4.2.2 Source of Surface Water Contamination RAO

Soil RAO 2 is:

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

Soil RAO 2 is met provided residual soil contamination is not disturbed. If residual soil contamination is disturbed, the contamination could migrate to surface water via particulate transport, which could result in some surface water sample results above surface water standards at some surface water monitoring locations. An institutional control is needed to prevent disturbance of soil.

10.4.2.3 Direct Exposure to Human or Ecological Receptors RAO

Soil RAO 3 is:

> *Prevent exposures that result in unacceptable risk to a 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 CFR 300.430[e][2][i][A][2]). Prevent significant risk of adverse ecological effects.*

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 wildlife refuge visitor [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. Section 11.0, Detailed Analysis of Alternatives, will evaluate alternatives that include the underlying assumptions used in the CRA human health calculations as an institutional control.

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 in some areas of the site where exceedances of volatilization PRGs in subsurface soil and groundwater indicate a potential indoor air risk (see Figure 10.3 and Figure 10.4). As a result, Section 11.0 will also evaluate alternatives to mitigate exposure over subsurface soil and groundwater sampling locations where exceedances of volatilization PRGs exist in order to prevent exposures that result in unacceptable risk to a WRW.

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 will evaluate 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.

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

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. However, additional ecological and sediment monitoring to address uncertainties identified in the ERA will be evaluated in Section 11.0.

10.5 Applicable or Relevant and Appropriate Requirements

This section identifies chemical-, location-, and action-specific ARARs.[13] The list of ARARs in Table 10.2 will be used in evaluating alternatives in the FS.

The degree of cleanup required by CERCLA section 121(d) for any contamination remaining on site and the final remedy selection requirements of the National Contingency Plan (NCP) for on-site remedial actions (40 CFR 300.430[f]) includes attainment of all ARARs identified in the final ROD unless a waiver is granted for particular ARARs.[14] The RI presents information about contaminants at RFETS in order to develop and evaluate effective remedial alternatives in the FS. The FS evaluation considers and provides an analysis of whether each remedial alternative is expected to meet the ARARs related to that alternative (Section 11.0). Final ARARs to be met by the remedial alternative proposed for the final remedy, and any proposed ARAR waivers, will be identified in the Proposed Plan. On-site remedial actions selected in the CAD/ROD must attain ARARs that are identified at the time the CAD/ROD is signed.

10.5.1 Definition of Applicable or Relevant and Appropriate Requirements

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other

[13] See the ARARs Technical Memorandum (DOE 2005d).
[14] See 40 CFR 300.430(f)(1)(ii)(C) regarding the grounds for ARAR waivers.

circumstance at a CERCLA site. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate.

In addition to ARARs, the lead and support agencies may, when appropriate, identify other nonpromulgated advisories, criteria, guidance documents, or proposed regulations that are to-be-considered (TBC) to supplement an ARAR provision for a particular release. TBCs are not legally binding, and do not have the status of potential ARARs. However, TBCs are used in determining the necessary level of cleanup for the protection of human health and the environment.

ARARs are identified as chemical-, location-, or action-specific. Chemical-specific requirements are usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in or discharged to the ambient environment.

Location-specific requirements are restrictions placed on the concentration of hazardous substances solely because they occur in special locations. Typical location restrictions include areas with sensitive or unique characteristics such as wetlands, areas of historical significance, or areas situated in locations requiring special precautions.

Action-specific requirements are usually technology- or activity-based requirements or limitations on actions taken with respect to management of the remediation waste or closure of the facility. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy.

ARARs for the final remedy are based on the conditions of the site after the implementation of all planned accelerated actions, and will consider the need to conduct additional work to achieve the selected final remedy.

The ARARs identified in Table 10.2 are based on the site conditions reasonably anticipated to exist after planned accelerated actions have been implemented. In particular, the following were considered:

- The in-place cover and stabilization of the Present and Original Landfills to meet containment remedy criteria specified in the IM/IRAs for the landfills in a manner consistent with achieving landfill final closure;

- Cleanup of soils to below the soil action levels (ALs) in Table 3 of the Action Levels and Standards Framework for Surface Water, Ground Water, and Soils (ALF), RFCA Attachment 5;

- The reasonably maximally exposed anticipated future land user of RFETS, which is the WRW; and

- Land use restrictions in and around the IA and in the WBEU in the eastern BZ (DOE et al. 2004).

Final remediation goals, including final ARARs, are determined when the final remedy is selected. The ARARs identified for the final remedy must be met, unless waived. The RFCA Parties may propose changes to the ARARs identified in Table 10.2 based upon final site conditions, the RI/FS Report, or the Proposed Plan. In addition, new or revised federal or state environmental statutes and promulgated rules or regulations could become ARARs.

10.5.2 Compliance With Identified Applicable or Relevant and Appropriate Requirements

The sources of identified ARARs (Table 10.2) and a summary of how key ARARs are met are provided below.

- Colorado Basic Standards and Methodologies and Site Specific Standards for Surface Water – This ARAR is met because surface water at the POCs meets surface water quality standards. 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. Therefore, an institutional control will be needed to prevent use of surface water upstream of the terminal ponds.

- Colorado Basic and Site Specific Standards for Groundwater – This ARAR is met because groundwater at the groundwater AOC wells and one or more Sentinel wells meets the groundwater quality standards. At Sentinel wells where groundwater data are above the groundwater quality standards, results of the RI conclude that, based on the environmental conditions and type of residual contamination, no additional actions can reasonably be taken at this time. Monitoring will continue. In addition, contaminated groundwater has been addressed on a sitewide basis for three plume areas where groundwater treatment systems are installed and operating as designed to improve groundwater quality that could adversely impact surface water quality. These systems will continue to be operated and monitored in accordance with their individual system O&M plans. Shallow (UHSU) groundwater impacted by site activities discharges to surface water upgradient of the site boundary. This impacted groundwater emanates from the former industrial area and discharges to surface water in the drainages upgradient of the terminal ponds. Water quality at AOC and Sentinel wells represents potential impacts from groundwater to surface water.

- National Pollutant Discharge Elimination System (NPDES) – This ARAR is met because the existing NPDES permit, which covered stormwater discharges and sanitary sewage treatment plant discharges, has been properly terminated. Point source and stormwater sources covered by the permit have been removed as part of site closure. In addition, the discharge from the seep treatment system at the Present Landfill to surface water upstream of No Name Gulch meets NPDES substantive requirements for such discharges. As part of the accelerated action decision, the system discharge meets the CERCLA permit waiver provisions. The discharge will be monitored for VOCs, semivolatile organic compounds (SVOCs), and metals with effluent limitations that are the surface water quality standards for Walnut Creek, Big Dry Creek segment 4a.

- Atomic Energy Act, Radiation Protection Standards for Decommissioning Licensed Facilities; Colorado Standards for Protection Against Radiation – These ARARs are met because residual levels of RFETS-related radiological soil contamination do not result in the exceedance of the 25-millirem (mrem) annual radiation dose limit for the WRW under the future RFETS land use as a wildlife refuge. If this land became unrestricted in the future, annual dose limits for the unrestricted user would also not be exceeded (see Attachment 1).

- Subtitle C: Hazardous Waste Management; Solid Waste Disposal Act; CHWA - Groundwater Protection and Monitoring – This ARAR is met because groundwater at the Present Landfill (including the landfill seep) and Original Landfill will be monitored under 6 CCR 1007-3, as required under the approved accelerated action decision documents.

- Subtitle C: Hazardous Waste Management; Solid Waste Disposal Act; CHWA - Closure and Post Closure – This ARAR is met because the Present and Original Landfills were adequately stabilized and covers were properly installed in accordance with regulatory agency-approved designs. In addition, the Original Landfill cover will be maintained and monitored in accordance with its individual landfill monitoring and maintenance plan under a post-closure care enforceable document to be determined by the RFCA Parties. The Present Landfill monitoring and maintenance plan is the post-closure care plan and is enforced under an environmental covenant.

- National Emission Standards for Asbestos – This ARAR is met at the Present Landfill because any asbestos-containing waste material was covered with at least 60 centimeters (cm) of compacted nonasbestos-containing material. The cover provides for ongoing containment of asbestos-containing waste material.

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

10.6 Conclusions

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 (Table 10.1). Most ARARs are met in the Central OU as long as the land surface is not disturbed; consequently, institutional controls are needed to ensure that some ARARs will continue to be met.

Because the CRA does not evaluate an unrestricted scenario, but instead evaluated 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.

Alternatives will be developed and evaluated in detail for the Central OU (Section 11.0).

10.7 References

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DOE, 2005a, Final Comprehensive Risk Assessment Work Plan and Methodology, Rocky Flats Environmental Technology Site, Golden, Colorado, September.

