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Second Five-Year Review Report for the Rocky Flats Site Jefferson and Boulder Counties, Colorado

September 2007

U.S. Department of Energy

Office of Legacy Management

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DOE-LM/1504-2007

Five-Year Review Report

Second Five-Year Review Report
for the
Rocky Flats Site
Jefferson and Boulder Counties, Colorado

Final September 2007

Prepared by
U.S. Department of Energy
Office of Legacy Management
Grand Junction, Colorado

Approved by: Date:

U.S. Department of Energy 9/14/07

Concurrence Letter Enclosed 9/14/07
U.S. Environmental Protection Agency

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SEP 14 2007

Re: Second Five-Year Review Report for the Rocky Flats Site Central Operable Unit, Jefferson and Boulder Counties, Colorado, September 2007

Dear Mr. Surovchak:

The Environmental Protection Agency (EPA) has completed review of the Second Five-Year Review Report for the Rocky Flats site. The second five-year review was conducted as a collaborative effort led by the U.S. Department of Energy (DOE) and included the Colorado Department of Public Health and Environment, U.S. Fish and Wildlife Service, and EPA. The second five-year review evaluates the status of the site since the First Five-Year Review Report was approved in September of 2002. This period includes the signing of the Corrective Action Decision/Record of Decision Rocky Flats Plant (USDOE) Peripheral Operable Unit and Central Operable Unit in September 2006.

DOE's adherence with EPA's draft Five-Year Review guidance (2001) resulted in a thorough evaluation of the Central Operable Unit providing a high degree of confidence that the Rocky Flats remedies remain protective of human health and the environment. EPA, therefore, concurs with the protectiveness statement made within the report regarding the remedies for the Central Operable Unit.

Sincerely,

Janet Wong
for Carol Rushin
Assistant Regional Administrator
Office of Ecosystems Protection
and Remediation

cc: Carl Spreng, CDPHE
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Acronyms and Abbreviations

AEA	Atomic Energy Act
AEU	Aquatic Exposure Unit
AL	action level
ANOVA	Analysis of Variance
AOC	Area of Concern
AOI	analyte of interest
ARAR	applicable or relevant and appropriate requirement
BMP	best management practice
BZ	Buffer Zone
CAD/ROD	Corrective Action Decision/Record of Decision
CCP	Comprehensive Conservation Plan
CCR	Code of Colorado Regulations
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CHWA	Colorado Hazardous Waste Act
COC	contaminant of concern
Corps	U.S. Army Corps of Engineers
CRA	Comprehensive Risk Assessment
CRS	Colorado Revised Statutes
CY	Calendar Year
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
ECOPC	ecological contaminant of potential concern
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
ESA	Endangered Species Act
ESL	ecological screening level
ETPTS	East Trenches Plume Treatment System
EU	Exposure Unit
FC	Functional Channel
FR	Federal Register
FY	Fiscal Year
HDPE	high-density polyethylene
HHRA	Human Health Risk Assessment
HR	high resolution
HRC	hydrogen releasing compound
IA	Industrial Area
IAG	Interagency Agreement
ICP/MS	inductively coupled plasma/mass spectrometry
IHSS	Individual Hazardous Substance Site
IM/IRA	Interim Measure/Interim Remedial Action
IMP	Integrated Monitoring Plan
IRIS	Integrated Risk Information System
K-H	Kaiser-Hill Company, L.L.C.
LHSU	lower hydrostratigraphic unit

LM	Office of Legacy Management
µg/L	micrograms per liter
m^3	cubic meter
M&M	monitoring and maintenance
MCL	maximum contaminant level
mg/L	milligrams per liter
mrem	millirem
MSPTS	Mound Site Plume Treatment System
NCP	National Contingency Plan
NOID	Notice of Intent for Partial Deletion
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NWP	nationwide permit
O&M	operation and maintenance
OLF	Original Landfill
OPWL	Original Process Waste Line
OU	Operable Unit
PAC	Potential Area of Concern
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
pCi/g	picocuries per gram
pCi/L	picocuries per liter
pCi/mg	picocuries per milligram
PIC	Potential Incident of Concern
PLF	Present Landfill
PLFTS	Present Landfill Treatment System
PMJM	Preble's meadow jumping mouse
POC	Point of Compliance
POE	Point of Evaluation
PQL	practical quantitation limit
PRG	preliminary remediation goal
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RFA	Rocky Flats Alluvium
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RFLMA	Rocky Flats Legacy Management Agreement
RI/FS	Remedial Investigation/Feasibility Study
RSAL	radionuclide soil action level
SEP	Solar Evaporation Pond
SPP	Solar Ponds Plume
SPPTS	Solar Ponds Plume Treatment System
SVOC	semivolatile organic compound
SWMU	Solid Waste Management Unit
TCE	trichloroethene
TIMS	thermal ionization mass spectrometry
TVS	table value standard
UBC	Under Building Contamination

UHSU	upper hydrostratigraphic unit
USC	U.S. Code
USFWS	U.S. Fish and Wildlife Service
UST	underground storage tank
VOC	volatile organic compound
WBEU	Wind Blown Area Exposure Unit
WQCC	Water Quality Control Commission
WRV	wildlife refuge visitor
WRW	wildlife refuge worker
yd^3	cubic yard

End of current text

Executive Summary

The U.S. Department of Energy's (DOE's) Rocky Flats Site (Rocky Flats), which is located approximately 16 miles northwest of Denver, Colorado, was listed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL) in 1989. Rocky Flats has two Operable Units (OUs) within the boundaries of the property: the 1,308-acre Central OU and the 4,883-acre Peripheral OU. The Central OU consolidates all areas of Rocky Flats that required additional remedial/response actions, while also considering practicalities of future land management. The Peripheral OU includes the remaining, generally unimpacted portions of Rocky Flats, and surrounds the Central OU. The Offsite Areas at Rocky Flats, known as OU 3, were addressed under a separate no action Corrective Action Decision/Record of Decision (CAD/ROD) dated June 3, 1997.

The final remedy was selected in the September 29, 2006, CAD/ROD after completion of cleanup and closure by DOE under the *Rocky Flats Cleanup Agreement* (RFCA). The CAD/ROD was based on the results of the July 2006 Remedial Investigation/Feasibility Study, Comprehensive (Human Health and Ecological) Risk Assessment (CRA), and Proposed Plan.

The response action in the final CAD/ROD is no action for the Peripheral OU, and institutional controls and physical controls with continued monitoring for the Central OU. Because remaining contamination in the Central OU does not allow for unlimited use and unrestricted exposure, periodic reviews are required by CERCLA to be conducted at least every five years to determine whether the Central OU remedial actions remain protective of human health and the environment.

DOE's Office of Legacy Management has conducted a five-year review of remedial actions implemented at Rocky Flats. OU 3 and the Peripheral OU were deleted from the NPL in May 2007 and are not part of this five-year review.

The CRA was based on a wildlife refuge worker (WRW) and wildlife refuge visitor exposure scenario. Most of the property outside the Central OU was transferred on July 12, 2007, to the U.S. Department of the Interior for establishment of a National Wildlife Refuge managed by the U.S. Fish and Wildlife Service (USFWS). The U.S. Environmental Protection Agency (EPA) certified that cleanup and closure of Rocky Flats is complete and the Central OU remedy is operating properly and successfully, in accordance with requirements for DOE to transfer land to USFWS for establishing the Refuge.

The Central OU land was retained by DOE for remedy implementation and is managed consistent with the Refuge purposes. Under CERCLA, EPA considers environmental concentrations corresponding to a cancer risk range of 1×10^{-6} as the point of departure up to 1×10^{-4} based on site-specific factors and a total noncancer hazard index less than or equal to 1 to be adequately protective of human health. Contaminated surface soil in the Central OU poses an estimated WRW cancer risk at the low end of the risk range (2×10^{-6} from plutonium-239/240).

The first five-year review at Rocky Flats was conducted for the period May 1997 through April 2002 and was performed when cleanup and closure activities were ongoing under RFCA. This five-year review covers the period May 2002 through April 2007 and evaluates the

performance of the remedy implemented under the final CAD/ROD. The *Rocky Flats Legacy Management Agreement* (RFLMA), between DOE, EPA, and the Colorado Department of Public Health and Environment (CDPHE), provides the implementing regulatory framework for the CAD/ROD so the remedy will remain protective. RFLMA modified and superseded RFCA.

The primary contaminants, contaminated media, and waste present in the Central OU are:

- Wastes disposed in the Present Landfill (PLF), which include asbestos and hazardous waste constituents, and the Original Landfill (OLF), which include trash and construction debris and some depleted uranium contamination. The landfills are closed with engineered covers, precipitation run-on and runoff controls, and water monitoring wells.
- Seep water at the PLF containing volatile organic compounds (VOCs). A passive seep treatment system uses aeration to treat the collected seep water. Treatment system effluent concentrations of total arsenic, boron, and manganese were greater than surface water standards for three consecutive samples, which triggered sampling of the downstream Landfill Pond. Based on results, only boron concentrations remain slightly above the RFLMA surface water standard at the end of 2006 and pond sampling was discontinued.
- Some subsurface soils with VOC, metals, and radionuclide contamination and areas where former building and infrastructure components, debris, and incinerator ash remain, with low levels of uranium, plutonium, and americium contamination.
- Areas of ground water that comprise contaminant plumes that contain VOCs, nitrates, and uranium at levels above surface water standards and in some cases above maximum contaminant levels (MCLs) for drinking water, which may impact surface water quality. Three passive ground water collection and treatment systems remove contaminants to reduce ground water contamination loading of VOCs, uranium, or nitrates to surface water.
- Surface soil contaminated with low levels of plutonium-239/240 and americium-241 that could impact surface water quality if contaminated soils were disturbed to the extent erosion could mobilize the contaminants.
- Subsurface soil contaminated with nitrates, uranium, and VOCs that contribute contaminants to ground water, which may impact surface water quality.
- Some subsurface areas with VOC contamination at levels that preclude occupied buildings in the area because volatilization could lead to unacceptable VOC levels in the buildings.

The remedy institutional controls prohibit soil disturbance activities that are not appropriately controlled, activities that could damage the landfill covers or other remedy components, and the non-remedy-related use of surface water or ground water. The physical controls include signage at access points to the Central OU listing the institutional controls and around the Central OU perimeter prohibiting access. Monitoring includes requirements to routinely inspect and maintain the landfill covers, treatment systems, and institutional controls; and sampling and analysis of ground water and surface water at specified locations and frequencies.

This review was conducted in accordance with EPA's *Comprehensive Five-Year Review Guidance,* dated June 2001. DOE, as the CERCLA federal lead agency under Executive Order 12580, conducted the review, using a team composed of knowledgeable DOE, DOE's contractor, CDPHE, and EPA staff. Community notification and involvement activities included

posting information about the review on the Rocky Flats website, publication of a notice of the review in the local newspaper on March 4, 2007, and public briefings.

The monitoring data used in this review are for the period ending December 31, 2006, to allow use of validated data. Other review activities were completed based on information through the end of April 2007. However, information on the deletion of OU 3 and the Peripheral OU from the NPL and establishment of the Refuge after that date are included to provide further background on the Central OU focus of the review.

This review assesses the performance of the final remedy in relation to remedy objectives and implementation requirements. Remedy selection decisions are not reopened but are evaluated against new requirements, if any.

The review addressed three questions to assess the protectiveness of the remedy, with the following approach and conclusions:

- Question A: Is the remedy functioning as intended? The technical performance of the remedy, including monitoring data, system performance, and conduct and results of operation and maintenance was determined to be consistent with that intended by the remedy. The required physical and institutional controls were determined to be in place and successfully preventing exposure. In addition to ongoing inspections of remedy components in accordance with RFLMA requirements, a Central OU inspection was also conducted on March 19, 2007. No significant items were found that would call into question the protectiveness of the remedy. The answer to this question is "yes."
- Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) still valid? The CRA underlying exposure scenarios and parameters remain valid and no changes have occurred in reference doses or slope factors, or applicable or relevant and appropriate requirements that would change the protectiveness of the remedy. The remedy RAOs also remain valid. The RAOs for contaminated ground water are to prevent adverse impacts to surface water quality, prevent exposure to ground water above MCLs, and restore ground water to meet surface water standards. The RAO for surface water is to meet surface water standards, and the RAOs for contaminated soil are to prevent adverse impacts to ground water and surface water and to prevent unacceptable risks from exposure. The answer to this question is "yes."
- Question C: Has any other information come to light that could call into question the protectiveness of the remedy? No new information not addressed or anticipated in the CAD/ROD was identified that could call into question the protectiveness of the remedy. The answer to this question is "no."

Based on the answers to Questions A, B, and C, this five-year review assessment concludes that the Central OU remedy continues to be protective of human health and the environment.

The following Five-Year Review Summary Form further summarizes information related to the review including issues, recommendations, and follow-up actions that were identified.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Rocky Flats Site		
EPA ID: CO7890010526		
Region: 8	**State:** CO	**City/County:** Golden/Jefferson and Boulder
SITE STATUS		
NPL STATUS **[X]** Final **[ ]** Deleted **[ ]** Other (specify)		
Remediation Status (choose all that apply) **[ ]** Under construction **[X]** Operating **[ ]** Complete		
Multiple OUs? **[ ]** Yes **[X]** No	**Construction Completed Date?** September 29, 2006	
Has Site been put into reuse? **[ ]** Yes **[X]** No		
REVIEW STATUS		
Lead Agency: **[ ]** EPA **[ ]** State **[ ]** Tribe **[ ]** Other Federal Agency **[X]** Dept. of Energy		
Author Name: Scott Surovchak		
Author Title: Rocky Flats Site Manager	**Author Affiliation:** U.S. DOE	
Review Period: May 2002 – April 2007		
Date(s) of Site inspection: March 19, 2007		
Type of review: **[X]** Post-SARA **[ ]** Pre-SARA **[ ]** NPL-Removal only **[ ]** Non-NPL Remedial Action Site **[ ]** NPL State/Tribe-lead **[ ]** Regional Discretion		
Review Number: **[ ]** 1 (first) **[X]** 2 (second) **[ ]** 3 (third) **[ ]** Other (specify)		
Triggering Action: **[ ]** Actual RA On-Site Construction at OU#_____ **[X]** Actual RA Start at OU#__3_____ **[ ]** Construction Complete **[ ]** Previous Five Year Review Report **[ ]** Other (specify)		
Triggering Action Date: May 2002, First Five-Year Review		
Due Date (*five years after triggering action date):* May 2007 (Report due August 1, 2007)		

[*OU refers to Operable Unit]

Issues, Recommendations, and Follow-up Actions

GS10 Uranium Concentrations

Issue: Samples from GS10, the surface water monitoring Point of Evaluation in South Walnut Creek at the Pond B-1 bypass, contained total uranium concentrations above the surface water standard in 2006. Surface water discharged from the Central OU meets surface water standards. Evaluation suggests that the GS10 levels are due to changes in hydrologic conditions, resulting

in ground water with predominantly naturally occurring uranium making up a larger proportion of stream flow at GS10.

Recommendation: Continue to monitor in accordance with RFLMA requirements. Employ special analytical methods to determine whether natural uranium isotopic signatures have significantly changed from the levels prior to closure.

Uranium Concentrations at OLF Wells
Issue: Uranium analytical results are higher than the surface water standard in one of three downgradient wells.

Recommendation: Continue to monitor the OLF ground water in accordance with RFLMA requirements. Employ special analytical methods to determine whether isotopic signatures indicate the results are predominantly natural uranium.

Sentinel Well 45605
Issue: Sentinel well 45605 is located within a hillside slump south of former Building 991, which has moved the well casing out of vertical, and the serviceability of the well is uncertain.

Recommendation: Continue to monitor this well in accordance with RFLMA. If necessary, after movement in the area stops, replace the well after regrading of the hillside has been completed.