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TABLES

Table 10.1
Summary and Status of the RAOs

Environmental Media	Problem Addressed by RAO	RAO for FS Evaluation	Comments
Groundwater	Contaminated groundwater migration	Groundwater RAO 1: Meet groundwater quality standards, which are the CWQCC surface water standards, at groundwater AOC wells. Section 10.2.2.1	This RAO is met. For the groundwater AOIs (or analytes if ECOCs are identified), 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 with one exception. Well 10594, which is located downgradient of Pond A-1 in North Walnut Creek, has sulfate results above background, which is higher than the surface water standard or PQL, in samples collected in 1995 and 1996.
	Restoration of usable contaminated groundwater to the beneficial use, which is surface water protection	Groundwater RAO 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. Section 10.2.2.2	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.
	Contaminated groundwater	Groundwater RAO 3: Prevent domestic and irrigation use of groundwater contaminated at levels above MCLs. Section 10.2.2.3	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 will be evaluated in Section 11.0.
Surface Water	Contaminated surface water	Meet surface water quality standards, which are the CWQCC surface water standards. Section 10.3.2.1	This RAO is met at all surface water POCs because no surface water AOI exceeds 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

Table 10.1
Summary and Status of the RAOs

Environmental Media	Problem Addressed by RAO	RAO for FS Evaluation	Comments
			are not available at the surface water POC. However, surface water sample results do not always meet CWQCC 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 will be evaluated in Section 11.0. The ERA evaluation concluded that there is no significant risk of adverse ecological effects; however, additional surface water monitoring identified to address uncertainties in the ERA will be evaluated in Section 11.0.
Soil	Source of groundwater contamination	Soil RAO 1: Prevent migration of contaminants to groundwater that would result in exceedances of groundwater RAOs. Section 10.4.2.1	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 some Sentinel wells. At this time no other additional actions can reasonably be taken.
	Source of surface water contamination via particulate erosion	Soil RAO 2: Prevent migration of contaminants that would result in exceedances of surface water RAOs. Section 10.4.2.2	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. An institutional control is needed to prevent

Table 10.1
Summary and Status of the RAOs

Environmental Media	Problem Addressed by RAO	RAO for FS Evaluation	Comments
			disturbance of soil. Specific mechanisms to prevent disturbance of soil will be evaluated in Section 11.0.
	Direct exposure to human or ecological receptors	Soil RAO 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 CFR 300.430[e][2][i][A][2]). Prevent significant risk of adverse ecological effects. Section 10.4.2.3	This RAO 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. Specific mechanisms to embody the underlying assumptions used in the CRA will be evaluated in Section 11.0. The qualitative assessment of the indoor air volatilization pathway concluded that the indoor air inhalation pathway is potentially significant if buildings were constructed and occupied in some areas of the site. Specific mechanisms to mitigate exposure to indoor air volatilization will be evaluated in Section 11.0. While this RAO is met based on the low risk presented by residual plutonium-239/240 remaining in surface soil, Section 11.0 will evaluate removing plutonium-239/240 contamination to below 9.8 pCi/g, which is the 1×10^{-6} WRW risk target concentration. The ERA evaluation concluded

Table 10.1
Summary and Status of the RAOs

Environmental Media	Problem Addressed by RAO	RAO for FS Evaluation	Comments
			that there is no significant risk of adverse ecological effects; however, additional ecological and sediment monitoring to address uncertainties identified in the ERA will be evaluated in Section 11.0.

Table 10.2
ARARs

CLEAN AIR ACT (CAA) (42 U.S. Code [USC] 7401 et. seq.)			
Requirement	**Citation**	**Type[a]**	**Comment**
NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS	**40 CFR 61**		
• National Emission Standards for Emissions of Radionuclides Other Than Radon From DOE Facilities	40 CFR 61, Subpart H		CAQCC Reg. No. 8 (5 CCR 1001-10) incorporates 40 CFR 61, Subpart H without change.
- Standard	61.92	C/L	Emissions of radionuclides to the ambient air from U.S. Department of Energy (DOE) facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent (EDE) of 10 mrem/yr.
- Emission Monitoring and Test Procedures	61.93	C/A	Radionuclide emissions shall be determined and EDE values to members of the public calculated using EPA-approved sampling procedures, computer models CAP–88 or AIRDOS–PC, or other procedures for which EPA has granted prior approval. Potential sources of radionuclide emissions will be evaluated in the FS based on results from established perimeter and on-site sampler networks. Periodic evaluation and monitoring (if required because of the source term) will be developed and implemented pursuant to the final remedy decision in the CAD/ROD.
- Compliance and Reporting	61.94	C/L/ A	Compliance with the standard shall be determined by calculating the highest EDE to any member of the public at any off-site point where there is a residence, school, business, or office.

Table 10.2
ARARs

CLEAN AIR ACT (CAA) (42 U.S. Code [USC] 7401 et. seq.)			
Requirement	**Citation**	**Type[a]**	**Comment**
• National Emission Standard for Asbestos	40 CFR 61, Subpart M		
- Cover	61.151(a)(3)	A/L	The Present Landfill, IHSS 114, may contain regulated asbestos-containing waste material. Any asbestos-containing waste material was covered with at least 60 cm (2 ft) of compacted nonasbestos-containing material. The cover will be maintained to prevent exposure of the asbestos-containing waste material. The specific maintenance plan will be documented as part of the final remedy decision and other enforceable document. Subpart M is only an ARAR for the Present Landfill, IHSS 114.
- Signage	61.151(b)	A/L	Because there is no natural barrier to adequately deter access by the general public, installation and maintenance of warning signs and fencing will be complied with under 40 CFR 61.151(a)(3).
- Notification to Administrator in writing at least 45 days prior to excavating or otherwise disturbing any asbestos-containing waste material	61.151(d)	A	Requirements for notification will be included as part of the final remedy decision in the CAD/ROD and other enforceable document.
- Notation on Deed	61.151(e)	A	The environmental covenant will include a notation that the Present Landfill, IHSS 114, may have been used for the disposal of asbestos-containing waste material.

Table 10.2
ARARs

FEDERAL WATER POLLUTION CONTROL ACT (Clean Water Act [CWA]) (33 USC 1251 et. seq.)			
Requirement	**Citation**	**Type**	**Comment**
COLORADO BASIC STANDARDS AND METHODOLOGIES FOR SURFACE WATER	5 CCR 1002-31		
• Process for Assigning Standards and Granting, Extending, or Removing Temporary Modifications	31.7	C/L	Assessment and monitoring of surface water quality is described in the surface water remedial action. Remediation alternatives that would require changes to standards, temporary modifications, and the use of mixing zones may be evaluated in the FS. Monitoring requirements will be developed and implemented pursuant to the final remedy decision in the CAD/ROD.
• Mixing Zones	31.10		
• Basic Standards Applicable to Surface Waters of the State	31.11		
CLASSIFICATION AND NUMERIC STANDARDS SOUTH PLATTE RIVER BASIN, LARAMIE RIVER BASIN, REPUBLICAN RIVER BASIN, SMOKY HILL RIVER BASIN	5 CCR 1002-38		
• Classification Tables	38.6	C/L	This requirement lists use classifications and parameters for segments 4a, 4b, and 5 of Big Dry Creek (Woman and Walnut Creeks on RFETS).
COLORADO BASIC STANDARDS FOR GROUND WATER	5 CCR 1002-41	C/L	
• Point of Compliance	41.6	C/L	The POCs for assessment and monitoring of groundwater quality are the AOC wells described in the groundwater and soils RAOs.
SITE SPECIFIC WATER QUALITY CLASSIFICATIONS AND STANDARDS FOR GROUND WATER	5 CCR 1002-42		
• Rocky Flats Area, Jefferson and Boulder Counties	42.7(1)	C/L	The use classification for groundwater at RFETS is surface water protection. This classification recognizes that groundwater is not a current or potential source of drinking water, recognizing that controls to prohibit and prevent use of contaminated groundwater are and will be in place at RFETS.

Table 10.2
ARARs

FEDERAL WATER POLLUTION CONTROL ACT (Clean Water Act [CWA]) (33 USC 1251 et. seq.)			
Requirement	**Citation**	**Type**	**Comment**
PERMITS FOR DREDGED OR FILL MATERIAL; DISCHARGES OF DREDGED OR FILL MATERIAL INTO WATERS OF THE UNITED STATES	33 USC 1344; 33 CFR 323		
• Definitions • Discharges Requiring Permits	33 CFR 323.2 33 CFR 323.3	A/L	On-site remedial actions do not require permits, but remedies requiring discharge of dredge or fill material into waters of the United States (types of activities are defined in the regulation) must meet substantive requirements of any nationwide or regional permit or specific NPDES permit that may otherwise be required. Requirements for any remedial alternatives that require discharge of dredge or fill material will be evaluated in the FS. Final requirements will be implemented pursuant to the final remedy decision in the CAD/ROD.
DOE COMPLIANCE WITH FLOODPLAIN/WETLANDS ENVIRONMENTAL REVIEW REQUIREMENTS	10 CFR 1022		
• Floodplain/Wetlands Determination • Floodplain/Wetlands Assessment • Applicant Responsibilities	10 CFR 1022.11 10 CFR 1022.12 10 CFR 1022.13	A/L	
NPDES	**33 USC 1342; 40 CFR 122**		
• Stormwater Permit for Construction Activities	40 CFR 122.26	A/L	On-site remedial actions do not require permits, but remedies that discharge pollutants from point sources or that involve stormwater discharges must meet substantive requirements for a site-specific or general NPDES permit. Substantive requirements for an NPDES permit are included in the Present Landfill IM/IRA. These requirements will be carried forward into the final CAD/ROD. Requirements for any remedial alternatives that require discharge of pollutants will be evaluated in the FS. Final requirements will be implemented pursuant to the final remedy decision in the CAD/ROD.
• General Permits	40 CFR 122.28	A/L	

Table 10.2
ARARs

FEDERAL WATER POLLUTION CONTROL ACT (Clean Water Act [CWA]) (33 USC 1251 et. seq.)			
Requirement	**Citation**	**Type**	**Comment**
• RCRA Subtitle C Hazardous Waste Landfill Effluent Limitations	40 CFR 445.11	A/C	Parameters that will be monitored for at the Present Landfill (IHSS 114) seep treatment system discharge are metals, VOCs, SVOCs, and nitrates. The effluent limits are the surface water standards applicable for the receiving water as listed in RFCA Attachment 5, Table 1.