Water Quality Standards Changes
Issue: Changes to RFLMA surface water standards for arsenic, copper, and uranium may be promulgated by the Colorado Water Quality Control Commission (WQCC) at the completion of the triennial review for the Big Dry Creek Basin in 2009. Also, the existing temporary modifications to the standards for nitrates and certain VOCs incorporated in the RFLMA surface water standards are set to expire in 2009. The impacts of any changes to standards at the time of completion of the Colorado WQCC triennial review will depend on the results of continuing remedy implementation activities.

Recommendation: DOE should actively participate in the triennial review process to identify issues and collect and provide any necessary data to the WQCC for its decision-making process.

OLF Cover
Issue: Routine inspections have identified historical seeps and small areas of slumps and slides on the OLF cover that need to be addressed and repaired as necessary to continue to meet cover design criteria.

Recommendation: Continue to inspect the OLF cover in accordance with RFLMA requirements. Cover repairs should be made in accordance with the OLF Monitoring and Maintenance (M&M) Plan so that design criteria continue to be met. An engineering evaluation to identify possible causes as well as approaches to address the causes should be completed.

Solar Ponds Plume Treatment System Treatability Study
Issue: Routine maintenance for this system is difficult and inefficient.

Recommendation: Complete treatability study to determine whether a simpler, more efficient, and less management-intensive system could be designed and installed. Based on the results, proposed modifications should be developed in accordance with RFLMA.

Protectiveness Statement

The remedy for the Central OU is protective of human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled.

Other Comments:

RFLMA requires an evaluation of actions that could reduce the need to rely on institutional controls and this five-year review considered new technologies that might reduce ground water contamination faster or more efficiently than the current remedy. None were identified for further investigation at this point.

RFLMA also specifies that the inspection frequency of the final cover and stormwater management systems for the OLF and PLF be evaluated in the CERCLA periodic review. Under the landfill M&M Plans, monthly inspections have been ongoing since June 2006 and it is recommended that the frequency be reduced to quarterly for the PLF.

The next five-year review report will be submitted to EPA for concurrence by August 1, 2012.

1.0 Introduction

The U.S. Department of Energy's (DOE's) Office of Legacy Management (LM) has conducted a second five-year review of remedial actions implemented at the Rocky Flats Site (Rocky Flats).[1] Because remaining contamination in portions of Rocky Flats do not allow for unlimited use and unrestricted exposure, periodic reviews are required by law to be conducted at least every five years to determine whether remedial actions remain protective of human health and the environment.

The First Five-Year Review Report for Rocky Flats, dated July 2002, was for the period May 1997 through April 2002 and was approved by DOE in August 2002 and by the U.S. Environmental Protection Agency (EPA) in September 2002 (DOE 2002). The methods, findings, and conclusions of this second five-year review, including identified issues and recommendations and follow-up actions, are documented in this report.

Rocky Flats is a 6,191-acre[2] (DOE 2007a) facility owned by the United States. Rocky Flats was established in 1951 as part of the United States' nationwide nuclear weapons complex to manufacture nuclear weapons components under the jurisdiction and control of DOE and its predecessor agencies. The land was acquired beginning in 1951, with additional parcels acquired in 1974 and 1975. The majority of the land was used as a security buffer around an approximately 300-acre Industrial Area (IA) near the center of Rocky Flats. In 1995, control and jurisdiction of 234 acres (located in the northwestern corner of Rocky Flats) were transferred to the DOE Golden Field Office to be used as a scientific wind turbine testing facility for development of alternative energies (DOE 1998). This area is known as the National Wind Technology Center. Pursuant to the 2002 National Defense Authorization Act, an additional 25 acres were transferred from Rocky Flats to the National Wind Technology Center (EPA 2003).

Rocky Flats is located in the Denver metropolitan area, approximately 16 miles northwest of Denver, Colorado, and 10 miles south of Boulder, Colorado (Figure 1). Nearby communities include the Cities of Arvada, Broomfield, and Westminster, Colorado. The majority of the Rocky Flats Site is located in Jefferson County, with a small portion located in Boulder County, Colorado.

DOE has conducted investigation and remediation at Rocky Flats since the mid-1980s, and has completed cleanup and closure of the Site in accordance with requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Resource Conservation and Recovery Act (RCRA), and the Colorado Hazardous Waste Act (CHWA). The EPA Superfund Identification Number for Rocky Flats is CO7890010526.

Two Operable Units (OUs) are located within the boundaries of Rocky Flats: the Central OU and the Peripheral OU (Figure 2). The 1,308-acre (DOE 2007a) Central OU consolidates all areas of Rocky Flats that require additional remedial/corrective actions, while also considering

[1] The National Priorities List (NPL) identification is the Rocky Flats Plant. Over the years of its existence, the Rocky Flats Plant was also known as the Rocky Flats Environmental Technology Site (RFETS), the Rocky Flats Site, or simply the Site.
[2] The 6,191-acre total is based on a land survey completed in 2007. All acreage is reported as "more or less." The previously reported Rocky Flats acreage of approximately 6,240 acres was estimated and not from a total survey.

practicalities of future land management. The Peripheral OU includes the remaining, generally unimpacted portions of Rocky Flats, and surrounds the Central OU. The final Corrective Action Decision/Record of Decision (CAD/ROD) for Rocky Flats was issued on September 29, 2006 (DOE et al. 2006). The response action in the final CAD/ROD is no action for the Peripheral OU, and institutional and physical controls with continued monitoring for the Central OU. The Offsite Areas at Rocky Flats, also known as OU 3, were addressed under a separate no action CAD/ROD dated April 1997 (DOE et al. 1997). No action CAD/RODs were issued for the Peripheral OU and OU 3 because they were determined to be in a protective state allowing unrestricted and unlimited use.

Consequently, because remaining contamination in the Central OU does not allow for unlimited use and unrestricted exposure, this second five-year review focuses on whether the final remedy for the Central OU continues to be protective of human health and the environment.

The five-year review process does not reopen the remedy decision, but looks at conditions in the Central OU based on documents and other sources described in this report for comparison to the remedy design goals and objectives.

1.1 Period Covered by the Review and Related Information

The OU 3 CAD/ROD was the triggering date for the first five-year review period of May 1997 through April 2002. DOE is implementing the Central OU remedy institutional and physical controls and monitoring requirements in accordance with the *Rocky Flats Legacy Management Agreement* (RFLMA) (DOE et al. 2007), a Federal Facility Agreement and Consent Order under CERCLA, RCRA, and CHWA, between DOE, EPA Region 8, and the Colorado Department of Public Health and Environment (CDPHE) (the RFLMA Parties). The review was conducted based on remedy-related information available through April 2007, and the report was prepared to meet RFLMA requirements for submittal to EPA by August 1, 2007, so that a final report could be approved by EPA by September 17, 2007. Although the review end date is April 2007 to be consistent with the end of the review period for the first five-year review, recent events after April 2007 related to the public participation process, the CERCLA status of OU 3 and the Peripheral OU, and the establishment of the Rocky Flats National Wildlife Refuge are included for information and to provide further background related to the Central OU focus of this review.

The cutoff date for environmental monitoring data evaluated in this review was for samples collected as of December 31, 2006, to allow use of validated data. The dates for other remedy-related information evaluated in the review are noted in the report.

Jurisdiction and control of 3,953 acres of Rocky Flats were transferred to the U.S. Fish and Wildlife Service (USFWS) in July 2007 for the purposes of establishing the Rocky Flats National Wildlife Refuge, as prescribed by the Rocky Flats National Wildlife Refuge Act of 2001 (Refuge Act). The portion of Rocky Flats retained by DOE includes the Central OU, and the portion being transferred to USFWS includes the Peripheral OU. An additional 929 acres of the Peripheral OU will be transferred to USFWS in the future after issues related to privately held subsurface mineral rights are resolved.

The CAD/RODs for OU 3 (April 1997) and the Peripheral OU (September 2006) determined that conditions in those OUs are suitable for unrestricted use. As such, OU 3 and the Peripheral OU are not evaluated in this report and will not be included in future reviews.

EPA published a Notice of Intent for Partial Deletion (NOID) of the Rocky Flats Site (Plant) from the National Priorities List (NPL) on March 13, 2007 (72 Federal Register [FR] 11313, March 13, 2007) (EPA 2007a) to delete the Peripheral OU and OU 3 from the NPL. The NOID was based on the results of the remedial investigations leading to the CAD/ROD no action remedies being selected for these OUs. The NOID states that because no hazardous substances occur in the OUs above levels that allow for unlimited use and unrestricted exposure no five-year review is required for these OUs. EPA subsequently published a Notice of Partial Deletion from the NPL for the Peripheral OU and OU 3, which includes a responsiveness summary, on May 25, 2007 (72 FR 29276, May 25, 2007) (EPA 2007b).

1.2 Contents of the Report

In addition to this Introduction section, which includes information on the legal authority for the review, DOE's responsibility to conduct the review, and other review characteristics, the report consists of the following sections:

- Section 2.0, "Rocky Flats Chronology," provides information on the Rocky Flats Site history and the regulatory framework.
- Section 3.0, "Background," includes a description of the Rocky Flats Site's physical characteristics, land and resource use, and contamination history. Accelerated actions conducted at Rocky Flats in accordance with RFCA, as well as activities to complete Site closure in general, are also described. The basis for taking action, including results of the Remedial Investigation/Feasibility Study (RI/FS) including the Comprehensive Risk Assessment (CRA), is also covered in this section.
- Section 4.0, "Remedial Actions," provides details on the selected remedy for the Central OU, including the remedy selection process, implementation of the preferred remedy, and the system operations associated with the remedy.
- Section 5.0, "Progress Since the Last Five-Year Review," evaluates the status of Rocky Flats since the first five-year review was conducted in 2002. This section reviews the protectiveness statements from the first review, as well as the issues and recommendations identified.
- Section 6.0, "Five-Year Review Process," describes the activities performed during the current five-year review, and includes a review of new technologies potentially applicable to the Central OU and an evaluation of existing institutional controls.
- Section 7.0, "Technical Assessment," focuses on three questions used to evaluate whether the remedy at the Central OU is protective:
  - —Question A: Is the remedy functioning as intended by the decision documents?
  - —Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of remedy selection still valid?
  - —Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

- Section 8.0, "Issues, Recommendations, and Follow-Up Actions," presents issues identified during the review that currently could—or could in the future—prevent the remedy from being protective. Recommendations and follow-up actions are also presented.
- Section 9.0, "Protectiveness Statement," presents the protectiveness statement for the Central OU.
- Section 10.0, "Next Review," discusses the anticipated schedule for the third five-year review of the Rocky Flats Site and the date the report will be due.
- Section 11.0, "References," lists the references used to prepare this report.

This report also includes several appendices as follows:

- Appendix A contains the RFLMA (DOE et al. 2007) Attachment 2 figures and tables for reference.
- Appendix B contains the inspection checklist and maps for the March 19, 2007, inspection of Rocky Flats. Several photographs taken during the inspection are also included. This appendix also includes the CDPHE inspection report for their April 19, 2007, inspection of the monitoring and sampling of RCRA wells at Rocky Flats.
- Appendix C contains several aerial photographs that illustrate the changes since the first five-year review, as well as other photographs depicting conditions at Rocky Flats.

1.3 Authority for Conducting the Five-Year Review

This review was conducted pursuant to CERCLA Section 121 and the National Contingency Plan (NCP). CERCLA Section 121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

EPA interpreted this requirement further in the NCP; 40 *Code of Federal Regulations* (CFR) Section 300.430(f)(4)(ii) states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

1.4 Agency Conducting the Five-Year Review

DOE is the lead agency for CERCLA section 121 reviews at DOE sites, in accordance with Executive Order 12580. EPA Region 8 and CDPHE are the designated support agencies for this CERCLA review. This DOE-led review was conducted by a team composed of personnel from DOE-LM; DOE-LM's Rocky Flats contractor, S.M. Stoller Corporation; EPA; CDPHE; and USFWS.

1.5 Other Review Characteristics

The conduct of the review and format of this report follows EPA's *Comprehensive Five-Year Review Guidance* (EPA 2001).

DOE followed the *Rocky Flats Site Legacy Management Public Involvement Plan* (DOE 2007b) to notify and inform the public regarding the five-year review process and to solicit input. Further details on the public participation activities are provided in Section 6.0.

In addition, the review included an evaluation of RFLMA remedy implementation requirements and the following RFLMA paragraph 67 periodic review requirement:

> *…To the extent that remedies have incorporated institutional controls, the Parties shall review the continuing effectiveness of such controls, and shall evaluate whether additional response action could be taken that would reduce the need to rely on institutional controls. In making such an evaluation, the Parties shall consider all relevant factors, including advances in technology and the availability of funds. …*

RFLMA Attachment 2, "Legacy Management Requirements," also provides in Section 7.3:

> *… the 5-year review will evaluate the components of the remedy (including, but not limited to, requirements for monitoring, maintenance and inspections, institutional controls, and reporting.) The 5-year review will determine whether such remedy components will be continued, modified, or discontinued.*

End of current text

2.0 Rocky Flats Chronology

Some key events in the Rocky Flats Site's nearly 60-year history related to releases to the environment, site investigation, and cleanup progress under successive agreements and orders leading to the final CAD/ROD and after the CAD/ROD are presented in Table 1. Additional information on the history and the regulatory framework for investigation and cleanup of Rocky Flats is provided in the following sections.

2.1 Rocky Flats History

Beginning in 1951 DOE and its predecessor agencies and contractors managed and operated Rocky Flats under authorization of the Atomic Energy Act (AEA). Rocky Flats was part of the United States' nationwide nuclear weapons complex to manufacture nuclear weapons components from various radioactive, hazardous, and nonhazardous materials. Other support activities included chemical recovery and purification of recyclable transuranic radionuclides (i.e., plutonium, which is a "special nuclear material" under the AEA) and research and development in metallurgy, machining, nondestructive testing, coatings, remote engineering, chemistry, and physics. Manufacturing activities, accidental industrial fires and spills, and support activities including waste management resulted in the release of hazardous substances, hazardous wastes, and hazardous waste constituents to air, soil, sediment, ground water, and surface water at Rocky Flats.

The majority of Rocky Flats structures were located within an approximately 300-acre industrialized area at the center of the approximately 6,191-acre property. The IA was surrounded by the security Buffer Zone (BZ), which contained some supporting activities, such as waste disposal, but was left mostly undisturbed.

Some buildings and infrastructure systems became contaminated. Leaking storage drums, unlined disposal trenches, surface water impoundments, and leaking underground tanks contributed to the contamination of soils at Rocky Flats. Contaminants released to the environment include, but are not limited to, plutonium-239/240, americium-241, depleted uranium and enriched uranium, carbon tetrachloride, tetrachloroethene (PCE), trichloroethene (TCE), nitrates, and chromium.

Volatile organic compounds (VOCs), nitrate, and uranium contaminated shallow ground water. Plutonium, uranium, and americium contaminated soils. The potential for radioactive particles on soil to become airborne during strong winds or to be transported to streams was a concern.

Investigation and cleanup of released hazardous substances, including hazardous wastes, began in the 1980s. Beginning in 1992, when weapons components production halted, the Rocky Flats mission included the safe storage and shipment of special nuclear material, nuclear deactivation and decommissioning, waste management and shipment, environmental investigations, cleanup, and site closure.

All planned cleanup actions have been completed and the Peripheral OU portion of the Rocky Flats Site has been transitioned to the Rocky Flats National Wildlife Refuge. Potential future users of the wildlife refuge include wildlife refuge workers (WRWs) and wildlife refuge visitors (WRVs).

2.2 Rocky Flats Regulatory Framework

Because environmental investigations indicated that operations at Rocky Flats resulted in the release of materials defined by CERCLA as hazardous substances, contaminants, and pollutants, as well as hazardous wastes and waste constituents as defined by RCRA and CHWA, EPA proposed Rocky Flats for inclusion on the CERCLA NPL in 1984. The listing became final in 1989.