Table 10.2
ARARs

NATURAL RESOURCE AND WILDLIFE PROTECTION LAWS			
Requirement	**Citation**	**Type**	**Comment**
ENDANGERED SPECIES ACT (ESA)	**16 USC 1531 et seq.**		
• Early Consultation	50 CFR 402.11	A/L	The objective is to identify and minimize early in the planning stage of an action any potential conflicts between the action and federally listed proposed species and designated and proposed critical habitat.
• Biological Assessment ➢ Purpose ➢ Preparation Requirements ➢ Request for Information ➢ Director's Response ➢ No Listed Species or Critical Habitat Present ➢ Listed Species or Critical Habitat Present ➢ Verification of Current Accuracy of Species List ➢ Contents ➢ Identical/Similar to Previous Action ➢ Permit Requirements ➢ Completion Time ➢ Submission of Biological Assessment ➢ Use of Biological Assessment	50 CFR 402.12	A/L	DOE will evaluate in the FS the potential effects of the action on listed and proposed species and designated and proposed critical habitat and determine whether any such species or habitat are likely to be adversely affected in determining whether formal consultation or a conference is necessary.
• Interagency Cooperation	50 CFR 402		
• Informal Consultation	50 CFR 402.13	A/L	This step is an optional process that includes all discussions, correspondence, and so forth between the U.S. Fish and Wildlife Service (USFWS) and DOE to assist in determining whether formal consultation or a conference is required. If, during this step, it is determined by DOE, with the written concurrence of USFWS, that the action is not likely to adversely affect listed species or critical habitat, the consultation process is terminated and no further action is necessary. Otherwise, formal consultation shall occur.
• Formal Consultation	50 CFR 402.14	A/L	Results of informal or formal consultation shall be evaluated in the FS.

Table 10.2
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NATURAL RESOURCE AND WILDLIFE PROTECTION LAWS			
Requirement	**Citation**	**Type**	**Comment**
MIGRATORY BIRD TREATY	16 USC 701-715		
• Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants	50 CFR 10	A/L	Remedial alternatives will be evaluated in the FS regarding whether they may be planned and implemented to prevent or minimize contact with listed birds and nests.
COLORADO WILDLIFE STATUTES	**Colorado Revised Statutes (CRS) 33-1-101 to 33-6-209**		
• Compliance With the Colorado Wildlife Statutes, Including Nongame, Endangered, or Threatened Species Conservation Act and the State Statutes Regarding Illegal Possession	CRS 33-1-101 CRS 33-1-102(34) and (43) CRS 33-2-104 CRS 33-2-105 CRS 33-6-109	A/L	Remedial alternatives will be evaluated in the FS regarding whether they may result in any prohibited taking or possession of any species or subspecies of wildlife appearing on the list of wildlife indigenous to the State of Colorado determined to be endangered within the State. The state interprets "taking" as including contamination-induced deaths of individual members of a species. The assessment for the Preble's meadow jumping mouse (PMJM) in the CRA will address the potential for individual mice to be adversely affected by contact with ecological contaminants of potential concern (ECOPCs). For other species with stable or healthy populations, the assessment will focus on population-level effects where some individuals may suffer adverse effects, but the effects are not ecologically meaningful because the overall site population is not significantly affected.
ARCHEOLOGICAL AND HISTORICAL PRESERVATION ACT	16 USC 469a-1		
• Notification and Request for Preservation of Data, Survey of Sites; Preservation of Data; Compensation	16 USC 469a-1(a) 16 USC 469a-1(b)	L	This Act differs from the National Historic Preservation Act in that it encompasses a broader scope of resources than those listed on the National Register and requires only preservation of the data (including analysis and publication).

Table 10.2
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NATURAL RESOURCE AND WILDLIFE PROTECTION LAWS			
Requirement	**Citation**	**Type**	**Comment**
FEDERAL NOXIOUS WEED ACT	Pub. L. 93-629; 7 USC 2814 et seq.		
• Management of Undesirable Plants on Federal Lands • Duties of Federal Agencies	7 USC 2814 (a)(3), (a)(4), (c)(1), (c)(2)	A	Remedial alternatives will be evaluated in the FS regarding whether they may result in any undesirable plant species at RFETS and control measures needed for undesirable plant species targeted under any state agency cooperative agreements.
COLORADO NOXIOUS WEED ACT	CRS 35-5.5-101 et seq.		
• Duty to Manage Noxious Weeds	Section 104	L/A	Remedial alternatives will be evaluated in the FS regarding whether they may need to use integrated methods to manage noxious weeds if the same are likely to be materially damaging to DOE property or the land of neighboring landowners.
• Cooperation with Federal and State Agencies	Section 111	L/A	The local governing bodies in Colorado are authorized to enter into cooperative agreements with federal and state agencies for the integrated management of noxious weeds within their respective territorial jurisdictions. The Jefferson County Noxious Weed Management Plan establishes the countywide strategy for the management, control, and eradication of noxious weeds in the County.
NATIONAL WILDLIFE REFUGE SYSTEM ADMINISTRATION ACT	16 USC 668dd(c)	L	This Act prohibits interference with natural growth or wildlife on national wildlife refuges administered by USFWS, unless permitted.

Table 10.2
ARARs

ATOMIC ENERGY ACT, 42 USC 2011, et seq.			
Requirement	**Citation**	**Type**	**Comment**
RADIATION PROTECTION STANDARDS AND DECOMMISSIONING US NUCLEAR REGULATORY COMMISSION LICENSED FACILITIES	6 CCR 1007-1 10 CFR		Colorado Division of Laboratory and Radiation Services regulations, 6 CCR 1007-1 (Radiation Health [RH]), are identified as ARARs. Comparable federal regulations are shown in parenthesis for reference.
• Decommissioning Plan Contents – Must include a description of methods used to ensure protection of workers and the environment against radiation hazards during decommissioning.	RH 3.16.4.3(3) (70.38[g][4][iii])	A	10 CFR 70 relates to special nuclear material. Identical provisions for source material and byproduct material are found at 10 CFR Parts 40 and 30, respectively, but are omitted here for simplicity. The ARAR is for environmental protection, not worker health and safety aspects of the rule, which are not ARARs.
• Decommissioning Plan Contents – Must include a description of the planned final radiation survey.	RH 3.16.4.3(4) (70.38[g][4][iv])	A/L	The requirements for a final radiation survey will be met through implementation of the Sampling and Analysis Plans (SAPs) and the IMP.
• Decommissioning Plan Contents – Must include a description of the intended final condition of the site upon decommissioning.	RH 3.16.4.3(6) (70.38[g][4][i])	A/L	The description will be provided for remedial alternatives in the FS.
• Decommissioning Under Restricted Conditions – Must demonstrate that reductions in residual radioactivity necessary to comply with the provisions of RH 4.61.2 (unrestricted use) would result in net public or environmental harm or were not being made because residual levels of contamination associated with restricted conditions are as low as reasonably achievable (ALARA), taking into account consideration of any detriments expected to potentially result from decontamination and waste disposal.	RH 3.16.4.3(7)(a) and 4.61.3.1 (20.1403[a])	A/L	The evaluation will be provided for remedial alternatives in the FS.
• Decommissioning Plan Contents for Restricted Conditions – Must specify intent to decommission by restricting use of the site and describe legally enforceable institutional controls and other mechanisms that provide reasonable assurance that the total EDE (TEDE) from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 25 mrem (0.25 millisiever+ [mSv]) per year.	RH 3.16.4.3(7)(b) RH 3.16.4.6 (20.1403[b] and [d])	A/L	The description will be provided in the FS, and specific plans will be developed and implemented pursuant to the final remedy decision in the CAD/ROD. 10 CFR 20.1403(c) specifies requirements for financial assurance to allow independent third party, including a government custodian of the site, to carry out control and maintenance of the site. (RH 3.16.4.6 specifies a long-term care warranty under RH 3.9.5.10 that may be required if restricted conditions are used.) The