Under CERCLA, the responsibility for the response action for hazardous substance releases at Rocky Flats is delegated to DOE as the lead agency in accordance with Executive Order 12580. EPA and CDPHE are the support agencies. Under RCRA and CHWA, DOE is responsible for corrective action for releases of hazardous waste and hazardous waste constituents at Rocky Flats. In Colorado, RCRA/CHWA corrective action is regulated by CDPHE.

Investigation and cleanup activities were formally covered under three successive federal facility agreements and compliance orders, beginning in 1986 and culminating with RFCA, signed by DOE, EPA, and CDPHE in July 1996. Cleanup, closure, and selection of the final remedy were accomplished in accordance with RFCA, and are described in more detail in Section 4.0.

On March 14, 2007, DOE, EPA, and CDPHE entered into RFLMA. RFLMA establishes the regulatory framework for implementing the final remedy for Rocky Flats, and ensuring that it remains protective of human health and environment. RFLMA modifies and supersedes RFCA.

3.0 Background

This section presents information on the Rocky Flats Site background, including physical characteristics, land and resource use, history of contamination, and initial responses (e.g., accelerated actions). The basis for taking action, including results of the RI, is also presented.

3.1 Physical Characteristics

The Rocky Flats Site is located at the interface between the Great Plains and the Rocky Mountains. Approximately 2 miles west of the Site's western boundary, the foothills of the Front Range of the Rocky Mountains rise sharply above the plains. The western portion of Rocky Flats is located on a broad, relatively flat pediment that slopes eastward from these foothills. On the eastern portion of Rocky Flats, the pediment surface is dissected by small stream valleys that trend generally from the west down to the east. The primary topographic features at Rocky Flats are the Rock Creek, Walnut Creek, and Woman Creek drainages. Manmade retention ponds exist at Rocky Flats, including 10 in the Walnut Creek drainage and in the Woman Creek drainage in the Central OU (Figure 1, Appendix A). (Appendix A of this Second Five-Year Review Report contains the RFLMA Attachment 2 figures and tables.) In addition, several manmade ditches cross Rocky Flats, including the South Interceptor Ditch, McKay Ditch, Upper Church Ditch, and Smart Ditch.

Rocky Flats is biologically diverse, reflecting its geographical setting. Five primary plant communities occur there: mesic mixed grassland, xeric tall grass prairie, wetlands, riparian woodlands, and tall upland shrubs. Grasslands are the dominant plant communities. Typical wildlife includes mammals such as mule deer, coyote, whitetail deer, black-tailed prairie dogs, foxes, elk, skunks, and a variety of rodents and other small mammals. The Preble's meadow jumping mouse (PMJM), a federally listed threatened species at the time of the CAD/ROD, is found along the drainages. Over 200 species of birds have been observed at Rocky Flats. A small number of reptiles and amphibians occur at Rocky Flats, including the prairie rattlesnake.

Accelerated remedial actions resulted in the removal of buildings, except for the former east and west vehicle inspection sheds. Surface pavement has been removed. Revegetation and erosion mats and/or hydromulching were utilized to control erosion in areas of disturbed soil and sloping surfaces. Five Functional Channels (FCs) were configured to also minimize soil disturbance and were generally placed in areas of existing major surface water drainage features. Erosion was controlled in the FCs by armoring the majority of the channels with riprap or erosion matting and revegetation. Some of the channel sections are covered with soil and are being used as mitigation wetlands. Each of the five FCs was designed to convey the 100-year storm event.

Other manmade features at Rocky Flats include protective covers constructed under approved Interim Measure/Interim Remedial Action (IM/IRA) decision documents at two landfills, the Original Landfill (OLF) (DOE 2004a) and the Present Landfill (PLF) (DOE 2004b), which were used for historic Rocky Flats Site operations. The OLF has a soil cover layer with a minimum thickness of 2 feet. The PLF cover consists of a soil cover, geosynthetic clay liner, flexible membrane liner, geocomposite drainage layer, cushion layer, cobble layer, and soil cover layer.

Between the ground surface and 3 feet below grade, essentially all structures have been removed, with the exception of some utility lines less than 2 inches in diameter, the aforementioned vehicle inspection sheds, three ground water collection and treatment systems that serve an ongoing function, and the PLF seep collection and treatment system. At depths greater than 3 feet below grade, some subsurface structures remain in place following the completion of accelerated actions under RFCA. These include slabs, tunnels, and building foundations (including in some areas caissons or grade beams); sewer lines and water lines; culverts, foundation drains, and storm drains; valve vaults and process waste lines (both Original Process Waste Lines and New Process Waste Lines); and remnants of utility conduits (cables, wires, and the like). RFLMA Attachment 2, Figures 3 and 4 (Appendix A of this report) depict remaining slabs, tunnels, and building foundations, as well as remaining valve vaults and process waste lines, respectively.

Some of these subsurface features may contain residual contamination. Portions of the former Buildings 371/374 basement and sub-basement slab/walls, former Building 730 basement slab, former Building 771 first and second floor slabs and walls, former Building 771C slab, former Building 774 first and second floor slab/walls, and the tunnel between former Buildings 771 and 776 have residual americium-241 and plutonium-239/240 contamination. The remaining contamination in these former building slabs, walls, and tunnel is fixed within the building concrete matrix after concrete surface removal by mechanical decontamination was performed to the extent practical. In addition, portions of former Building 991 floor slabs have residual nonfriable asbestos contamination.

With regard to Rocky Flats geology, the Laramie and Arapahoe Formations are exposed at the surface or underlie the Rocky Flats Site, beneath which are the Fox Hills Sandstone and Pierre Shale. The latter formations are exposed in quarries along the western edge of Rocky Flats. Unconsolidated surficial deposits (for example, the Rocky Flats Alluvium [RFA] and the Verdos terrace alluvium) unconformably overlie bedrock. The unconsolidated surficial deposits, combined with the weathered portion of subcropping bedrock (Arapahoe and/or Laramie Formations) form the upper hydrostratigraphic unit (UHSU). Because of the wide extent of unconsolidated surficial materials beneath the historic IA and eastern part of the Rocky Flats Site, and their relatively high hydraulic conductivity compared to that of the underlying weathered and unweathered claystone bedrock, the unconsolidated portion of the UHSU is the primary influence on ground water flow and contaminant transport at Rocky Flats. Ground water flow in the UHSU generally follows Site topography.

In the western portions of Rocky Flats, where the thickness of the RFA may exceed 100 feet, the depth to UHSU ground water is 50 to 70 feet. The depth to ground water generally becomes shallower, and the saturated thickness becomes thinner, from west to east as the alluvial layer thins and the underlying claystones are closer to the surface. The amount of ground water in the UHSU is limited. Although some monitoring wells in the UHSU have been estimated as capable of producing enough water for residential uses, ground water at Rocky Flats has never been used as a drinking water source, and this use is not anticipated in the future.

The relatively small portion of infiltrating precipitation that does become shallow ground water and is not lost to evapotranspiration ultimately discharges to surface water before reaching the eastern boundary of the Rocky Flats Site. Therefore, the UHSU ground water that has been impacted by Rocky Flats activities discharges to surface water prior to leaving the Central OU.

In addition to the UHSU, a lower hydrostratigraphic unit (LHSU) has been identified at Rocky Flats. The LHSU is composed of the unweathered Arapahoe, Laramie, and Fox Hills Formations. The upper Laramie Formation claystones of the LHSU, with low permeability, act as an effective aquitard that restricts downward vertical ground water flow from the UHSU to the LHSU. Because the LHSU is hydraulically isolated from the UHSU, and because the LHSU does not show evidence of contamination from the UHSU, the LHSU is not a concern as a contaminant transport pathway from the Rocky Flats Site.

3.2 Land and Resource Use

All of the Rocky Flats Site is currently the property of the United States, with activities there administered by DOE. Rocky Flats is currently closed to public access; however, per the Refuge Act, jurisdiction for the majority of the Site was transferred to USFWS in July 2007 for the purpose of establishing the Rocky Flats National Wildlife Refuge.

The purposes of the Refuge are as follows:

- Restoring and preserving native ecosystems;
- Providing habitat for and population management of native plants and migratory and resident wildlife;
- Conserving threatened and endangered species; and
- Providing opportunities for compatible scientific research.

Management options for the Refuge were evaluated and proposed in a Comprehensive Conservation Plan (CCP) (USFWS 2004). The CCP served as the Environmental Impact Statement for this action as required under the National Environmental Policy Act.

As a result of the Refuge Act, the following land management implications are expected:

- Land ownership will remain with the United States.[3]
- The U.S. Department of the Interior (DOI), specifically USFWS, will administer the Refuge.
- The lands retained by DOE are expected to be managed consistent with the Refuge, unless the needs of the remedy dictate otherwise.
- Once designated as a National Wildlife Refuge, the transferred property will not be subject to annexation by any unit of general local government.
- The Refuge Act prohibits the United States from transferring any rights, title, or interest in land within the boundaries of Rocky Flats, except for the purpose of transportation improvements on the eastern edge of the Rocky Flats Site that is bordered by Indiana Street.
- Use of the land for residential, commercial, or industrial purposes will not occur, and surface water and ground water will not be used for potable water supplies. The land is not anticipated to be used as cropland, although the CCP allows for limited livestock grazing for the purpose of vegetation management.

[3] Ownership by the United States is subject to existing private subsurface mineral rights.

Specific prohibitions on activities on lands to be retained by DOE (i.e., the Central OU) are included in the remedy as institutional controls, as discussed in Section 4.0.

Until recently, land around Rocky Flats consisted primarily of rangeland, preserved open space, mining areas, and low-density residential areas. However, this rural pattern is beginning to change due to the spread of development from the surrounding communities. The towns of Superior, Broomfield, and Arvada have already experienced extensive development north, northeast, and southeast of Rocky Flats.

State-owned lands southwest and west of Rocky Flats are used for grazing, mining, and storage and conveyance of municipal water supplies. Along Highway 93, an area of land approximately 1,200 feet wide adjacent to the Rocky Flats Site's western boundary is available for eventual development, open space, or highway right-of-way. The 259-acre DOE National Wind Technology Center is located adjacent to the northwestern corner of the Peripheral OU on lands transferred from the DOE Rocky Flats Project Office. Preserved open space is the primary existing and proposed use of the lands immediately north (Boulder County and City of Boulder) and east (Cities of Broomfield and Westminster) of Rocky Flats.

Areas within the Peripheral OU and adjacent privately owned lands west of Rocky Flats have been permitted by the State of Colorado and Jefferson County for mineral extraction (primarily clay, sand, and gravel mining). To the south, several cattle and horse operations and small hay fields exist at present. However, a mixed-use residential and commercial development known as Vauxmont, within the City of Arvada, is proposed for an area immediately adjacent to the southern boundary of Rocky Flats. By 2020, the Denver Regional Council of Governments projects that the entire area south of the Rocky Flats Site will be developed, as well as areas to the southeast that are either not already developed or protected as open space (by the City of Westminster) around Standley Lake.

As discussed previously, shallow ground water that has been contaminated by Rocky Flats Site-related activities becomes surface water prior to leaving Rocky Flats. Surface water in Walnut Creek is not used as a supply of drinking water in the vicinity of Rocky Flats. Water in Walnut Creek downstream of Rocky Flats may be impounded by the City of Broomfield in Great Western Reservoir for reuse as irrigation water. Surface water in Woman Creek is also not used as a drinking water supply in the vicinity of Rocky Flats. Water leaving Rocky Flats in Woman Creek is collected in Woman Creek Reservoir above Standley Lake. It is then held, tested, and released to Walnut Creek below Great Western Reservoir. Woman Creek Reservoir is operated by the Woman Creek Reservoir Authority, a consortium of the Cities of Westminster, Thornton, and Northglenn, using funds provided by DOE.

3.3 History of Contamination

Rocky Flats was a large industrial facility, composed of over 800 structures, including several large processing facilities for plutonium and uranium. The vast majority of industrial activities (including waste disposal) took place in or near the center of the Rocky Flats Site, in the approximately 300-acre IA. Several waste disposal pits and two larger landfills are or were present at Rocky Flats.

The majority of Rocky Flats, known previously as the BZ, contained some supporting activities such as waste disposal, but was generally left undisturbed. This land provided a security and safety buffer area around the IA. Portions of the BZ have been co-managed by USFWS for ecological resources since 1999.

Over the decades, manufacturing activities, accidental industrial fires and spills, and support activities such as waste management resulted in the release of contaminants to the air, soil, sediment, ground water, and surface water at Rocky Flats. Some of the more noteworthy environmental incidents and practices are described below.

- Building fires occurred on a number of occasions at Rocky Flats; of these, two are most notable. On September 11, 1957, a fire occurred in a glovebox in historic Building 771 in a plutonium fabrication line. The fire and subsequent control efforts resulted in the spread of contamination within the building and breached the filter plenums. On May 11, 1969, a major fire occurred in gloveboxes in historic Building 776, started by the spontaneous ignition of plutonium, causing extensive building contamination and release of plutonium to the atmosphere. The fire led to a number of follow-on actions including use of inert atmospheres in gloveboxes, upgrades to the retention pond system, and purchase (in 1974) of additional BZ property.
- Drum storage in the area known as the historic 903 Pad, located off the southeast corner of the former IA, caused environmental contamination. The Plant stored drums containing radioactive waste on the pad beginning at least in 1958, and possibly as early as 1955. The wastes contained various hazardous constituents, including beryllium, solvents, and uranium, as well as waste oils containing plutonium-239/240. Leaking drums were discovered as early as 1959, when a rust inhibitor was added to the drum contents in an attempt to prevent further deterioration. The area was closed in April 1967 when a heavy rainstorm caused the release of more contamination from the drums. The drums were removed in 1968, by which time numerous drums were empty, their contents having leaked entirely. Contaminated soil particles were spread by the wind and the area was covered by an asphalt pad in November 1969. The 903 Pad windblown contamination is the major source for plutonium-239/240 releases to the environment from Rocky Flats operations.
- The Plant used various disposal trenches and waste dumps during its early years. Many of these historic disposal sites, such as the Mound and Trenches T-1, T-3, and T-4, are located just northeast of the 903 Pad, in the Mound-East Trenches Area. The various disposal areas were used from approximately 1954 to 1968. Many of the wastes that ended up there originated from historic Building 444 or other buildings on the south side of the former IA. Common contaminants included depleted uranium and solvents. Uranium in drums excavated from Trench T-1 made it necessary to take precautions to prevent these drums from catching fire from spontaneous combustion. A number of these sites (the Mound Source Area and Trenches T-1, T-2/Ryan's Pit, T-3, and T-4) were remediated in the late 1990s.
- The Plant put wastewaters containing nitrates and radioactive contaminants (primarily uranium) in a series of solar evaporation ponds that were used in various configurations since December 1953. The Solar Ponds were located in the northeast corner of the former IA, and were lined with earth, clay, concrete, asphalt, and other materials at one time or another. In 1961, results from monitoring wells showed high nitrate concentrations in ground water around the ponds, and a French drain system to capture this ground water

was installed in the 1960s. This system was upgraded in 1981 to include a pump house to capture more of the contaminated water. The Solar Ponds no longer exist, having been drained and the sludge removed from them in the 1980s and 1990s.

- Two major landfills operated at the Rocky Flats Site. The first, known as the OLF, occupies approximately 20 acres on the north side of Woman Creek. The OLF operated as an unlined waste dump from the opening of Rocky Flats in 1952 until 1968. The landfill contains approximately 70,000 cubic yards of waste of various types, including construction debris, concrete, and scrap metal. The landfill also contains solvents, paints, oils, pesticides, and items contaminated with beryllium and uranium. The second landfill, known as the PLF, is located north of the former IA at the head of No Name Gulch, the drainage immediately north of North Walnut Creek. Disposal operations began there in 1968 and continued until 1998. The landfill was originally intended as a sanitary landfill to receive uncontaminated solid wastes such as office trash, construction debris, and scrap metal. However, the landfill also received hazardous wastes streams (such as paints and solvents), beryllium-contaminated materials, asbestos-containing materials, polychlorinated biphenyls (PCBs) from fluorescent light ballasts, and radioactively contaminated sludge from the Rocky Flats Sewage Treatment Plant.