Table 10.2
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ATOMIC ENERGY ACT, 42 USC 2011, et seq.			
Requirement	**Citation**	**Type**	**Comment**
			RFCA Parties agree that the FS need not evaluate a long-term care warranty at this time.
• Decommissioning Under Restricted Conditions – Residual radioactivity at the site has been reduced so that if the institutional controls were no longer in effect, there is reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group is ALARA and would not exceed either: (1) 100 mrem (1 mSv) per year; or (2) 500 mrem (5 mSv) per year, provided: (i) further reductions in residual radioactivity necessary to comply with the 100 mrem/yr (1 mSv/yr) value is not technically achievable, would be prohibitively expensive, or would result in net public or environmental harm; (ii) provisions for durable, legally enforceable institutional controls, which provide reasonable assurance that the TEDE from residual radioactivity distinguishable from background to the average member of the critical group will not exceed 25 mrem/yr (0.25 mSv) (see 4.61.3.2); and (iii) periodic rechecks of the site no less frequently than every 5 years to ensure that the institutional controls remain in place as necessary to meet the criteria of § 20.1403(b).	RH 3.16.4.3(7)(c) (20.1403[e])	A/L	The analysis will be provided in the FS, and specific plans will be developed and implemented pursuant to the final remedy decision in the CAD/ROD. Like 10 CFR 20.1403(c), 10 CFR 20.1403(e) also specifies requirements for financial assurance to allow an independent third party, including a government custodian of the site, to carry the 5-year review. The RFCA Parties agree that the FS need not evaluate a long-term care warranty at this time.
• Surveys – A radiation survey has been performed that demonstrates that the premises are suitable for release in accordance with the criteria for decommissioning in 10 CFR Part 20, Subpart E including, as appropriate, a radiation survey performed in any separate building or outdoor area that contains residual radioactivity.	RH 3.16.6.2 (70.38[k][3][i])	A/L	Requirements for radiation surveys have been met through the data collected and contained in the SAPs and the IMP.

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ATOMIC ENERGY ACT, 42 USC 2011, et seq.			
Requirement	**Citation**	**Type**	**Comment**
• Units and Calibration – As appropriate, gamma levels must be reported at radioactive concentrations in picocuries per liter (pCi/L) or pCi/g; instruments used must be identified and instrument calibration/testing must be certified.	RH 3.16.6.3 (70.38[j][2][i])	A/L	See comment for RH 3.16.6.2 above. Units are specified in the plans.
• Completion Criteria – The criteria must include a determination that (1) radioactive materials have been properly disposed of and records of disposal have been forwarded to CDPHE, (2) regulatory requirements for license termination have been met, (3) long-term care warranty has been established, if required, and (4) institutional controls have been implemented to limit public doses, if required.	RH 3.16.7	A/L	Although license termination is not relevant to Rocky Flats, the substantive criteria in this regulation are relevant and appropriate to determining the endpoint for decommissioning at Rocky Flats. Subsection (1) is met by implementing the on-site remedial actions required under the final remedial decision in the CAD/ROD (off-site disposal is not subject to ARARs), and subsections (2) and (4) are addressed in RH 4.61.2 through .4 (10 CFR 20.1402) (discussed below). Subsection (3), which is grounded in RH 3.9.5.10 (10 CFR 20.1403[c]), is discussed above under RH 3.16.4.6 (10 CFR 20.1403 [b] and [d]). Records of disposal were forwarded to CDPHE in closeout reports.
• New Information – If, based on new or previously unknown information, the criteria in RH 4.61 are not met and residual radioactivity remaining at RFETS could result in a significant threat to public health and safety, additional cleanup can be required.	RH 3.16.8	L	This standard is generally consistent with the "imminent and substantial endangerment" standard under CERCLA. Present risk of future harm (for example, a risk of cancer due to long-term exposure) can be an "imminent" threat.
• Radiation Protection Program – To the extent practicable, procedures and controls used shall be based on sound radiation protection principles to achieve public doses that are ALARA.	RH 4.5.2 (20.1101[b])	A	Planned implementation of site-approved procedures to meet DOE Order 5400.5, “Radiation Protection of the Public and the Environment” and the Site’s Integrated Work Control Package will be described for remedial alternatives in the FS, and specific plans will be developed and implemented pursuant to the final remedy decision in the CAD/ROD.

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ATOMIC ENERGY ACT, 42 USC 2011, et seq.			
Requirement	**Citation**	**Type**	**Comment**
• Radiation Protection Program – The Program imposes constraint on air emissions of radioactive material to the environment to implement ALARA. "Individual member of the public likely to receive the highest dose" will not be expected to receive a TEDE greater than 10 mrem/yr from air emissions. Requires exceedance reporting and corrective action to ensure against recurrence.	RH 4.5.4 (20.1101[d])	A	The Program will be implemented consistent with 40 CFR 61, Subpart H ARARs. The state interprets "individual member of the public" to include a USFWS worker.
• Dose Limits for Individual Members of Public – Surveys of radiation levels in unrestricted areas and radioactive materials in effluents released to unrestricted areas shall be made to demonstrate compliance with the dose limits for individual members of the public.	RH 4.15.1 (20.1302[a])	A/L	Surveys will be conducted pursuant to site-approved procedures to meet DOE Order 5400.5, "Radiation Protection of the Public and the Environment." Will be implemented consistent with 40 CFR 61, Subpart H ARARs for air emissions. Surface water quality will be monitored and assessed as described in the surface water RAOs.
• Dose Limits for Individual Members of Public – The limits provide the means to demonstrate compliance with RH 4.14 (10 CFR 20.1301[a]) by measurement or calculation that dose does not exceed the annual limit, or by demonstrating that annual average radioactive material concentration released in gaseous and liquid effluents at the boundary of the unrestricted area does not exceed Appendix B, Table 2, "Effluent Concentrations," and, if an individual were continually present in an unrestricted area, the dose from external sources would not exceed 0.002 rem (0.02mSv) in an hour and 0.05 rem (0.5 mSv) in a year.	RH 4.15.2.1 and .2 (20.1302[b])	L	Site-approved procedures to meet DOE Order 5400.5, "Radiation Protection of the Public and the Environment," are based on the same dose rate limits. Will be implemented consistent with 40 CFR 61, Subpart H ARARs for air emissions. Surface water quality will be monitored and assessed as described in the surface water RAOs.
• Surveys – Surveys shall be made as necessary to evaluate radiation levels, concentrations of radioactive material, and potential radiological hazards that could be present.	RH 4.17.1 (20.1501[a])	A/L	Requirements for radiation surveys will be met through implementation of the SAPs and the IMP for Environmental Restoration.
• Calibration Frequency – Instruments and equipment used for qualitative radiation measurements must be calibrated periodically for the radiation measured. • Calibration Intervals – Intervals shall not exceed 12 months, unless otherwise noted by regulation.	20.1501(b) RH 4.17.2	A	Requirements for equipment calibration will be met through implementation of the SAPs and the IMP.

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ATOMIC ENERGY ACT, 42 USC 2011, et seq.			
Requirement	**Citation**	**Type**	**Comment**
• Waste Disposal – Waste shall be disposed of only by transfer to authorized recipient, decay in storage, and release in effluents within the limits of subpart RH 4.14 (20.1301).	RH 4.33 (20.2001[a][3])	A/L	Transfer to authorized recipient is not ARAR because transfer is not an on-site remedial action. Decay in storage is not a feasible alternative. Remedial alternative components that involve off-site release in effluents (if any) will be evaluated in the FS.
• Radiological Criteria for Decommissioning (applicable to certain facilities licensed to use radioactive materials) – Maximum TEDE to "average member of the critical group" within the first 1,000 years after decommissioning must be calculated.	RH 4.61.1.2 (20.1401(d))	A/L	Although license termination is not applicable to Rocky Flats, the substantive criteria in this regulation are relevant and appropriate standards for the RFETS final remedy. See Results of the Interagency Review of Radionuclide Soil Action Levels, September 30, 2002.
• Criteria for Unrestricted Use – Residual radioactivity above background has been reduced to levels that are ALARA and results in TEDE to average member of the critical group that does not exceed 25 mrem/yr, including groundwater sources of drinking water. Determination of dose and residual activity levels that ALARA must take into account consideration of any detriments expected to potentially result from decontamination and waste disposal.	RH 4.61.1.3 RH 4.61.2 (20.1402)	A/L	The analysis will be provided in the FS, and specific plans will be developed and implemented pursuant to the final remedy decision in the CAD/ROD. Locations of past burial of certain ash and debris contaminated with low levels of uranium and plutonium will be evaluated under this rule for release under unrestricted or restricted release criteria, as appropriate, pursuant to this ARAR. The RFCA Parties have determined that 6 CCR 1007-1, Part 14 Licensing Requirements for Land Disposal of Low-level Radioactive Waste, need not be identified as an ARAR because the radiological criteria for decommissioning was intended to cover these types of past burial practices.
• Criteria for Restricted Use – Provisions were made for durable, legally enforceable institutional controls that provide reasonable assurance that TEDE to average member of the critical group will not exceed 25 mrem/yr, and, if institutional controls were no longer in effect, TEDE above background is ALARA and would not exceed either 100 mrem/yr or 500 mrem/yr if demonstrated that further reductions are not technically achievable, would be prohibitively expensive, or would result in net public or environmental harm.	RH 4.61.3.2 and .3 (20.1403[b] and [e])	A/L	The analysis will be provided in the FS, and specific plans will be developed and implemented pursuant to the final remedy decision in the CAD/ROD. See comment for RH 4.61.2 above.