During cleanup, specific locations where solid wastes, hazardous substances, pollutants, contaminants, hazardous wastes, or hazardous constituents may have been disposed or released into the environment were designated as Individual Hazardous Substances Sites (IHSSs), Potential Areas of Concern (PACs), Under Building Contamination (UBC) Sites, or Potential Incidents of Concern (PICs).[4] The locations of some of these areas are shown on Figure 3. Contaminants released to the environment from the activities at Rocky Flats have included, but were not limited to, radionuclides such as plutonium-239/240, americium-241, and various uranium isotopes; organic solvents such as TCE, PCE, and carbon tetrachloride; metals such as chromium; and nitrates.

3.4 Initial Response

Considerable remediation of Rocky Flats took place during the late 1990s and early 2000s under the auspices of RFCA, which adopted an accelerated action approach to the cleanup, equivalent to the removal authority found in CERCLA. Activities performed at Rocky Flats in accordance with RFCA, and to complete Site closure in general, included the following:

- All special nuclear materials were packaged and shipped to other DOE facilities, including:
  - —Approximately 21 tons of weapons-grade material; and
  - —Approximately 100 tons of plutonium residues and 30,000 liters of plutonium and enriched uranium solutions, which were processed to meet transportation and receiver site requirements.

[4] Over time, IHSSs, PACs, UBC Sites, and PICs totaled 421 areas requiring investigation and/or remediation. Regardless of the designation, each area was evaluated and investigated as needed. See Appendix B of the RI/FS Report for detailed information regarding each historical IHSS, PAC, UBC Site, and PIC.

- More than 800 structures were decontaminated to the degree necessary and removed, including five major plutonium facilities and two uranium facilities totaling over 1 million square feet.
- A total of 1,457 gloveboxes, many of them highly contaminated with radioactive materials, were decontaminated, removed from their buildings, and disposed of off site.
- Six hundred ninety tanks, many of which were highly contaminated, were decontaminated, removed, and shipped off site.
- A total of 421 IHSSs, PACs, UBC Sites, and PICs were investigated and dispositioned, either by accelerated actions or by a determination that no accelerated action was required.
- Engineered covers were installed on the PLF and the OLF.
- Three ground water treatment systems (addressing contamination from the Solar Ponds, East Trenches disposal area, and Mound Site disposal area) and one seep treatment system (at the PLF) were installed and continue to operate; more than 11 million gallons of ground water and 5 million gallons of seep water have been successfully treated to date.
- All waste from cleanup and closure activities was managed and packaged appropriately, and shipped for off-site disposal, including:

  —More than 15,000 cubic meters (m^3) of transuranic and transuranic mixed waste;

  —More than 500,000 m^3 of low-level and low-level mixed radioactive wastes (this includes contaminated soils from areas such as the 903 Pad and Lip Area);

  —More than 820,000 m^3 of sanitary waste, much of it building debris; and

  —More than 4,300 m^3 of nonradioactive hazardous waste.

Many of these activities were achieved by or in coordination with the conduct of accelerated CERCLA and RCRA/CHWA remedial actions, using RFCA action levels (ALs). The foregoing work was completed in October 2005 (K-H 2005a) and accepted by DOE in December 2005 (DOE 2005a). DOE continued to prepare a final CAD/ROD and finalize regulatory requirements for the land to be retained by DOE for remedy-related purposes, and to prepare to transfer remaining portions to DOI for the Wildlife Refuge.

The RI/FS for Rocky Flats (DOE 2006a) analyzed Site conditions following the completion of these actions, calculated the risks posed by residual contaminants to the anticipated future land users, and evaluated alternatives for the final remedial action. The Proposed Plan for Rocky Flats (DOE 2006b) identified DOE's preferred final remedy for the Site and provided the rationale for that preference. The selected final remedial decisions for Rocky Flats are documented in the CAD/ROD (DOE et al. 2006).

3.5 Basis for Taking Action

As discussed in previous sections, DOE began more than 20 years ago to investigate and take remedial actions pursuant to CERCLA, RCRA, and CWHA to address the known or suspected release of hazardous substances at Rocky Flats.

3.5.1 Nature and Extent of Contamination

In the RI/FS Report (DOE 2006a), the nature and extent of contamination for soil, sediment, ground water, surface water, and air were evaluated after completion of the RFCA accelerated actions. Each nature and extent of contamination evaluation identified analytes of interest (AOIs). AOIs are chemicals that have been detected at concentrations that may contribute to the risk to future receptors. The evaluation studied the extent of sitewide contaminants and evaluated which chemicals remained after the completed accelerated actions. The nature and extent of AOIs identified in the RI/FS Report are presented in Table 2.

3.5.2 Summary of Risks

As part of the RI/FS Report, a CRA was completed for Rocky Flats. The CRA consists of two parts: a Human Health Risk Assessment (HHRA) and an Ecological Risk Assessment (ERA). The risk assessment evaluated various exposure scenarios and potential adverse impacts to human health and the environment that may exist from contaminated environmental media associated with Rocky Flats-related activities. The CRA was designed to provide information to decision makers to help determine the final remedy that is adequately protective of human health and the environment.

For purposes of the CRA, the Rocky Flats Site was divided into 12 Exposure Units (EUs) for assessing potential risks to human health and terrestrial ecological receptors. Rocky Flats was also divided into seven Aquatic Exposure Units (AEUs) for assessing potential risks to aquatic ecological receptors. A sitewide analysis was also conducted for wide-ranging terrestrial receptors. The EUs were designated based on known sources and potential contaminant release patterns to allow areas with similar types of potential contaminants to be evaluated collectively. Other criteria used to designate the EUs included separate watersheds, similar topography, vegetation, expected future land use, and functional areas. Functional areas refer to areas that fall within a size range where future on-site workers would likely spend their time. AEUs were designated to represent separate drainages on the upper and lower portions of a large single drainage.

The outcome of the CRA is the identification of human health contaminants of concern (COCs) and ecological contaminants of potential concern (ECOPCs), and the estimated risk posed by each.

3.5.2.1 Human Health Risk Assessment

CDPHE defines acceptable human health risk as a lifetime excess cancer risk less than 1×10^{-6} from exposure to carcinogenic compounds and/or a hazard quotient less than 1.0 for noncarcinogenic compounds. Under CERCLA and the NCP, EPA considers environmental concentrations corresponding to a 1×10^{-6} to 1×10^{-4} cancer risk range and a total noncancer hazard index less than or equal to 1 to be adequately protective of human health.

The risk management conclusion based on the HHRA identified only one COC within one EU that required further evaluation in the FS. The surface soil COC for the Wind Blown Area EU (WBEU), located within the Central OU, is plutonium-239/240 with an estimated cancer risk of 2×10^{-6}. While conditions at Rocky Flats are protective of human health based on the low risk presented by this COC, the FS evaluated removal of surface soil to reduce the residual

plutonium-239/240 contamination to below the WRW preliminary remediation goal (PRG) of 9.8 picocuries per gram (pCi/g).

VOCs have been detected in the subsurface in some subsurface soil and ground water sampling locations of Rocky Flats. The indoor air inhalation pathway is potentially significant if buildings were constructed in these locations. In locations where there are no exceedances of the volatilization PRGs, the indoor air inhalation pathway is assumed to be insignificant. The results of this assessment were further evaluated in the FS.

Contaminated subsurface features remain in the subsurface in the former IA. These features were not evaluated in the CRA because of the assumption therein that there is no exposure pathway for a WRW given that he or she will not be digging below 3 feet. Consequently, the FS embodied this CRA assumption in an institutional control.

3.5.2.2 Ecological Risk Assessment

The overall risk management goal used in the ERA 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.*

The ERA was designed and implemented to determine whether Rocky Flats Site conditions meet the defined goal, and evaluated both terrestrial and aquatic receptors.

No significant risks were identified for any receptor in any EU. In addition, the high species diversity and continued use of Rocky Flats by numerous vertebrate species indicate habitat quality for these species remains acceptable and the ecosystem functions are being maintained. Data collected on wildlife abundance and diversity indicate wildlife populations are stable and species richness remains high at Rocky Flats. This supports the chemical risk conclusions that no significant risks are predicted for receptor populations.

The AEU assessments indicate there are no continuing, significant risks to aquatic life from residual ECOPCs due to Rocky Flats-related operations. Overall, the aquatic communities are limited by natural environmental conditions such as low flows and poor habitat characteristic of this area along the Colorado Front Range. No additional significant risks above what would be expected to be encountered in the natural environment in the vicinity of Rocky Flats are predicted for the aquatic life receptors evaluated in the ERA.

The overall conclusions of the ERA indicate Rocky Flats Site conditions due to residual contamination do not represent significant risk of adverse ecological effects to receptors from exposure to Rocky Flats-related residual contamination. However, additional surface water, sediment, and ecological monitoring were recommended to address uncertainties identified in the ERA. The additional monitoring is included in RFLMA Attachment 2, Table 5 (Appendix A of this report).

3.5.3 Contaminant Fate and Transport

The contaminant fate and transport evaluation used information about the Rocky Flats Site physical characteristics, contaminant source characteristics, and contaminant distribution across the Site to describe how contaminants could migrate in environmental media. The primary focus, consistent with the RFCA objectives, was evaluating the potential for contaminants from any medium to impact surface water quality. Evaluation of a contaminant's fate and transport is based upon two criteria: (1) does a complete migration pathway exist based on an evaluation of contaminant transport in each environmental medium, and (2) is there a potential impact to surface water quality based on data collected at representative ground water and surface water monitoring locations.

A complete pathway from surface soil or sediment to surface water is measured at representative surface water monitoring locations; a complete pathway from subsurface soil or ground water to surface water is measured at representative ground water monitoring locations (at Area of Concern [AOC] wells and Sentinel wells). AOC wells are those wells within a drainage and downgradient of a contaminant plume or group of plumes. AOC wells are monitored to determine whether the plume(s) may be discharging to surface water. Sentinel wells are typically located near downgradient edges of contaminant plumes, in drainages, and downgradient of ground water treatment systems. These wells are monitored to determine whether concentrations of contaminants are increasing, which could indicate plume migration or treatment system problems. RFLMA Attachment 2, Figure 1 (Appendix A of this report) presents ground water and surface water monitoring locations.

Complete pathways from surface soil/surface sediment to surface water were identified for two surface soil AOIs: americium-241 and plutonium-239/240.

Complete pathways from subsurface soil to surface water (via ground water) were identified for five subsurface soil AOIs, all of which are VOCs. These AOIs were carbon tetrachloride, chloroform, methylene chloride, PCE, and TCE. All of these subsurface soil AOIs are associated with one or more ground water areas, as listed below.

Complete pathways from shallow (UHSU) ground water to surface water were identified for 10 ground water AOIs: uranium (sum of isotopes uranium-233/234, uranium-235, and uranium-238), cis-1,2-dichloroethene, carbon tetrachloride, PCE, TCE, chloroform, methylene chloride, nitrate/nitrite (as N), fluoride, and sulfate. These ground water AOIs are primarily associated with one or more Sentinel wells, which are discussed in more detail in Section 4.0, in five ground water areas (Appendix A of this report, Figure 2), specifically:

- North of former Building 771;
- Historical East Trenches area (downgradient portion of plume);
- Historical Solar Evaporation Ponds area and 700 Area Northeast area (downgradient portion of plume);
- Historical Mound Site/Oil Burn Pit #2 area (downgradient portion of plumes); and
- Historical 903 Pad/Ryan's Pit area.

The fate and transport evaluation focused on potential impacts on surface water quality. The surface water data are provided for reference because they confirm the AOIs' presence in surface water (necessary to confirm a complete pathway to surface water exists). Four surface water AOIs were observed intermittently at concentrations above the highest of the surface water standard, background, or practical quantitation limit (PQL) at representative surface water locations. These AOIs are plutonium-239/240, americium-241, uranium (sum of isotopes), and nitrate/nitrite (as N).

Air AOIs are not evaluated using this process because the potential contaminant exposure received by a human receptor via the airborne pathway is insignificant, as measured against EPA's 10-millirem (mrem) annual benchmark level for the airborne pathway.

3.5.4 Conclusions of the Remedial Investigation

Together, the nature and extent of contamination evaluations, results of the CRA, and contaminant fate and transport information were used to assess the extent to which residual contamination may pose a threat to human health and the environment.

Key conclusions of the RI include:

- Air emissions present no health or environmental concerns at present and anticipated future levels. Air, therefore, was not evaluated in the FS.
- Because the RI concluded that the Peripheral OU poses no current or potential future threat to human health or the environment, an FS for this OU was not required and no remedial alternatives were evaluated.
- Based on results of the RI, an FS was required for the Central OU. The specific media evaluated in the FS were:

  —Ground water

  - Areas where contaminated ground water may impact surface water;
  - Sampling locations where ground water contamination exceeds federal maximum contaminant levels (MCLs); and
  - Sampling locations where exceedances of volatilization PRGs in ground water indicate a potential indoor air risk.

  —Surface Water

  - Surface water upstream of Ponds A-4, B-5, and C-2 (known as the terminal ponds), where there are locations where some surface water monitoring results do not meet Colorado surface water quality standards for some analytes.

  —Soil

  - Subsurface soil where complete pathways from subsurface soil to surface water (via ground water) may impact surface water;
  - Surface soil that may contribute to intermittent exceedances of the surface water standard for americium-241 and plutonium-239/240 upstream of the terminal ponds;

- Surface soil in the WBEU where results of the CRA indicate the potential risk to a WRW is 2×10^{-6} for plutonium-239/240; and
- Subsurface soil sampling locations where exceedances of volatilization PRGs in subsurface soil indicate a potential indoor air risk.

Based on data and modeling results, it is likely that residual VOC sources and associated downgradient ground water concentrations will persist in the environment for decades to hundreds of years even with the source removals that were implemented as accelerated actions.

Ground water contamination above MCLs exists in some sampling locations at Rocky Flats, generally within the ground water plume areas (Appendix A of this report, Figure 2). Ground water actions were implemented to treat contaminated ground water that may impact surface water quality. The actions are:

- Installation and operation of the Present Landfill (Seep) Treatment System (PLFTS) to treat VOCs; and
- Installation and operation of the three ground water treatment systems: the East Trenches Plume Treatment System (ETPTS) and Mound Site Plume Treatment System (MSPTS), which are designed to treat VOCs, and the Solar Ponds Plume Treatment System (SPPTS), which is designed to treat nitrate and uranium.

Continued operation of these four systems serves to protect surface water quality over the short and intermediate term by removing contaminant loading to surface water. This protection also serves to meet long-term goals for returning ground water to its beneficial use of surface water protection.

Surface water sample results do not always meet Colorado surface water quality standards for some analytes at some monitoring locations upstream of the terminal ponds. Specific mechanisms to prevent use of surface water in these areas were evaluated in the FS. Surface water leaving Rocky Flats was determined to be acceptable for all uses.

4.0 Remedial Actions

This section provides details on the selected remedy for the Central OU, including the selection process used to identify the preferred remedy, implementation of the remedy, and system operations associated with the remedy.

4.1 Remedial Action Objectives

RAOs are contaminant-specific goals for the final comprehensive response action and are used in developing and evaluating remedial alternatives. The results of the RI were compared to the RAOs to determine whether additional response actions were needed to meet the RAOs. Final remediation objectives were incorporated into the CAD/ROD for the selected remedy.

RAOs provide the foundation upon which remedial cleanup alternatives are developed. Based on the results of the RI, RAOs were developed for ground water, surface water, soil, and environmental protection as follows:

- Ground Water RAO 1—Meet ground water quality standards, which are the Colorado Water Quality Control Commission (WQCC) surface water standards, at ground water AOC wells.
- Ground Water RAO 2—Restore contaminated ground water 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 ground water Sentinel wells. Also, prevent significant risk of adverse ecological effects.
- Ground Water RAO 3—Prevent domestic and irrigation use of ground water contaminated at levels above MCLs.
- Surface Water RAO—Meet surface water quality standards, which are the Colorado WQCC surface water standards (statewide basic standards or stream segment-specific standards, including any temporary modifications).
- Soil RAO 1—Prevent migration of contaminants to ground water that would result in exceedances of ground water RAOs.
- Soil RAO 2—Prevent migration of contaminants that would result in exceedances of surface water RAOs.
- Soil RAO 3—Prevent exposures that result in unacceptable risk to the WRW. The 10^{-6} risk level was used as the point of departure for determining remediation goals for alternatives when applicable or relevant and appropriate requirements (ARARs) were not available or were not sufficiently protective because of the presence of multiple contaminants at the Rocky Flats Site or multiple pathways of exposure (40 CFR 300.430[e][2][i][A][2]). Also, prevent significant risk of adverse ecological effects.

Section 7.0 presents a discussion of the status of the RAOs at the time of the CAD/ROD and at the end of the five-year review period covered by this report.

4.2 Remedy Selection

The FS developed three alternatives for the Central OU. A detailed analysis of the Central OU remedial alternatives is provided in the RI/FS Report (DOE 2006a).[5]

4.2.1 Alternative 1, No Further Action With Monitoring

Alternative 1 consisted of the following components:

- Management of the PLF cover system and PLFTS would continue in accordance with the approved Monitoring and Maintenance (M&M) Plan (DOE 2006c). Management of the OLF cover system would continue in accordance with the approved M&M Plan (DOE 2006d).
- Management of the three existing ground water treatment systems (MSPTS, ETPTS, and SPPTS) would continue. These systems were designed to intercept shallow contaminated ground water and divert it to underground cells containing treatment media specific to the contaminants in the respective plumes. The MSPTS and ETPTS treat ground water containing VOCs by passing it through a zero-valent iron media. The SPPTS treats ground water containing nitrate and uranium by passing it through media containing sawdust (to facilitate nitrate removal) and zero-valent iron (for uranium removal).
- Surface water and ground water monitoring as defined in the Fiscal Year (FY) 2005 Integrated Monitoring Plan (IMP) (K-H 2005b).
- Additional environmental sampling to further reduce uncertainties identified in the ERA portion of the CRA.

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[5] The CRA did not specifically evaluate an unrestricted use scenario for the Peripheral OU because the Peripheral OU was unimpacted by site activities from a hazardous waste perspective (no hazardous wastes or constituents were placed in or migrated into the Peripheral OU) and only a small portion of the OU was impacted by site activities from a radiological perspective (plutonium in surface soil). These conclusions are based on extensive process knowledge, a comprehensive sampling project, and studies of disturbed areas noted in historical aerial photographs. The Proposed Plan and CAD/ROD explained that based on the levels of residual surface soil plutonium contamination in the Peripheral OU, the Peripheral OU is determined to be acceptable for all uses from a radiological perspective. The rationale for this determination was also explained in the NOID, section VI.A.1, Description of the Peripheral OU Remedial Investigation (RI).

As discussed in the Proposed Plan, CAD/ROD, and NOID, if the highest level of surface soil plutonium contamination in the Peripheral OU (20 pCi/g) was considered to be the average concentration in an Exposure Unit, it would correspond to a risk of approximately 1×10^{-5} for a rural resident. Though not specifically mentioned in the NOID, this statement is based on the Radionuclide Soil Action Level Task 3 Report, Calculations of Surface Radionuclide Soil Action Levels for Plutonium, Americium, and Uranium, completed by the regulatory agencies in 2002 (Task 3 Report). The Task 3 Report is referenced and discussed in the RI, Proposed Plan, and CAD/ROD. The rural resident was determined to be the foreseeable future land user in the unrestricted use scenario in the Task 3 Report.

The RI also evaluated compliance with the Radiation Control Regulations, 6 Code of Colorado Regulations (CCR) 1007-1, Part 4, which were identified as ARARs for Rocky Flats. Based on the Task 3 Report, if the highest level of surface soil plutonium contamination in the Peripheral OU was assumed to be the average concentration it would result in an annual dose to the rural resident that is well below the limit established by the ARAR. There are no institutional controls established for the Peripheral OU. Thus, a five-year review for the Peripheral OU is not required, because levels of residual contamination were determined to allow for unrestricted use and unlimited exposure.

- Quarterly reporting of environmental monitoring results and timely reporting of adverse changes in Rocky Flats conditions to the regulatory agencies.

4.2.2 Alternative 2, Institutional and Physical Controls

Alternative 2, Institutional and Physical Controls, added the implementation of institutional and physical controls to Alternative 1. Institutional controls include legally enforceable and administrative land use restrictions and physical controls including signage or other physical features to control access and activity within the Central OU. Land use restrictions are limitations or prohibitions on specific activities within designated areas of the Central OU to ensure that the conditions remain protective for the WRW and WRV, and ensure the continued functioning of the remedy. Physical controls are items such as signage or monuments along the perimeter of the Central OU to notify the WRW and WRV that they are at the Central OU boundary. Physical controls also include measures that may be necessary to protect monitoring systems or other engineered portions of the remedy. DOE would retain jurisdiction over the engineered structures and monitoring systems associated with the completed actions. Institutional controls for the Central OU are described below:

- The construction and use of buildings that would be occupied on a permanent or temporary basis (such as for residences or offices) would be prohibited. The construction and use of storage sheds or other unoccupied structures would be permitted, consistent with the restrictions below, and provided such use does not impair any aspect of the response action at Rocky Flats.
- Excavation, drilling, and other intrusive activities below a depth of 3 feet would be prohibited, except for remedy-related purposes.
- No grading, excavation, digging, tilling, or other disturbance of any kind of surface soils would be permitted, except in accordance with an Erosion Control Plan approved by CDPHE or EPA. Any such soil disturbance would restore the soil surface to preexisting grade.
- Surface water within the Central OU above the terminal ponds would not be used for drinking water or agricultural purposes.
- The construction or operation of ground water wells would be prohibited, except for remedy-related purposes.
- Digging, drilling, tilling, grading, excavation, construction of any sort (including construction of any structures, paths, trails, or roads), and vehicular traffic would be prohibited on the covers of the PLF and the OLF, except for authorized response actions.
- Activities that could damage or impair the proper functioning of any engineered component of the response action including, but not limited to, any treatment system, monitoring well, landfill cap, or surveyed benchmark would be prohibited.

Physical controls would consist of signage installed along the perimeter of the Central OU to notify the WRW and WRV that they are at the Central OU boundary, and notify them of the land use restrictions in place in the Central OU. Physical controls would also protect the remedy to ensure it functions as designed.

Institutional and physical controls would be inspected periodically. If evidence of activities that violate the restrictions or damage of the physical controls is found, DOE would develop a plan to correct the condition and the correction would be implemented. Inspections and corrective actions would be documented in an annual report to the regulatory agencies. Institutional and physical controls would be incorporated throughout the Central OU in an environmental covenant granted by DOE to CDPHE.

4.2.3 Alternative 3, Targeted Surface Soil Removal

This alternative consists of removing the top 6 inches of soil in areas of residual surface soil contamination that have activities above the plutonium-239/240 WRW PRG concentration of 9.8 pCi/g (based on 1×10^{-6} target risk). Surface soil over approximately 368 acres would be removed. The removed soil would be placed in shipping containers and then shipped for disposal at a permitted low-level radioactive waste disposal facility. The duration of this removal operation is estimated to be 3 years. Alternative 3 also includes implementation of the features of Alternatives 1 and 2.

4.3 Selected Remedy for the Central OU

The selected remedy/corrective action for the Central OU is Alternative 2, No Further Action With Monitoring, plus Institutional and Physical Controls. The selected remedy/corrective action consists of environmental monitoring and continued operation and maintenance (O&M) of engineered structures including the landfill covers and ground water treatment systems.

4.4 Remedy Implementation

The requirements of the remedy are implemented in accordance with RFLMA and through an environmental covenant for the Central OU granted by DOE to CDPHE. The covenant is recorded in Jefferson County, Colorado, Reception Number 2006148295. Individual components of the remedy are described in more detail below.

4.4.1 Institutional Controls

DOE is required to employ administrative procedures to control all modification, maintenance, or other activities requiring excavation within the Central OU to prevent violation of the restrictions listed in RFLMA Attachment 2, Table 4 (Appendix A of this report). DOE must also ensure that all such activities will not compromise the integrity or function of the remedy or result in uncontrolled releases of or exposures to subsurface contamination, in accordance with the land use restrictions in RFLMA Attachment 2, Table 4 (Appendix A of this report).

In addition, DOE must utilize work control procedures to help maintain the use restrictions and ensure protection of the integrity of the institutional controls. These procedures are derived from EPA and State of Colorado regulation and guidance as well as DOE Orders and guidance. The DOE Integrated Safety Management System utilizes processes such as the job hazard analysis to identify and mediate environmental, health, and safety risks to ensure all work is done in a safe and environmentally protective manner.

4.4.2 Physical Controls

DOE is required to post signs legible from at least 25 feet at intervals around the perimeter of the Central OU, sufficient to notify persons that they are at the boundary of the Central OU. These signs will measure at least 11 inches by 14 inches and will include the following language: "U.S. Department of Energy – No Trespassing." In addition, signs listing the institutional controls use restrictions and providing contact information must be posted at access points to the Central OU.

DOE is also required to maintain physical controls as necessary to protect engineered elements of the remedy, such as landfill covers, ground water treatment systems, and monitoring equipment. In particular, DOE is required to implement remedy monitoring and maintenance, water monitoring, and operational monitoring, as described below.

4.5 Remedy Monitoring and Maintenance

The following specific remedy monitoring and maintenance activities are required to be conducted.

- Landfills—Inspection and maintenance requirements for the PLF and OLF remedies are provided in the approved Landfill M&M Plans (DOE 2006c, 2006d) and listed in RFLMA Attachment 2, Table 3 (Appendix A of this report).
- Ground water treatment systems—Each system will be monitored, at a minimum, for untreated influent and treated effluent, and for impacts to surface water downstream of the effluent discharge point according to the water monitoring and sampling criteria discussed below. The systems will be maintained to ensure the effluent meets surface water standards discussed below.
- Residual subsurface contamination—DOE must monitor the Central OU for significant erosion annually and following major precipitation events. DOE will evaluate whether the erosion is in proximity to the subsurface features shown on RFLMA Attachment 2, Figures 3 and 4 (Appendix A of this report). Monitoring will include visual observation (and measurements, if necessary) of precursor evidence of significant erosion (cracks, rills, slumping, subsidence, sediment deposition, and so forth).
- Physical controls—DOE must inspect the condition of signs and other physical controls maintained on a quarterly basis.
- Institutional controls—DOE must determine the effectiveness of the institutional controls described in RFLMA Attachment 2, Table 4 (Appendix A of this report) and in the Environmental Covenant by inspecting the Central OU at least annually for any evidence of violations of those controls. DOE will also annually verify that the covenant remains in the Administrative Record and on file with the Jefferson County Planning and Zoning Department.
- Ecological monitoring—The ERA determined that residual contamination does not represent a significant risk of adverse ecological effects. The CAD/ROD, however, requires that specific additional sampling be conducted to reduce the uncertainties determined in the ERA. The required additional ecological sampling is listed in RFLMA Attachment 2, Table 5 (Appendix A of this report).

4.6 Water Monitoring

Water monitoring and evaluation is required to be conducted as described below.

4.6.1 Water Monitoring Locations and Sampling Criteria

Surface water and ground water monitoring locations required to implement the remedy are shown on RFLMA Attachment 2, Figure 1 (Appendix A of this report). Monitoring activities are outlined in RFLMA Attachment 2, Table 2 (Appendix A of this report) and are designed to provide data that meet designated monitoring objectives to support operational and regulatory decision making. Particular aspects of the monitoring activities presented in RFLMA Attachment 2, Table 2 (Appendix A of this report) are discussed below.

Environmental sampling, analysis, and data management must conform to the *Legacy Management CERCLA Sites Quality Assurance Project Plan* (DOE 2007c) and meet the quality assurance and quality control requirements in current EPA guidance. Standard EPA analytical methods will be used with the intent that detection limits will be less than the respective standards. If standard analytical methods cannot attain the standard, then alternative methods or PQLs will be proposed to CDPHE, as discussed below.

4.6.2 Surface Water Standards and Application to Ground Water

Protection of surface water was a basis for making soil and ground water response action decisions during the cleanup period so that surface water on the Rocky Flats Site and leaving Rocky Flats would be of sufficient quality to support all uses. The applicable surface water uses are consistent with the following Colorado WQCC surface water use classifications:

- Water Supply;
- Aquatic Life—Warm 2;
- Recreation 2; and
- Agriculture.

The remedy performance standards for surface water are listed in RFLMA Attachment 2, Table 1 (Appendix A of this report) and are based on WQCC Regulation No. 31: Basic Standards and Methodologies for Surface Water (5 Code of Colorado Regulations [CCR] 1002-31) and on the Rocky Flats-specific standards in WQCC Regulation No. 38 (5 CCR 1002-38). If the basic standard numeric values and Rocky Flats-specific standards differ, the Site-specific standard applies, except where temporary modifications are in place. Temporary modifications are listed in RFLMA Attachment 2, Table 1 (Appendix A of this report) for six organic compounds, nitrate, and nitrite, and have been granted through the year 2009 by the WQCC. In addition to PQLs allowed by the WQCC regulations, Rocky Flats-specific PQLs may be proposed to CDPHE for approval.

The WQCC-designated ground water use classification at Rocky Flats is surface water protection. The numeric values for measuring potential effects of contaminated ground water on surface water quality are the surface water standards in RFLMA Attachment 2, Table 1 (Appendix A of this report).

RFLMA provides criteria and strategies for comparing surface water and ground water analytical results to these numeric values, which are implemented through the use of a series of logic flowcharts. These flowcharts are identified in the RFLMA Attachment 2, Table 2 Notes (Appendix A of this report), and are contained in that Attachment as Figures 5 through 13 (Appendix A of this report). The same logic flowchart process was used for this second five-year review in evaluating water monitoring data, as described and discussed in more detail in Section 6.0.

4.6.3 Surface Water Monitoring Classifications

Compliance with the surface water standards in RFLMA Attachment 2, Table 1 (Appendix A of this report) will be measured at the Points of Compliance (POCs) downstream of the terminal ponds in Woman and Walnut Creeks. If the terminal ponds are removed, new monitoring and compliance points will be designated and will consider ground water in alluvium. Points of Evaluation (POEs) and additional performance monitoring locations serve to monitor the quality of surface water in the Central OU. The surface water monitoring classifications for Rocky Flats are as follows:

- POCs: Located in Woman and Walnut Creeks downstream of the terminal ponds and at Indiana Street.
- POEs: Located in the Central OU upstream of the ponds and POCs. These locations are used to evaluate water quality in comparison to the surface water standards in RFLMA Attachment 2, Table 1 (Appendix A of this report).
- Performance monitoring locations: Located downstream of specific remedies to determine the short- and long-term effectiveness of these remedies where known contaminants may affect surface water.