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ATOMIC ENERGY ACT, 42 USC 2011, et seq.			
Requirement	**Citation**	**Type**	**Comment**
• Alternate (Decommissioning) Criteria – Alternate criteria may be used if: - Assurance is provided that public health and safety would continue to be protected; - It is unlikely that TEDE would be more than 100 mrem/yr; - Restrictions are employed for on-site use that minimizes exposures at the site; and - Doses are reduced to ALARA levels.	RH 4.61.4.1.1 through .3 (20.1404[a])	A/L	The analysis will be provided in the FS, and specific plans will be developed and implemented pursuant to the final remedy decision in the CAD/ROD.

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SUBTITLE C: HAZARDOUS WASTE MANAGEMENT (CHWA [CRS § § 25-15-101 to -217]) SOLID WASTE DISPOSAL ACT (RCRA) (42 USC § 6901 et. seq.)			
Requirement	**Citation**	**Type**	**Comment**
GENERAL	6 CCR 1007-3, Part 261, Subpart A (40 CFR 261, Subpart A)		
• Exclusions	.4(a)(2)	A	Industrial wastewater discharges that are point source discharges subject to regulation under Section 402 of the CWA are not considered solid wastes.
IDENTIFICATION AND LISTING OF HAZARDOUS WASTES	6 CCR 1007-3, 261 (40 CFR 261)	A	All remediation waste will be characterized to determine a hazardous waste classification.
GENERATOR STANDARDS	6 CCR 1007-3 Part 262 (40 CFR Part 262)		
• Hazardous Waste Determinations	.11	A/C	Persons who generate solid wastes are required to determine whether the wastes are hazardous according to 6 CCR 1007-3 Parts 261, 267, and 279 (40 CFR Parts 261, 266, and 279).
• Hazardous Waste Accumulation Areas	.34	A	Persons who accumulate hazardous waste in containers or tanks must manage the waste in a manner that protects human health and the environment.
GENERAL	6 CCR 1007-3, Part 265, Subpart A (40 CFR 265, Subpart A)		
• Purpose, Scope, and Applicability	.1(c)(10)	A	The requirements of Part 265 do not apply to elementary neutralization units or wastewater treatment units.
GENERAL FACILITY STANDARDS	6 CCR 1007-3 Part 265, Subpart B (40 CFR Part 265, Subpart B)		
• Security	.14	A/L	The owner/operator of a facility must prevent unauthorized access.
• General Inspection Requirements	.15	A/L	The owner/operator of a facility must inspect for malfunctions, deteriorations, and releases, and must remedy deficiencies.
• Personnel Training Requirements	.16	A/C	Personnel must be trained.
• Requirements for Ignitable, Reactive or Incompatible Wastes	.17	A	

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SUBTITLE C: HAZARDOUS WASTE MANAGEMENT (CHWA [CRS § § 25-15-101 to -217]) SOLID WASTE DISPOSAL ACT (RCRA) (42 USC § 6901 et. seq.)			
Requirement	**Citation**	**Type**	**Comment**
PREPAREDNESS AND PREVENTION	6 CCR 1007-3 Part 265, Subpart C (40 CFR 265, Subpart C)		The analysis will be provided in the FS, and ultimately in the CAD/ROD for the final action.
• Required Equipment	.32	A/C	Facilities must be equipped with specified equipment to mitigate incidents should they occur.
• Testing and Maintenance of Equipment	.33	A/C	Equipment must be maintained.
• Access to Communications or Alarm System	.34	A/L	Employees must have access to emergency communications when managing hazardous waste.
• Arrangement with Local Authorities	.37	A/L	The owner/operator must make arrangements with specified local emergency personnel.
CONTINGENCY PLAN AND EMERGENCY PROCEDURES	6 CCR 1007-3 Part 265, Subpart D (40 CFR Part 265, Subpart D)		The analysis will be provided in the FS, and ultimately in the CAD/ROD for the final action.
• Purpose and Implementation	.51	A/C	Emergencies such as fire, explosion, or release of hazardous waste must be mitigated immediately.
• Emergency Coordinator	.55	A	A designated employee is responsible for coordinating emergency response actions.
• Emergency Procedures	.56	A	The emergency procedures of the RFETS Emergency Response Plan will be followed.
GROUNDWATER PROTECTION (RELEASES FROM SWMUs)	6 CCR 1007-3 Part 264, Subpart F (40 CFR Part 264, Subpart F)		
• Applicability – Requires compliance with corrective action requirements for SWMUs, and for "regulated units" that received hazardous waste after July 26, 1982. SWMUs are subject to 264.101. Regulated units are subject to monitoring and response programs and groundwater protection standards for hazardous constituents that exceed specified standards at the POC (264.91 - 264.100).	264.90	A/C	The only regulated units are the SEP, IHSS 101, and the Present Landfill, IHSS 114, which are being closed under Part 265 (Interim Status) requirements. The SEP, IHSS 101, was closed under 6 CCR 1007-3, section 265.110(d) and is not subject to post-closure monitoring because there are no hazardous constituents that exceed specified standards at a groundwater POC. The Present Landfill, IHSS 114, was closed under 6 CCR 1007-3,

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SUBTITLE C: HAZARDOUS WASTE MANAGEMENT (CHWA [CRS § § 25-15-101 to -217]) SOLID WASTE DISPOSAL ACT (RCRA) (42 USC § 6901 et. seq.)			
Requirement	**Citation**	**Type**	**Comment**
			section 265.111 and is subject to post closure monitoring, response, and groundwater protection standards for hazardous constituents that exceed specified standards at the POC under Part 264. A groundwater monitoring system was implemented under the Present Landfill IM/IRA and the IMP pursuant to 6 CCR 1007-3, section 264.93. A total of six (three upgradient and three downgradient) RCRA groundwater monitoring wells have been established. The constituents that will be monitored for are VOCs and metals. The purpose of the monitoring is to evaluate upgradient versus downgradient groundwater quality at the Present Landfill. These specific monitoring requirements and maintenance plans will be documented as part of the final remedy decision in the CAD/ROD and other enforceable document.
• Concentration Limits – Alternate concentration limits may be approved that do not pose a substantial present or potential hazard to human health and the environment.	264.94 (b) (c)	C	While IHSS 114 will be subject to interim status post-closure monitoring, and SWMUs are not subject to this requirement, this section provides criteria that may be relevant and appropriate in establishing groundwater concentrations for post-closure groundwater monitoring. ACLs will be evaluated if necessary in the FS. Specific plans will be developed and implemented pursuant to the final remedy decision in the CAD/ROD.
• Corrective Action for SWMUs	264.101	A/L	Each IHSS has been evaluated, and an accelerated action taken as necessary, in compliance with RFCA. RFCA paragraph 11 states that compliance with the requirements of this Agreement will be deemed to achieve compliance with (c) the corrective action

SUBTITLE C: HAZARDOUS WASTE MANAGEMENT (CHWA [CRS § § 25-15-101 to -217]) SOLID WASTE DISPOSAL ACT (RCRA) (42 USC § 6901 et. seq.)			
Requirement	**Citation**	**Type**	**Comment**
			requirements of CHWA, including 6 CCR 1007-3 sections 264.101 and 265.5, and (d) the closure requirements of CHWA for those hazardous waste management units identified in RFCA Attachment 3. It is anticipated that the completion of the accelerated actions will complete the corrective action for soil at each IHSS (formerly SWMU). In recognition that groundwater contamination could be caused by releases from multiple hazardous waste management units and/or from sources other than but around hazardous waste management units, corrective action for groundwater has been addressed on a sitewide basis. Two groundwater plume treatment systems (ETPTS and MSPTS) were installed as accelerated actions. These systems, combined with the source removal accelerated actions, are anticipated to be the corrective action for groundwater. The O&M of the groundwater plume treatment systems will continue and be identified in the FS. Notwithstanding the above, the RFCA Parties recognize that the final remedial/corrective action decisions may require some additional work as specified in the CAD/ROD to ensure an adequate remedy.
GROUNDWATER MONITORING	6 CCR 1007-3 Part 265, Subpart F (40 CFR Part 265, Subpart F)		
• Applicability – Monitoring applies to landfills, surface impoundments, and land treatment facilities ("regulated units"). Program must be capable of determining facility's impacts on groundwater in uppermost aquifer underlying the facility. Alternate groundwater monitoring system (265.90[d]) or alternative requirements (265.90[f]) may be approved for any of the requirements specified in Subpart F.	265.90	A/L/ C	Alternate groundwater monitoring system may be approved if it is known that monitoring indicator parameters are already exceeded at required monitoring points. Alternative requirements that are protective of human health and the environment may be approved if a regulated unit is situated among

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SUBTITLE C: HAZARDOUS WASTE MANAGEMENT (CHWA [CRS § § 25-15-101 to -217]) SOLID WASTE DISPOSAL ACT (RCRA) (42 USC § 6901 et. seq.)			
Requirement	**Citation**	**Type**	**Comment**
			SWMUs or AOC, a release has occurred, and the regulated unit and SWMU or AOC are likely to have contributed to the release. A groundwater monitoring system was implemented under the Original Landfill, IHSS 115, IM/IRA. A total of four (one upgradient and three downgradient) RCRA groundwater monitoring wells have been established. The constituents that will be monitored for are VOCs, SVOCs, pesticides, and metals (including uranium). The purpose of the monitoring is to evaluate upgradient versus downgradient groundwater quality at the Original Landfill. These specific monitoring requirements and maintenance plans will be documented as part of the final remedy decision in the CAD/ROD.
• Groundwater Monitoring System – System must have at least one upgradient well to monitor water representative of background not affected by the facility. It must have at least three downgradient wells at the limit of the waste management area to immediately detect hazardous waste or constituents migrating from the waste management area to the uppermost aquifer. Alternate downgradient wells may be approved and the limit of the waste management area may encompass several waste management components.	265.91	A/L/ C	The rationale for monitoring well locations for the Original Landfill is described in the Original Landfill IM/IRA. Selection of well locations will be documented as part of the final remedy decision in the CAD/ROD.
• Sampling and Analysis – A plan must be in place for obtaining and analyzing samples for concentrations of specified groundwater quality and contamination parameters at least annually and semiannually, respectively. This is for the periodic indicator evaluation of groundwater.	265.92	A/C	The rationale for monitoring well sampling and analysis parameters is described in the Original Landfill IM/IRA. The sampling and analysis plan will be documented as part of the final remedy decision in the CAD/ROD.
• Preparation, Evaluation, and Response – A groundwater quality assessment outline must describe a comprehensive groundwater monitoring program capable of determining whether hazardous waste and constituents have entered the groundwater and the extent, migration, and concentration of contamination. If evaluation is triggered by the periodic indicator evaluations, sampling and analysis frequency	265.93	A/C	The outline for groundwater quality assessment is described in the Original Landfill IM/IRA. The evaluation plan will be documented as part of the final remedy decision in the CAD/ROD.

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ARARs

SUBTITLE C: HAZARDOUS WASTE MANAGEMENT (CHWA [CRS § § 25-15-101 to -217]) SOLID WASTE DISPOSAL ACT (RCRA) (42 USC § 6901 et. seq.)			
Requirement	**Citation**	**Type**	**Comment**
under this section will be at least quarterly. Annual evaluation of groundwater elevations must be made to determine whether well location requirements are satisfied.			
• Recordkeeping and Reporting	265.94	A	Recordkeeping and reporting protocols will be implemented pursuant to the final remedy decision in the CAD/ROD.
CLOSURE AND POST-CLOSURE	6 CCR 1007-3 Part 265, Subpart G (40 CFR Part 265, Subpart G)		This ARAR applies to the Present Landfill, IHSS 114, and the Original Landfill, IHSS 115.
• Applicability – Hazardous waste management facilities must meet closure requirements and, relevant to RFETS, hazardous waste disposal facilities and tank systems closed as landfills are subject to post-closure care requirements. Alternative requirements (265.110[d]) may be approved for any of the requirements specified in Subpart G.	265.110	A	Alternate closure requirements may be approved if a "regulated unit" is situated among SWMUs or AOC, a release has occurred, and the regulated unit and SWMU or AOCs are likely to have contributed to the release. Closure must be protective of human health and the environment.
• Closure Performance Standard	265.111		If alternate closure requirements are approved per 265.110(d), closure must meet 265.111(a) and (b). Otherwise, 265.111(c) must also be met.
• Disposal or Decontamination of Equipment, Structures, or Soils	265.114	A	
• Survey Plat – A plat prepared by a professional land surveyor must show the location of waste in relation to survey benchmarks.	265.116	L	A survey plat will be prepared and provided to third parties and retained by DOE as required by the final remedy decision.
• Post-Closure Care and Use of Property – A 30-year period for identified post-closure care monitoring, maintenance, and security requirements must be specified. Period may be shortened or extended, based on protection of human health and the environment.	265.117	A	The post-closure care period and any necessary restrictions on land use or disturbance will be analyzed in the FS. The plan for post-closure care and use will be developed and implemented as required by the final remedy decision.
• Post-Closure Plan – For each hazardous waste management unit subject to the requirements of this section, the post-closure plan must identify the activities that will be carried on after closure of each disposal unit and the frequency of the activities.	265.118	A	

Table 10.2
ARARs

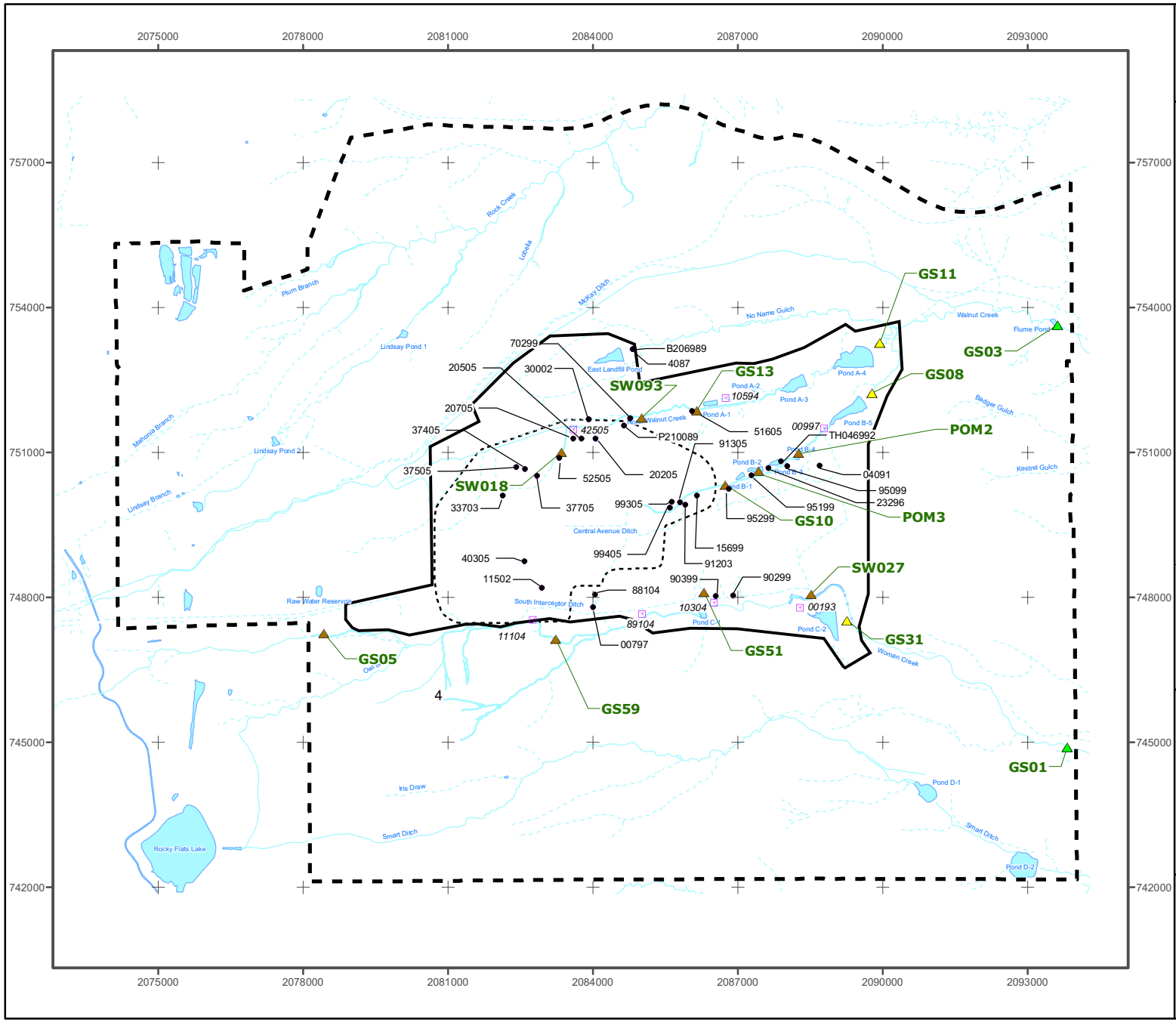
SUBTITLE C: HAZARDOUS WASTE MANAGEMENT (CHWA [CRS § § 25-15-101 to -217]) SOLID WASTE DISPOSAL ACT (RCRA) (42 USC § 6901 et. seq.)			
Requirement	**Citation**	**Type**	**Comment**
• Post-Closure Notices – The plat should be filed with the local authority and the property deed (if any) annotated and recorded to include the plat.	265.119	A	A survey plat will be prepared and provided to third parties and retained by DOE as required by the final remedy decision.
• Certification of Completion of Post-Closure Care	265.120	A	Certification that the post-closure care period was performed in accordance with the approved post-closure plan will be submitted no later than 60 days after the completion of the established post-closure care period.
• Post-Closure Requirements for Facilities That Obtain Enforceable Documents in Lieu of Post-Closure Permits	265.121	A	
LANDFILLS	6 CCR 1007-3 Part 265, Subpart N (40 CFR Part 265, Subpart N)		
• Surveying and Recordkeeping	265.309		
• Closure and Post-Closure Care – Specifications for final cover construction and design, and the maintenance of monitoring and other components and benchmarks, must be identified.	265.310(b)(1), (3), (4), and (5)	A/L	The Present Landfill, IHSS 114, and the Original Landfill, IHSS 115, are the only units that will have a cover that must attain this ARAR.