4.6.4 Ground Water Monitoring Classifications

Ground water is monitored in or near areas of ground water contamination that might adversely affect surface water quality. Contaminated ground water emerges to surface water before leaving the Central OU. DOE must maintain a network of ground water monitoring wells, as described below, to assess the potential effects of contaminated ground water on surface water quality. These wells and sampling criteria are identified in RFLMA Attachment 2, Table 2 (Appendix A of this report). The ground water monitoring classifications are as follows:

- AOC wells: Located within a drainage and downgradient of a contaminant plume or group of contaminant plumes. These wells are monitored to determine whether the plume(s) may be discharging to surface water.
- Sentinel wells: Typically located near downgradient edges of contaminant plumes, in drainages, and downgradient of ground water treatment systems. These wells are monitored to determine whether concentrations of contaminants are increasing, which could indicate plume migration or treatment system problems.
- Evaluation wells: Typically located within plumes and near plume source areas, or in the interior of the Central OU. Data from these wells will help determine when monitoring of an area or plume can cease. A subset of these wells is located in areas that may experience significant changes in ground water conditions as a result of closure activities.

- RCRA wells: Dedicated to monitoring the PLF and OLF.

RFLMA Attachment 2, Figure 2 (Appendix A of this report) provides the Central OU ground water composite plume map.

4.7 Operational Monitoring

Operational monitoring is not a requirement of the CAD/ROD, but is a requirement of RFLMA. Operational monitoring provides information that will supplement CAD/ROD-required monitoring. Operational monitoring consists of the following elements:

- Boundary wells—Boundary wells are located on the east boundary of Rocky Flats where Walnut Creek and Woman Creek exit the Site. These wells are used to demonstrate that contaminants listed in RFLMA Attachment 2, Table 2 (Appendix A of this report) are not migrating off Rocky Flats.
- Pre-discharge pond sampling—DOE will collect pre-discharge samples from Ponds A-4, B-5, and C-2, and as needed from any other upstream pond temporarily functioning as a terminal pond. DOE will notify the appropriate parties in accordance with RFLMA in advance of pre-discharge pond sampling. CDPHE and EPA will be allowed the opportunity to collect duplicate or split samples. Samples will be analyzed for POC constituents far enough in advance of a routine discharge to allow action to be taken if exceedances are indicated, but near enough to the time of discharge to be representative of the discharge composition. Ponds will be operated to maintain dam safety regardless of the status or results of pond sampling.
- Adverse biological conditions—DOE will note evidence of adverse biological conditions (e.g., unexpected mortality or morbidity) observed during other M&M activities described above.

4.8 Remedy Preliminary Closeout Report

The remedy is in place and EPA issued the Preliminary Closeout Report for the remedy on September 29, 2006 (EPA 2006).

4.9 Determination That Remedy Is Operating Properly and Successfully

The Refuge Act requires EPA to certify that response actions at Rocky Flats are operating properly and successfully before jurisdiction at the Site can transfer from DOE to DOI for establishment of the Refuge. On June 11, 2007, EPA certified that cleanup and closure of Rocky Flats has been completed, except for O&M associated with the response actions in the Central OU, and that all response actions in the Central OU are operating properly and successfully (EPA 2007c).

4.10 Legacy Management Activities

The activities being conducted at Rocky Flats are now referred to as post-closure, or LM activities. As discussed in Section 3.4, the physical cleanup and closure work was completed in October 2005. Thus, post-closure or LM activities have been ongoing since that time. The

CAD/ROD and RFLMA establish the regulatory requirements for the ongoing remedy-related work.

Not all LM activities are directly required or specifically related to the remedy, but are conducted pursuant to DOE's jurisdiction and control responsibilities for the Rocky Flats property. These LM activities are also related to compliance with DOE directives and use of best management practices (BMPs).

During the post-closure period LM activities included the following:

- Staff responded to a grass fire on April 2, 2006, which burned approximately 850 acres on the northeast corner of the Peripheral OU/Central OU. Surface water monitoring station GS08 was destroyed by the fire and subsequently replaced; other damaged items, such as fences, were repaired. Several permanent photo-monitoring locations were established in and around the wildfire location to document the ecological effects of the fire. Initial photos were taken shortly following the fire, and throughout the 2006 growing season, to track effects of the fire on vegetation.
- Road maintenance repairs and upgrades are conducted to allow safe, continual access to and within the Central OU. Depending on the specific problem being addressed, the improvements included road base, geotextile fabric, rock water crossings, and surfactant.
- Maintenance of erosion controls existing from RFCA cleanup and closure is conducted and subsequent recontouring is maintained and repaired to protect the bare soil areas until the vegetation can stabilize the soil. This maintenance includes response to damage from high precipitation events (for example, such as the eroded cuts along the edge of the riprap area of FC-5 that were subsequently filled with riprap to minimize further downcutting). Areas lacking sufficient vegetative cover were reseeded to ensure adequate establishment of the native vegetation in these areas.
- Revegetation and weed control are being conducted to help establish native vegetation species.
- Monitoring and reporting on PMJM habitat and wetland mitigation areas in accordance with USFWS requirements are ongoing.
- Rocky Flats property security is assessed on a continuous basis and surveillance of the property when workers are not normally present is conducted. The perimeter fence is maintained and replaced as required.
- The Central OU three-strand barbed wire fence construction was completed in March 2007.

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5.0 Progress Since the Last Five-Year Review

As described in previous sections, the major accomplishment since the last review is completion of cleanup and closure and implementation of the final remedy. Appendix C contains photographs of Rocky Flats in 2002 and 2007 illustrating the significant changes over the period.

The scope of the first review included a review of the CAD/RODs for OU 1 (881 Hillside) and OU 3 (Offsite Areas), as well as the accelerated actions completed as of September 31, 2001.

The accelerated actions analyzed in the first five-year review also included:

- Trench T-1;
- Trench T-2 (Ryan's Pit);
- Trenches T-3 and T-4;
- Mound Site;
- ETPTS;
- MSPTS;
- SPPTS;
- Solar Ponds sludge removal action;
- OU 7 seep; and
- Underground storage tank (UST) accelerated action.

Table 3 provides a summary description of these accelerated actions and the CAD/RODs. Figure 4, from the First Five-Year Review Report (DOE 2002), shows the locations of these accelerated actions.

The trigger for the first five-year review was May 1997 based on the CAD/ROD for OU 3. While the OU 3 CAD/ROD was no action, the RFCA Parties were at that time conducting a technical review of radionuclide soil action levels (RSALs) and agreed that a five-year review of the OU 3 remedy should be conducted to consider the outcome of the soil AL review. The soil AL review was completed in 2001 resulting in modification of RFCA in June 2002, prior to the approval of the First Five-Year Review Report in September 2002. The modified RSALs were used in the first five-year review.

The assessment of the first five-year review concluded that ongoing custody and control of the Rocky Flats Site by DOE, monitoring programs, and restriction of public access served to adequately control risks posed by contamination at the Site at the time of the review.

The OU 1 and OU 3 remedies were considered protective.[6] In addition, the accelerated actions analyzed during the review addressed the immediate hazards.

[6] As discussed in Section 1.0, OU 3 is not evaluated in this review. OU 1 is no longer a designated OU in the CAD/ROD and the former OU 1 area is within the Central OU. Thus, OU 1 is not separately evaluated in this review.

The protectiveness statement from the First Five-Year Review Report follows:

> *Ongoing custody and control of the Site by DOE, monitoring programs, and restriction of public access serve to adequately control risks posed by contamination at RFETS at this time. In addition, DOE has every intent of implementing the requirements of RFCA, CERCLA, and RCRA to cleanup and close the Site in a manner that is protective of human health and the environment. This final remedy will be developed as part of the RI/FS process, resulting in a final CAD/ROD that is protective.*
>
> *RFETS has completed several remedies for a number of OUs. For OU 1 and OU 3, the remedies as discussed in this report are protective.*
>
> *RFETS has also completed several accelerated actions to address hazards posed on an individual IHSS basis. For the accelerated actions analyzed during this Five-Year Review, the immediate hazard has been addressed. Further, for the most part, the accelerated actions are protective and are functioning as intended.*

Table 4, taken from the First-Five Year Review Report (DOE 2002), summarizes the protectiveness of the OUs and remedial actions analyzed during the review.

The First Five-Year Review Report identified several issues relevant to the determination that the identified remedies and accelerated actions are protective and should be considered as the Rocky Flats Site proceeds with the cleanup pursuant to RFCA. Table 5 summarizes the First Five-Year Review Report-identified issues and associated recommendations, both near- and short-term. Table 5 also presents the current status of each recommendation. Based on the results of the second five-year review, all issues from the first five-year review have been satisfactorily closed out because they have been addressed by the implementation requirements of the final remedy or incorporated into new recommendations and follow-up actions in this report.

6.0 Five-Year Review Process

This section describes the second five-year review process components used to gather information for the assessment of the remedy performance. As discussed in Section 3.4, the cleanup and closure activities required under RFCA were completed in October 2005 and the post-closure activities, including water monitoring, have been ongoing since that time. The September 2006 CAD/ROD and March 2007 RFLMA establish the regulatory requirements to implement the remedy.

To recap, the selected remedy for the Central OU is institutional and physical controls, with continued monitoring. The remedy decision is discussed and described in more detail in Section 4.0 of this report.

This second five-year review focuses on the final remedy, even though it has only been in place during the latter part of the period covered by this review, because the purpose of the review is to assess the continuing protectiveness of the implemented remedy.

The five-year review process does not reopen the remedy decision, but looks at conditions in the Central OU based on documents and other sources described in this report for comparison to the remedy design goals and objectives.

6.1 Administrative Components

The Rocky Flats CERCLA five-year review team consisted of personnel from DOE, CDPHE, EPA, USFWS, and DOE's LM contractor, the S.M. Stoller Corporation.

The schedule to complete the review was based on submittal of the report to EPA by August 1, 2007, as required by RFLMA (DOE et al. 2007), to allow for EPA approval by September 17, 2007. The five-year review planning process began in January 2007 for the following tasks:

- Community Involvement;
- Document Review;
- Data Review;
- Site Inspection; and
- Five-Year Review Report Preparation.

6.2 Community Notification and Involvement

Notice was published in two local newspapers (The Denver Post and The Rocky Mountain News) that the Rocky Flats second five-year review process had begun and listed the planned public briefings and opportunities for public input. The notice appeared in the March 4, 2007, editions of both newspapers. A Fact Sheet describing the Rocky Flats Site's CERCLA review process and public participation opportunities was posted to the Rocky Flats public website on March 1, 2007.

The review team gave a public presentation at the May 7, 2007, Rocky Flats Stewardship Council[7] meeting, which was open to the public. The public was notified of this presentation in the March 4, 2007, newspaper notice, as well as on the Rocky Flats and Stewardship Council public websites. This presentation included an overview of the review process and a question and answer period.

Questions regarding the need for air monitoring to ensure remedy protectiveness to firefighters when fighting grass fires in the Central OU were raised by some Stewardship Council members during the meeting. The review team responded that based upon the evaluation in the RI/FS, which includes modeling of wind erosion of residual radionuclides in soil following a hypothetical fire and the fate and transport of residual radionuclides in air, the risk of exposure from grass fires is insignificant. Air monitoring is not required by the CAD/ROD because the air exposure pathway does not present a significant risk or dose. Thus, this five-year review scope does not evaluate remedy performance in relation to the air exposure pathway. No other issues regarding the review scope or process were identified at the meeting.

In addition, the review team met with staff members from the local municipalities of Broomfield, Westminster, and Northglenn, as well as the Rocky Flats Stewardship Council, on May 10, 2007, to discuss the review and answer questions. No issues regarding the review scope or process were identified through community feedback during the review period.

EPA guidance includes consideration of the need for interviews with local residents or other stakeholders to identify issues that might be included in the review. Based on the recent public participation activities leading up to the CAD/ROD and the steps taken to inform the public about this review, the review team concluded specific interviews were not needed.

6.3 Document Review

The documents listed below are relevant to the selected remedy and served as the key references to assess remedy performance and controls in relation to the remedy goals and objectives.

RCRA Facility Investigation-Remedial Investigation/Corrective Measures Study-Feasibility Study Report for the Rocky Flats Environmental Technology Site (RI/FS Report) (DOE 2006a)—The RI/FS Report, which is discussed in more detail in Section 3.0 of this report, contains information on the identification and locations of hazardous substances that remained in the Central OU upon the completion of cleanup and closure activities conducted under RFCA. Ground water and surface water monitoring data in the RI/FS are for the period through July 31, 2005. Sediment monitoring data are also through July 31, 2005. Sampling for these media is required by the CAD/ROD and is discussed further in Section 6.6.

Soil monitoring data in the RI/FS reflect the conditions after completion of all RFCA investigations and accelerated actions and are for the period through August 22, 2005, when these accelerated actions were completed. Air monitoring data are for the period ending

[7] The Rocky Flats Stewardship Council formed in March 2006 to provide ongoing oversight of Rocky Flats. Membership includes elected officials from counties and cities surrounding Rocky Flats, as well as three community organizations and one individual, and partners with DOE and USFWS to provide periodic updates to the community about issues related to the management of the remedy for the Central OU at Rocky Flats.

October 31, 2005. Continuing periodic soil monitoring or air monitoring is not required in the CAD/ROD (DOE et al. 2006).

RAOs to address the risks posed by remaining hazardous substances were developed in the RI/FS and remedy alternatives were evaluated, resulting in a proposed alternative to be selected as the remedy. The RAOs also included identified ARARs to be achieved for use in evaluation of remedy alternatives. RAOs and ARARs are discussed further in Section 7.0 of this report.

In addition to the above information, several components of the RI/FS are of particular interest in this five-year review as described below.

- CRA and CRA Methodology—An evaluation, including a quantification when required, of the risks posed by remaining hazardous substances to human health and the environment is presented in the CRA. The CRA includes an HHRA and an ERA (hereinafter, reference to the CRA includes the HHRA and the ERA, unless the terms are specifically limited in the text). The exposure scenario and exposure parameters used in the CRA were developed and documented in the CRA Methodology (DOE 2005b).

  These documents are relevant to evaluate whether any changes to cancer slope factors and toxicity factors that were used to identify human health COCs or toxicity factors used to identify ECOPCs may affect protectiveness of the remedy. In addition, differences between the implemented remedy exposure parameters and the exposure parameters used in the CRA site conceptual model may affect protectiveness of the remedy.

- O&M Costs—Projected costs to implement each remedial alternative are presented in the RI/FS and the CAD/ROD. The projected cost of implementing the selected remedy versus the actual implementation cost may provide an indication of whether the remedy is performing as expected.

Rocky Flats Environmental Technology Site Proposed Plan (DOE 2006b)—The Proposed Plan was based on the results of the RI/FS. The Proposed Plan summarizes the remedial alternatives evaluation and presents DOE's proposed alternative to be selected as the remedy for public review and comment. The Proposed Plan includes the RAOs developed in the RI/FS.

Corrective Action Decision/Record of Decision for Rocky Flats Plant (USDOE) Peripheral Operable Unit and Central Operable Unit (DOE et al. 2006)—The CAD/ROD selected the remedy currently being implemented at Rocky Flats. The CAD/ROD finalized the RAOs, including identified ARARs to be achieved by the selected remedy. The CAD/ROD contains information regarding the objective and rationale for each of the institutional controls established for the final remedy, which also are relevant in assessing remedy performance. The ARARs review is discussed in more detail below.

Rocky Flats Legacy Management Agreement (DOE et al. 2007)—RFLMA is the regulatory framework for implementing the final response action selected and approved in the CAD/ROD, and ensuring that it remains protective of human health and the environment. In particular, RFLMA Attachment 2, "Legacy Management Requirements," specifies the requirements to ensure continuing protectiveness, which are thus relevant to this five-year review assessment of performance. RFLMA Attachment 2 specifies:

- Remedy performance standards and requirements, including surface water standards;

- Physical controls, including engineered remedies and signs;
- Monitoring requirements, including for surface water, ground water, remedy monitoring and maintenance, and operational monitoring;
- Action determinations;
- Periodic reporting requirements, including quarterly and annual LM reports; and
- CERCLA five-year review requirements.

Environmental Covenant Between DOE and CDPHE pursuant to section 25-153-21, Colorado Revised Statutes (CRS) (DOE and CDPHE 2006)—The Covenant contains the CAD/ROD institutional control use restrictions, a legal description for the Central OU, and a summary description of wastes disposed of at the PLF.

Present Landfill Monitoring and Maintenance Plan and Post-Closure Plan (PLF M&M Plan) (DOE 2006c)—The PLF M&M Plan is designed to meet the following objectives:

- Describe the procedures to maintain the integrity and effectiveness of the final cover, including making repairs as necessary;
- Describe the features to maintain and monitor the ground water monitoring system; and
- Present the Landfill Seep and East Landfill Pond Environmental Monitoring Plan.

The PLF M&M Plan is incorporated by reference in RFLMA and the water monitoring criteria are included in RFLMA Attachment 2, Table 2, "Water Monitoring Locations and Sampling Criteria" (Appendix A of this report). The M&M Plan fulfills the requirements for a post-closure plan in 6 CCR 1007-3 §265.118 and the requirements of 6 CCR 1007-3 §265.119(a)(3).

Final Landfill Monitoring and Maintenance Plan, Rocky Flats Environmental Technology Site Original Landfill (OLF M&M Plan) (DOE 2006d)—The OLF M&M Plan is designed to meet the following objectives:

- Describe the procedures to be used to maintain the integrity and effectiveness of the final cover, including making repairs as necessary;
- Describe the features necessary to maintain and monitor the ground water monitoring system; and
- Describe the features necessary to prevent run-on and runoff from eroding or otherwise damaging the final cover.

The OLF M&M Plan is incorporated by reference in RFLMA and the water monitoring criteria are included in RFLMA Attachment 2, Table 2, "Water Monitoring Locations and Sampling Criteria" (Appendix A of this report).

Rocky Flats, Colorado, Site Vegetation Management Plan (DOE 2006e)—This plan employs an integrated framework of techniques to control excessive vegetation that can increase wildfire hazards, control present and future infestations of noxious weeds, and enhance the native plant communities and wildlife habitat.

Rocky Flats, Colorado, Site Wetland Mitigation Monitoring and Management Plan (DOE 2006f)—This plan outlines a strategy to determine whether wetland mitigation efforts at Rocky Flats have successfully mitigated for wetland impacts resulting from cleanup and closure activities. Approximately 7.7 acres of wetlands were affected by cleanup and closure activities at Rocky Flats. The overall performance objective is to reestablish a minimum of 7.7 acres of wetlands to mitigate and replace those that were affected by closure activities.

Other documents also provide monitoring data and information on the evaluation of the data, as discussed in Section 6.6.

6.4 ARARs Review

Section 121(d) of CERCLA and the NCP, 40 CFR 300.430(f)(1)(ii)(B), require that on-site remedial actions must attain those ARARs that were identified at the time of the CERCLA remedy decision. The ARARs to be met for the Central OU final remedy are identified by specific statutory or regulatory citation in the CAD/ROD, Table 21 (DOE et al. 2006).

Among other things, the RFLMA, Attachment 2 requirements outlined previously provide the remedy implementation, operation and administrative activities, and controls to achieve ARAR requirements. All ARARs identified in Table 21 of the CAD/ROD have been implemented and are being attained.

These laws and regulations may be revised from time to time by legislative or regulatory agency action. In accordance with 40 CFR 300.430(f)(1)(ii)(B)(*1*), requirements that are promulgated after the remedy decision must be attained only when determined to be applicable or relevant and appropriate and necessary to ensure the protectiveness of the remedy.

ARARs are identified as chemical-, location-, and/or action-specific. Chemical-specific requirements are usually health- or risk-based numerical values or methodologies. 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 because they occur in particular locations. Action-specific requirements are usually technology- or activity-based requirements or limitations on actions taken with respect to management of remediation waste or closure of a facility.

A review of the CAD/ROD ARARs through April 2007 was conducted to determine whether there have been any promulgated changes to these statutes or regulations relevant to the chemicals, location, and/or action addressed by the CAD/ROD for the Central OU.

Table 6 lists the ARARs and the RFLMA, Attachment 2-required activity or control or other activity or document designed to achieve the ARAR. Changes to ARARs are noted in Table 6.

6.4.1 Promulgated ARAR Changes

Promulgated ARAR changes since the CAD/ROD are briefly discussed below.

Natural Resource and Wildlife Protection Laws, 2 CCR 406-3—In 2006, the Colorado Wildlife Commission modified the legal methods of take for game species, including the black-tailed prairie dogs, by landowners where necessary to control damage on land owned by them.

Permits for Dredged or Fill Material; Discharges of Dredged or Fill Material Into Waters of the United States, 33 CFR 323—On-site remedial actions do not require permits, but remedies requiring discharge of dredge or fill material into waters of the United States, as defined in the ARAR, must meet substantive requirements of any nationwide or regional permit or specific permit that may otherwise be required pursuant to the Clean Water Act.

Under this ARAR, some types of activities conducted to implement the remedy may result in the discharge of dredge or fill material that require meeting substantive requirements of a permit, such as removing sediment from surface water sampling locations. Some types of activities are exempt from permit requirements, such as drainage ditch routine maintenance.

Virtually all anticipated remedy implementation activities that otherwise require a dredge or fill discharge permit are covered by nationwide permits (NWPs) issued by the permitting authority, the U.S. Army Corps of Engineers (Corps). The Corps reissued all existing NWPs, general conditions, and definitions in effect on the date of the CAD/ROD, and added 6 new NWPs, 2 new conditions, and 13 new definitions, effective March 19, 2007 (72 FR 11092, March 12, 2007).

While the reissued or new NWPs, conditions, or definitions added and clarified certain substantive aspects of the NWPs, the implementation of the remedy is not impacted because all activities subject to this ARAR are conducted in accordance with the March 19, 2007, requirements.

These promulgated ARARs changes do not impact the protectiveness of the remedy.

6.4.2 Colorado Water Quality Standards

The Walnut and Woman Creek portions in the Central OU are segments of the South Platte River Basin.

No changes to surface water standard requirements were promulgated after the remedy decision, thus RFLMA Attachment 2, Table 1 (Appendix A of this report) reflects the current promulgated standards. Changes for the South Platte River Basin will be considered by the Colorado WQCC during the next triennial review and are expected to be promulgated upon completion of that review in 2009.

As shown in Table 6, the water quality standards are based on Rule 38, "Classification and Numeric Standards South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin" (5 CCR 1002-38) and Rule 31, "Colorado Basic Standards and Methodologies for Surface Waters" (5 CCR 1002-31). If the numeric values from the basic

standards and the Rocky Flats-specific standards differ, the Site-specific standard applies, except where temporary modifications are in place.

Temporary modifications for the Walnut Creek portions of Segment 5 apply until December 31, 2009. Temporary modifications are for nitrate and nitrite, benzene, carbon tetrachloride, 1,2-dichloromethane, 1,1-dichloroethene, PCE, and TCE. The temporary modifications are below the WRW PRG values and below the chronic ecological screening level (ESL) values in the CRA, and thus do not impact the protectiveness of the remedy.

Because the use classification of ground water at Rocky Flats is surface water protection, the surface water standards also apply to ground water.

6.4.2.1 Changes in Water Quality Standards Since the First Five-Year Review

Since 2002, the Colorado WQCC completed a triennial review of Rule 38, "Classification and Numeric Standards South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin" (5 CCR 1002-38) in July 2004 and completed a triennial review of Rule 31, "Colorado Basic Standards and Methodologies for Surface Waters" (5 CCR 1002-31) in June 2005.

The triennial review of June 2005 resulted in WQCC action on a number of issues, including temporary modifications, antidegradation, recreational classifications, revisions to certain water quality standards, and the addition of new water quality standards for temperature and uranium.

The basic (i.e., statewide) standard for uranium adopted in 2005 is applicable to waters with drinking water use classification. The drinking water standard is 30 micrograms per liter (µg/L), comparable to the primary drinking water standard adopted by EPA in 2003. The statement of basis and purpose for this proceeding also indicates that the WQCC established a specific activity of 670 picocuries per milligram (pCi/mg) for natural uranium, to provide a consistent interpretation of water quality data. Using this specific activity results in an activity standard of 20 picocuries per liter (pCi/L). Uranium has a Rocky Flats-specific standard of 10 pCi/L in Walnut Creek and 11 pCi/L in Woman Creek, which have the drinking water use classification. The Rocky Flats-specific 10 pCi/L and 11 pCi/L standards were identified as ARARs for the final remedy and are contained in RFLMA Attachment 2, Table 1 (Appendix A of this report).

Modifications to the basic numeric standards for metals, including aluminum, arsenic, cadmium, and zinc, and table value standards (TVSs) for copper,[8] nickel, selenium, and thallium were adopted to reflect updated water quality criteria published by EPA in 2002. Of these metals, arsenic has a Rocky Flats-specific standard of 50 µg/L. The WQCC proposed addition of 1,4-dioxane to the Basic Standards. This chemical is a stabilizer in organic solvents such as those used during the production era at Rocky Flats. The modified Basic Standards for metals and 1,4-dioxane, TVSs for metals, and Rocky Flats-specific standard for arsenic were identified as

[8] EPA recently issued a revision of the aquatic life ambient fresh water quality criteria for copper (72 FR 7983, February 22, 2007). In the past, the TVS was calculated using the ambient hardness. Under the new method, EPA uses the Biotic Ligand Model to determine the TVS. This model requires inputs for other parameters besides hardness. This has not been adopted by the WQCC, but may be considered in the next triennial review.

ARARs for the final remedy, and are included in RFLMA Attachment 2, Table 1 (Appendix A of this report).

Changes to drinking water standards promulgated by EPA specify the MCL for arsenic of 10 µg/L. This was adopted as the Basic Standard upper limit by the WQCC in 2005. The WQCC indicated that Rocky Flats-specific arsenic standards will be reviewed as basin standards come up for review.

6.5 CRA Review

The exposure scenario and exposure parameters used in the CRA were developed and documented in the CRA Methodology (DOE 2005b). This information was reviewed to determine whether the scenario assumptions and parameters remain valid to evaluate the continuing remedy protectiveness.

6.5.1 Review of Cancer Slope Factors and Toxicity Factors

The COCs identified in the HHRA portion of the CRA included arsenic, vanadium, benzo(a)pyrene, 2,3,7,8-tetrachlorodibenzodioxin, and plutonium 239/240. The cancer slope factors and reference doses that were used in the CRA were from EPA's Integrated Risk Information System (IRIS) database.[9] IRIS was reviewed for these COCs and no changes have been made since the publication of the CRA in 2006. Radiation dose calculations were also performed for the HHRA and for ARAR comparison using the RESRAD computer code.[10] No changes have been made to the dose conversion factors used in the evaluation of the deer meat ingestion pathway or for the dose rate calculations for ARAR comparison. Therefore, no revisions to the calculations of potential risks and hazards presented in the HHRA portion of the CRA are warranted.

In addition, the toxicity reference values used in the ERA portion of the CRA were identified through the consultative process with members of the Risk Assessment Working Group for RFETS, including EPA, CDPHE, and DOE representatives and are documented in the CRA Methodology (DOE 2005b). There have been no changes to these values, thus no revisions to the estimates of potential ecological risk presented in the CRA are warranted.

6.5.2 Review of Exposure Assumptions

The indoor air/vapor intrusion evaluation in the CRA was conducted using EPA guidance that was current at the time the CRA Methodology was prepared. Since that time, EPA has revised some of the assumptions and approaches for evaluating the vapor intrusion pathway. Therefore, if the indoor air pathway were re-evaluated with more current approaches, the number of areas within the Central OU where the indoor air pathway is potentially significant could change. However, because there are institutional controls in place that prohibit the construction of buildings that will be occupied on a permanent or temporary basis (such as for residences or offices), the current remedy is protective of human health and no revisions to the indoor air evaluation are warranted at this time.

[9] The IRIS website is http://www.epa.gov/iris/.
[10] The RESRAD website is http://web.ead.anl.gov/resrad/.

The exposure assumptions for the WRW in the CRA included 230 days per year when exposure to surface soil may occur, and 20 days per year when exposure to subsurface soil may occur. Based on interviews with field operations personnel and other LM staff working in the Central OU, these assumptions are still appropriate, conservative estimates of potential exposure for workers within the Central OU.

Based on review of toxicity factors and exposure assumptions used in the HHRA and ERA portions of the CRA, the risk and hazard estimates presented in the CRA for the Rocky Flats Site are still valid and no revisions are warranted at this time.

6.6 Environmental Monitoring Data Review

The RI/FS Report provides and evaluates the monitoring results for all environmental media that were relevant to determining the nature and extent of contamination and the risks posed by remaining hazardous substances. After completion of cleanup and closure activities in October 2005, sampling and analysis continued in accordance with the RFCA IMP.

The CAD/ROD requirements were incorporated in the December 2006 Draft RFLMA that was issued for public review and comment. RFLMA became effective March 14, 2007, and superseded RFCA and the RFCA IMP. The monitoring, surveillance, and maintenance activities for which quarterly, annual, and five-year review reports are issued are included in RFLMA Attachment 2, "Legacy Management Requirements." These activities did not change from the draft to the final RFLMA.

The CAD/ROD requires continual, periodic monitoring of surface water and ground water but does not require any soil or air monitoring to implement the remedy. The CAD/ROD also requires additional sediment and pond water sampling and analysis to provide additional data to reduce uncertainties determined in the ERA portion of the CRA. The required additional sampling is contained in RFLMA Attachment 2, Table 5 (Appendix A of this report) and is expected to be completed in 2007; therefore, the associated data are not available for evaluation in this review.

The results of surface water and ground water monitoring activities to implement the CAD/ROD are relevant to determine whether RAOs, including ARARs, are achieved for these media. The data set in the RI/FS and the data collected under RFCA IMP requirements prior to and after signing of the CAD/ROD provide monitoring data for comparison purposes to evaluate remedy progress and to determine whether mitigating actions might be warranted. This includes high-resolution (HR) inductively coupled plasma/mass spectrometry (ICP/MS) or thermal ionization mass spectrometry (TIMS) data from 1997 to 2005 to determine the natural uranium isotopic content in select water sampling locations.

The water monitoring data results in the Calendar Year (CY) 2005 and 2006 Rocky Flats Site Annual Reports of Site Surveillance and Maintenance Activities (2005 and 2006 Annual Reports, respectively) (DOE 2006h, 2007d) contain the ground water and surface water monitoring data after the RI/FS data set ending date of July 31, 2005. These reports also include monitoring, inspection, and maintenance information for the PLF and OLF and the contaminated ground water treatment systems that were carried over into the RFLMA requirements. In some instances predecessor ground water sample location data (i.e., data from a current, replacement

well) were pooled with data from the pre-existing well, but only if those two data groups did not suggest a discontinuity.

The 2006 Annual Report (DOE 2007d) evaluates monitoring results to the end of CY 2006. For comparison purposes, the 2006 Annual Report includes a surface water data summary from 1997 forward, and ground water data summary from 2000 forward, or from the beginning of sample collection from a particular sampling point, if later than 2000. Therefore, the 2006 Annual Report provides the primary monitoring information to assess remedy performance over the relatively short time the remedy has been implemented, and this review is based primarily on that information.

6.6.1 Water Monitoring Locations

The relevant information considered in this review is for the water monitoring locations and sampling criteria in RFLMA Attachment 2, Figure 1 and Table 2 (Appendix A of this report).

In addition, the decision logic flowcharts in RFLMA Attachment 2, Figures 5 through 13 (Appendix A of this report) for each location were considered for application to the 2006 Annual Report analytical results. The flowcharts are consistent with the RFCA IMP evaluation criteria in effect for the 2006 Annual Report, except as noted in the discussion below. The flowcharts were considered for this review in relation to remedy performance and recommendations to continue, modify, or discontinue monitoring, as discussed in the Technical Assessment and the Issues, Recommendations, and Follow-Up sections of this report.