Table 10.2
ARARs

Requirement	Citation	Type	Comment
Polychlorinated Biphenyl (PCB) STORAGE AND DISPOSAL	40 CFR 761 Subpart D		
• PCB Bulk Product Waste	761.62(c)	A/C	General PCB Disposal Requirements – Concrete painted with PCB-based paints may be left in place in the basements of demolished building, and concrete rubble containing PCB-based paints may be stored onsite and used as backfill, pursuant to the letter from Kerrigan Clough to Joe Legare, Approval of Risk-Based Approach for Polychlorinated Biphenyls (PCBs)-Based Painted Concrete, November 2001.
ENVIRONMENTAL COVENANTS	CRS 25-15-317 et seq.		
• Nature of Environmental Covenants	25-15-318		The purpose of the covenant is to provide an effective and enforceable means of ensuring the conduct of any required maintenance, monitoring, or operation, and restricting future uses of the land, including placing restrictions on drilling for or pumping groundwater for as long as any residual contamination remains hazardous.
• Contents	25-15-319		The FS will evaluate alternatives that will involve required maintenance, monitoring, or operation, and restricting future uses of the land. The evaluation will include the assumption that enforceable means of ensuring the conduct of these actions will be in place as specified in the final CAD/ROD.
• When Required	25-15-320		An environmental covenant shall be required where residual contamination remains at levels that have been determined to be safe for one or more specific uses, but not all uses, or an engineered feature or structure is incorporated that requires monitoring, maintenance, or operation or that will not function as intended if disturbed.
• Creation, Modification, and Termination of an Environmental Covenant	25-15-321		

[a] A - Action-Specific ARAR; C - Chemical-Specific ARAR; L - Location-Specific ARAR

FIGURES


2075000
2078000
2081000
2084000
2087000
2090000
2093000
757000
754000
751000
748000
745000
742000
Rock Creek
Lindsay
Plum Branch
McKay Ditch
No Name Gulch
Walnut Creek
Flume Pond
Lindsay Pond 1
Lindsay Pond 2
Mahonia Branch
Lindsay Branch
Badger Gulch
Kestrel Gulch
East Landfill Pond
Pond A-1
Pond A-2
Pond A-3
Pond A-4
Pond B-1
Pond B-2
Pond B-3
Pond B-4
Pond B-5
Central Avenue Ditch
Raw Water Reservoir
South Interceptor Ditch
Pond C-1
Pond C-2
Owl Creek
Woman Creek
Iris Draw
Smart Ditch
Rocky Flats Lake
Pond D-1
Pond D-2
GS11
GS03
GS08
GS13
SW093
POM2
POM3
GS10
SW018
SW027
GS31
GS51
GS05
GS59
GS01
70299
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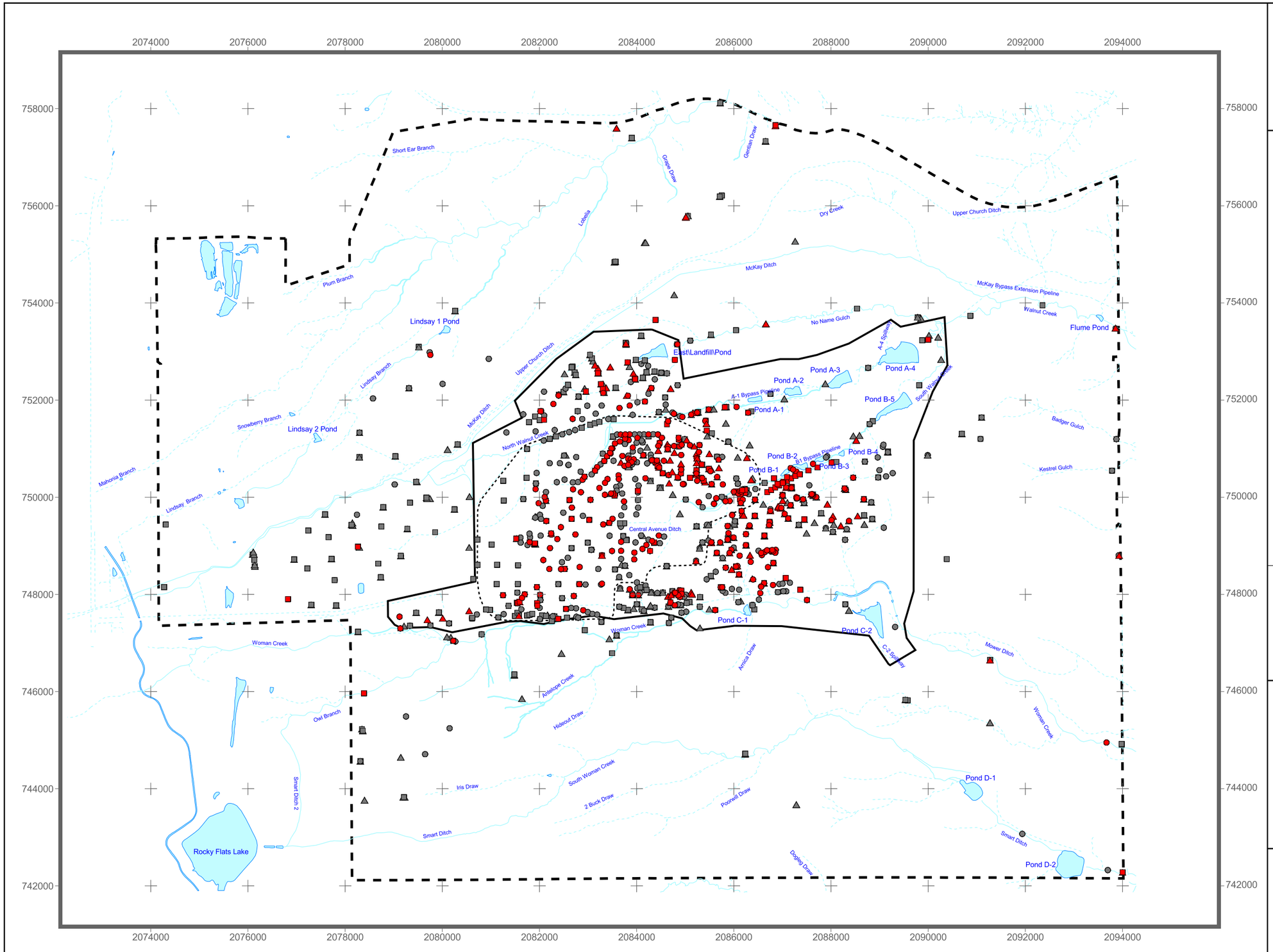
23296
33703
37705
99305
95199
95299
15699
99405
91203
40305
11502
88104
90399
90299
10304
00193
89104
11104
00797
4
Figure 10.1
Representative Groundwater and Surface Water Monitoring Locations
KEY
AOC well
Sentinel well
Surface water monitoring location representing segment 5
Surface water monitoring location representing segments 4a and 4b
Surface water monitoring location representing water quality upstream of the terminal ponds
Central OU boundary
Notes:
1) Groundwater monitoring in the Present Landfill and Original Landfill areas is defined in corresponding RFCA Decision Documents. This is defined and shown in the FY05 IMP.
2) Some of the wells shown on this figure and listed in the IMP will be replaced (with wells that have different identification numbers) and the IMP will be updated accordingly.
Standard Map Features
IA OU boundary
Pond
Site boundary
Perennial stream
Intermittent stream
Ephemeral stream
N
W
E
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
File: W:\Projects\FY2005\RIFS_Fig\Sec10\ArcMap\Fig10_01_GW_SW_Mon_Ntwk.mxd

Figure 10.2

UHSU Groundwater Monitoring Locations Where Composite MCLs Were Exceeded



KEY

- ○ Sample collected since January 1, 2000
- □ Sample collected between January 1, 1995 and December 31, 1999
- △ Sample collected between June 28, 1991 and December 31, 1994
- ● Concentrations > MCL
- ● Concentrations <= MCL

Standard Map Features

- Central OU boundary
- IA OU boundary
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N
W E
S

0 1000 2000 Feet

Scale 1:24,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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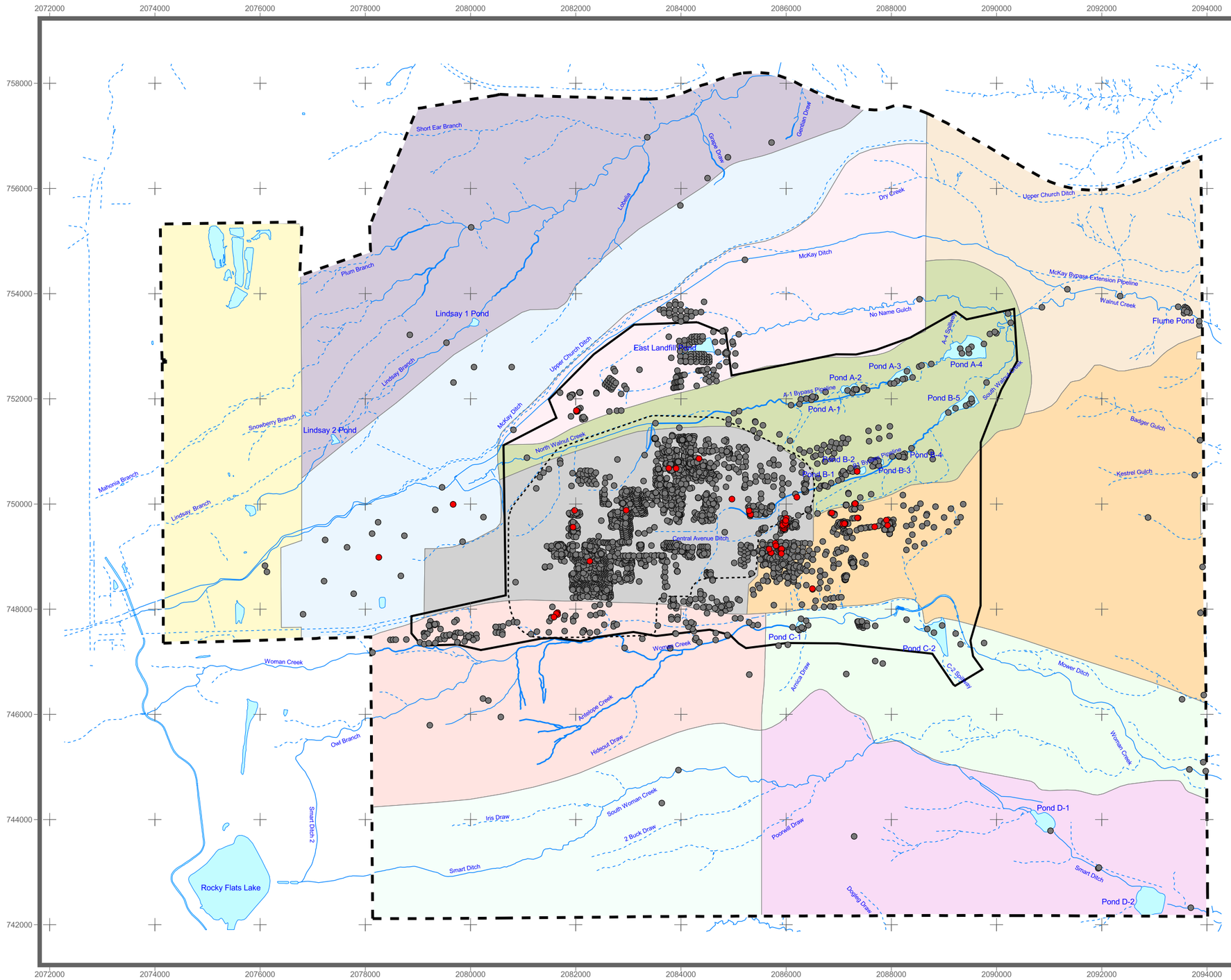
Figure 10.3

Subsurface Soil Sampling Locations Where Volatilization PRGs Were Exceeded



KEY

- Exceeded volatilization PRGs
- Did not exceed volatilization PRGs

A location is classified as a PRG exceedance if any analyte was detected at a concentration exceeding its PRG since June 28, 1991.

Standard Map Features

- Central OU boundary
- IA OU boundary
- Site boundary
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream

Exposure Units

- Industrial Area
- Inter-Drainage
- Lower Walnut Drainage
- Lower Woman Drainage
- No Name Gulch Drainage
- Rock Creek Drainage
- Southeast Buffer Zone Area
- Southwest Buffer Zone Area
- Upper Walnut Drainage
- Upper Woman Drainage
- West Area
- Wind Blown Area

N
W E
S

0 1000 2000 Feet

Scale 1:24,000

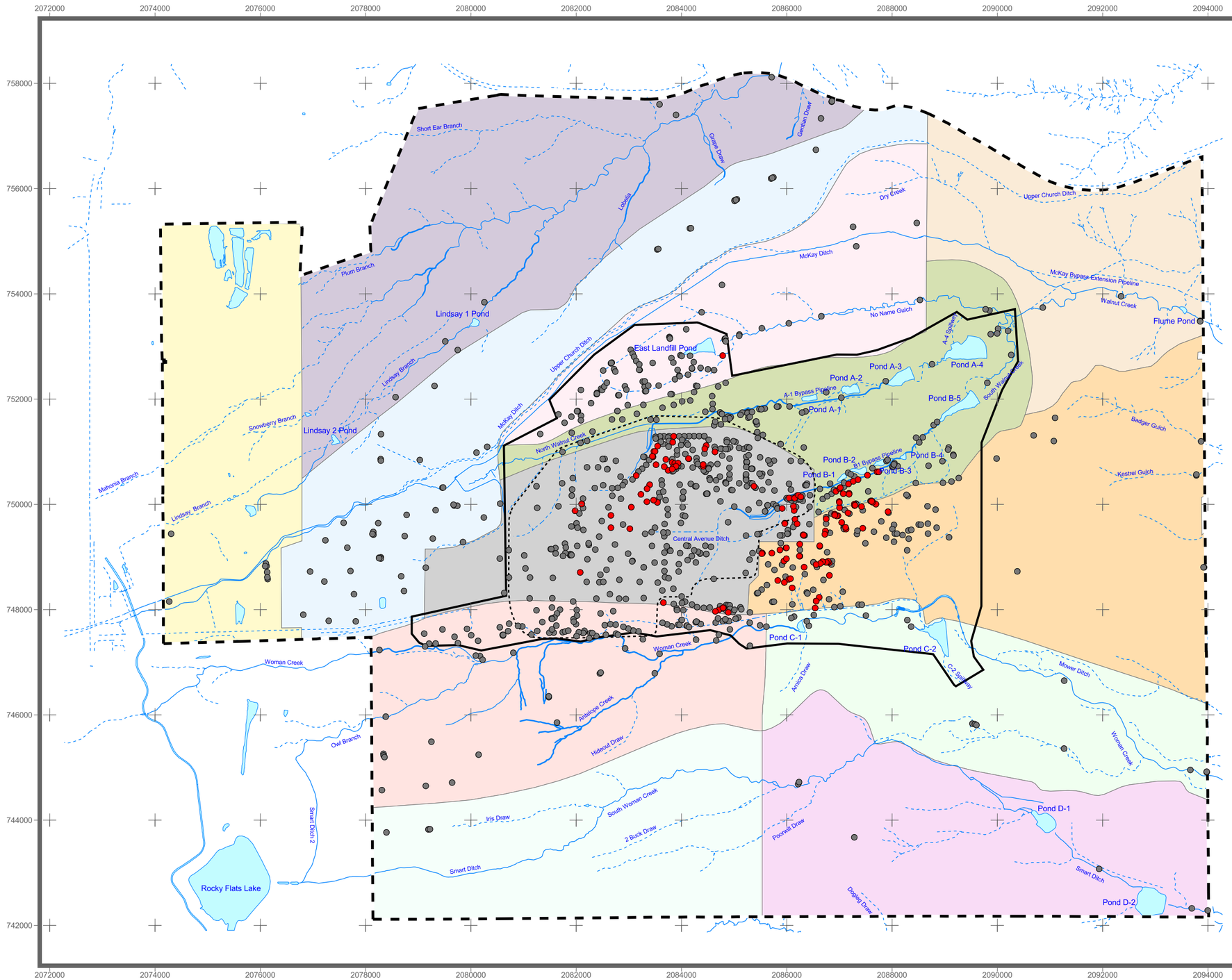
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

File: W:\Projects\FY2005\RIFS_Fig\Sec10\ArcView\FINAL_vol_screening_sec10.apr

Figure 10.4

Groundwater Sampling Locations Where Volatilization PRGs Were Exceeded



KEY

- Exceeded volatilization PRGs
- Did not exceed volatilization PRGs

A location is classified as a PRG exceedance if any analyte was detected at a concentration exceeding its PRG since June 28, 1991.

Standard Map Features

- Central OU boundary
- IA OU boundary
- Site boundary
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream

Exposure Units

- Industrial Area
- Inter-Drainage
- Lower Walnut Drainage
- Lower Woman Drainage
- No Name Gulch Drainage
- Rock Creek Drainage
- Southeast Buffer Zone Area
- Southwest Buffer Zone Area
- Upper Walnut Drainage
- Upper Woman Drainage
- West Area
- Wind Blown Area

N
W E
S

0 1000 2000 Feet

Scale 1:24,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

File: W:\Projects\FY2005\RIFS_Fig\Sec10\ArcView\FINAL_vol_screening_sec10.apr

RCRA FACILITY INVESTIGATION – REMEDIAL INVESTIGATION/
CORRECTIVE MEASURES STUDY – FEASIBILITY STUDY REPORT

REMEDIAL ACTION OBJECTIVES

SECTION 10.0: ATTACHMENT 1

CD ROM, Sitewide Radiation Dose Assessment

June 2006