6.6.2 Surface Water Monitoring Network

The surface water monitoring stations provide data relevant to the Surface Water RAO, which is listed in Section 4.1 of this report. The RFLMA Attachment 2 decision logic flowcharts in Figure 5, “Points of Compliance,” and Figure 6, “Points of Evaluation” (Appendix A of this report), are relevant to this data.

The RFLMA surface water monitoring network is complete and sampling and analysis are being performed as required. Monitoring for each type of monitoring point is discussed below.

The location of ponds and drainage features in the Central OU are shown on RFLMA Attachment 2, Figure 1, “Water Monitoring Locations at Rocky Flats” (Appendix A of this report). The ponds are grouped together in series based on the drainage in which they are located, with the A-Series Ponds in North Walnut Creek, the B-Series Ponds in South Walnut Creek, the C-Series Ponds in Woman Creek, and the Landfill Pond in No Name Gulch. Ponds A-4, B-5, and C-2 are referred to as the “terminal ponds,” in which water is retained and sampled prior to discharge from the Central OU.

Surface water flow volumes show expected reductions resulting from land configuration changes and removal of impervious surfaces. The surface water volume data for the period of this review prior to closure (i.e., the data used for the RI/FS) allow rough comparison with the data beginning to reflect the integrated post-closure hydrologic conditions, primarily related to the effects of changes in the following Rocky Flats Site conditions:

- All buildings (except for two small sheds) and all impervious surfaces were removed and drains were removed or disrupted, resulting in infiltration of precipitation into the ground rather than surface runoff of precipitation in these areas.
- The domestic water supply was discontinued and the supply and sewer lines were removed or disrupted, resulting in total elimination of imported water that previously contributed to ground water via leakage from these aging lines.
- The Sewage Treatment Plant was removed, resulting in total elimination of the discharge of the treated effluent to surface water.
- Most stormwater conveyances were removed and the land surface recontoured into five functional drainage channels approximating (but not intended to duplicate) drainage patterns prior to construction of the Rocky Flats facilities.

To illustrate these effects, in 2006 approximately 28 acre-feet of water flowed into the A- and B-Series Ponds in Walnut Creek, and there was no flow into Pond C-2 in Woman Creek. For 2002−2005, an average of approximately 274 acre-feet per year and 17 acre-feet per year flowed into the A- and B-Series Ponds and Pond C-2, respectively.[11] Approximately the same average volume was discharged from these ponds between 2002 and 2005. In 2006, there was no discharge from these ponds.[12]

Precipitation from 2002 to 2005 ranged from approximately 7.9 inches to 16.9 inches, with an annual average for the four years of approximately 11.8 inches. Precipitation in 2006 was approximately 9.2 inches.[13] Note that 2006 was a very dry year, but even during drought years prior to closure, volumes of surface water flowing across Rocky Flats were much higher than that measured in 2006.

Because these conditions were only fairly recently established, did not take place all at once, and the effects of each are somewhat interrelated, the hydrologic conditions at Rocky Flats are in a state of flux. It is expected to be several years or more before these conditions will approximate long-term steady-state conditions.

6.6.2.1 POCs

POCs are located in Walnut and Woman Creeks downstream of the terminal ponds and at Indiana Street. POCs are used to demonstrate compliance with RFLMA surface water standards. During CY 2006, no terminal pond discharges were needed and consequently there are no POC data for the terminal ponds discharge locations or for GS03, Walnut Creek at Indiana Street, in 2006. Data for 2006 are only available for POC GS01, Woman Creek at Indiana Street, because there is stream flow at this location year around. GS01 data do not represent any Pond C-2 water in this normal stream flow condition. Post-closure analytical data for surface water presented in the 2006 Quarterly and Annual Reports show that water quality at all POC locations meets the RFLMA surface water standards.

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[11] The A- and B-Series Pond inflow is the sum of flow measured at GS10 and SW093, and the Pond C-2 inflow is measured at SW027. See the CY 2006 Annual Report, Figures 2−8 and 2−9.
[12] The A- and B-Series Pond outflow is measured at GS11 and GS08, and the Pond C-2 outflow is measured at GS31.
[13] See the CY 2006 Annual Report, Figures 2−57 and 2−58.

6.6.2.2 POEs

POEs are located in the Central OU upstream of the ponds and POCs. POEs are used to evaluate water quality in comparison to RFLMA surface water standards. Post-closure results presented in the 2006 Annual Report show that water quality at all POE locations meets the RFLMA standard, except at GS10. GS10 results were above the Walnut Creek surface water standard of 10 pCi/L for total uranium based on the 12-month rolling average value for the sample collection period from April 30, 2006, through December 31, 2006. An evaluation (required by RFLMA Attachment 2, Section 6.0, "Action Determination") is ongoing. The evaluation includes an estimation of total uranium loads and an evaluation of water quality trends and correlations at GS10.

The GS10 reportable values are likely due to changes in hydrologic conditions at Rocky Flats. Prior to closure, the majority of the water at GS10 was surface runoff from roads, parking lots, and other impermeable surfaces; ground water recharge comprised a small fraction of the overall volume of water. Since closure and the removal of impermeable surfaces and elimination of the Sewage Treatment Plant effluent water, those sources of water have been eliminated, leaving only ground water recharge and occasional surface runoff. As a result, surface water at GS10 more closely resembles ground water in and upgradient of this area than it did prior to closure. HR ICP/MS or TIMS data indicate the ground water contains naturally occurring uranium, and uranium reported at GS10 is also predominantly natural. The range of 12-month rolling average values for GS10 for April 30, 2006, through December 31, 2006, is 10.19 to 13.41 pCi/L.

The GS10 uranium concentrations are well below WRW PRGs in the CRA (uranium-233/234 PRG = 600 pCi/L, uranium-235 PRG = 610 pCi/L, and uranium-238 PRG = 663 pCi/L), thus these levels do not impact the protectiveness of the remedy. Note that the levels are also below the 20 pCi/L statewide basic standard discussed in the review of ARARs.

6.6.2.3 Performance Monitoring Locations

Performance monitoring locations are downstream of specific remedies to determine short- and long-term effectiveness of these remedies where known contaminants may affect surface water. They also provide upstream water quality data in the event downstream water quality exceeds standards at POEs or POCs.

Surface water monitoring location GS13, in North Walnut Creek downstream of the SPPTS discharge gallery and upstream of Pond A-1, also had uranium concentrations exceeding the RFLMA standard. For the nine flow-paced samples collected from October 2005 to December 31, 2006, at GS 13 the 85th percentile and maximum total uranium concentrations were 18.9 and 21.6 pCi/L, respectively. This station helps in evaluating changes in the stream water quality resulting from removal of uranium and nitrate from ground water by the SPPTS and provides upstream water quality data in the event downstream water quality exceeds standards. From CY 1997 through closure in October 2005, the 85th percentile and maximum total uranium concentrations at GS13 were 12.9 and 23.5 pCi/L, respectively. Stream flow conditions include a higher proportion of ground water baseflow than conditions prior to closure.

The SPPTS is effectively removing uranium (and nitrate) from the contaminated ground water collected by the ground water interceptor barrier, and is thereby reducing the uranium loading to

North Walnut Creek (including at GS13). The discharge gallery concentrations show that the treated water commingles with contaminated ground water east of the ground water barrier and upstream of GS13. Like GS10, changes in hydrologic conditions result in ground water with naturally occurring uranium making up a larger proportion of stream flow at GS13.

The GS13 uranium concentrations are well below WRW PRGs in the CRA (uranium-233/234 PRG = 600 pCi/L, uranium-235 PRG = 610 pCi/L, and uranium-238 PRG = 663 pCi/L), thus these levels do not impact the protectiveness of the remedy.

6.6.3 Ground Water Monitoring Network

The ground water monitoring wells provide data relevant to the Ground Water RAOs, which are listed in Section 4.1. Ground water, which may include contaminated ground water, emerges to surface water before leaving the Central OU. The RFLMA Attachment 2 decision logic flowcharts in Figure 7, "Area of Concern Wells, Boundary Wells, and SW018," Figure 8, "Sentinel Wells," Figure 9, "Evaluation Wells," and Figure 10, "RCRA Wells" (see Appendix A) are relevant to the ground water monitoring data. Ground water monitoring results are compared to RFLMA surface water standards, because the use classification of Rocky Flats ground water is surface water protection.

The ground water monitoring network is complete and sampling and analyses are being performed as required. Monitoring for each type of well in the network is discussed below. Ground water is not negatively impacting surface water quality, except for uranium at GS10 and at GS13, which is predominantly natural uranium. Elevated concentrations of several metal analytes in ground water seep water treated by the PLFTS, discussed below, were also observed in the PLFTS effluent that discharges to surface water entering the Landfill Pond.

6.6.3.1 AOC Wells

AOC wells are located within a drainage and downgradient of a contaminant plume or group of contaminant plumes. AOC wells are monitored to determine whether contaminant plumes may be discharging to surface water.

The AOC wells meet surface water standards, except for well B206989, which was changed from a Sentinel well to an AOC well in RFLMA, and AOC well 10594, as discussed below.

Well B206989 was designated as a Sentinel well in the RI/FS, but has been designated as an AOC well in RFLMA, effective March 14, 2007. Well B206989 is located east of the Landfill Pond. Pursuant to RFLMA Attachment 2, Table 2, this well is sampled for VOCs, nitrate, and uranium. The RI/FS summary for well B206989 indicated that nitrate and uranium were above the surface water standard. The RI/FS notes that there is no contiguous nitrate plume in this area, and that nitrate is not widespread and is unlikely to impact surface water quality. The RI/FS also notes that based on HR ICP/MS or TIMS analysis, the uranium is from natural sources.

Well B206989 samples in 2006 were above the uranium and nitrate standards for the April 26, 2006, and October 10, 2006, semiannual samples. The uranium results were 130 µg/L (April) and 110 µg/L (October), and the nitrate results were 45 milligrams per liter (mg/L) (April) and 36 mg/L (October).

Because this is a newly designated AOC well in RFLMA, the subsequent semiannual samples will be compared to RFLMA Attachment 2, Figure 7 (Appendix A of this report). Figure 7 adopts a 120 µg/L threshold for uranium. The next semiannual sample results will determine whether concentrations remain above the threshold and constitute a reportable condition. The RFLMA Parties understood that this well did not meet Ground Water RAO 1 (to meet surface water standards at AOC wells) at the time it was changed to an AOC well, and this may become a reportable condition. However, no actions except for continued sampling regarding this well were identified when RFLMA became effective.

AOC well 10594, which is located below Pond A-1, produced a ground water sample having a uranium concentration of 170 µg/L on October 10, 2006, which is above the 120 µg/L uranium threshold in RFLMA Figure 7 (Appendix A of this report). The RI/FS also noted that this well produced uranium results above the surface water standard. The next semiannual sample results will determine whether concentrations remain above the threshold and constitute a reportable condition. The RI/FS notes that based on HR ICP/MS or TIMS analysis, the uranium at this location is from natural sources.

6.6.3.2 Sentinel Wells

Sentinel wells are typically located near downgradient edges of contaminant plumes, in drainages, and downgradient of ground water treatment systems. These wells are monitored to determine whether concentrations of contaminants are increasing, which could indicate plume migration or treatment system problems.

Ground water quality in Sentinel wells at the end of 2006 was generally consistent with conditions at the time of closure. Ground water does not meet surface water standards for many analytes in many Sentinel well locations and it is not expected to achieve standards for many years. Thus, continued implementation of the remedy to achieve Ground Water RAOs is necessary. There is no indication of significant plume migration or problems with the treatment systems that impact the continuing protectiveness of the remedy.

6.6.3.3 Evaluation Wells

Evaluation wells are typically located within plumes or near plume source areas, or in the interior of the Central OU. A subset of these wells is located in areas that may experience significant changes in ground water conditions because of closure activities. These wells are monitored to help determine when monitoring of a plume or area may cease.

Ground water does not meet surface water standards for many analytes in many Evaluation well locations and it is not expected to achieve standards for many years. Thus, continued monitoring to determine when Ground Water RAOs are met so monitoring may cease is necessary.

6.6.3.4 RCRA Wells

RCRA wells monitor the PLF and OLF to determine compliance with ARAR criteria. Monitoring at these wells is discussed below.

6.6.4 Ground Water Treatment System Monitoring and Operations and Maintenance

Sampling and analysis of treatment system influent and effluent is being conducted as required. Maintenance for three ground water plume treatment systems was conducted in 2006, including installation of automated instrumentation at the ETPTS and MSPTS, media replacement at the MSPTS, and plumbing repairs at the SPPTS. Notable observations related to the SPPTS are discussed below. Except for the periods when mechanical repairs were needed to restore system flows and exhausted media needed to be replaced, the three plume treatment systems are operating properly and successfully to remove the target contaminants from ground water and reduce contaminant load to surface water.

The PLFTS, which is a seep collection and flow-through aeration treatment system, did not require any repairs or maintenance in 2006, but sampling results for several analytes required investigation and additional sampling, as discussed below.

The RFLMA Attachment 2 decision logic flowchart on Figure 11, "Ground Water Treatment Systems" (Appendix A of this report), is relevant to the treatment systems monitoring data.

6.6.4.1 PLFTS

The quarterly monitoring results for the system effluent were above RFCA IMP surface water standards for several analytes in 2006 (i.e., RFLMA was not effective until March 14, 2007), triggering monthly sampling for those analytes. Total arsenic, boron, and manganese were greater than the RFCA surface water standard for three consecutive samples, which under the RFCA IMP triggered consultation and Landfill Pond sampling. The same actions would be required under RFLMA Attachment 2, Figure 11 (Appendix A of this report) for exceedances of RFLMA surface water standards. However, the RFLMA standard for arsenic is the Rocky Flats-specific standard of 50 µg/L, and manganese is not a RFLMA analyte,[14] and thus only boron would have triggered consultation and pond sampling under RFLMA standards.

The triggered pond samples were below the RFLMA standards for arsenic and manganese, but above the boron standard of 750 µg/L (1,200 and 1,280 µg/L on May 23 and July 25, 2006, respectively). The highest boron level at the PLFTS effluent was 2,100 µg/L on December 28, 2005. The boron standard is based on an agricultural use to protect fruit and nut trees, and the pond water is not used for agricultural purposes. The RFLMA Parties agreed sampling of the pond could be discontinued and consultation regarding PLFTS effluent samples would continue.

The 2006 Landfill Pond levels of arsenic, boron, and manganese were all well below the WRW PRG values in the CRA (arsenic PRG = 51 µg/L, boron PRG = 183,000 µg/L, and manganese PRG = 284,000 µg/L). Therefore, from a human health standpoint the measured values of these three metals in the pond surface water do not impact the protectiveness of the remedy.

[14] For all surface waters with a "water supply" classification that are not in actual use as a water supply, no water supply standards are applied for iron, manganese, or sulfate, unless the WQCC determines as the result of a site-specific rulemaking hearing that such standards are appropriate. Chloride, sulfate, iron, and manganese are secondary drinking water standards not applied to Big Dry Creek segments 4a, 4b, and 5 by the WQCC. See 5 CCR 1002-38.6(2), 1002-38.61(11), and 1002-31.37(H).

The Landfill Pond levels for arsenic, boron, and manganese are all below the chronic ESLs in the ERA portion of the CRA (chronic ESL for arsenic = 150 µg/L, chronic ESL for boron = 1,900 µg/L, and chronic ESL for manganese = 1,650 µg/L). The pond samples are appropriate for comparison to ESLs, because the location of the treatment system effluent is not in an aquatic habitat. The current data do not indicate that arsenic, boron, or manganese would be identified as ECOPCs and thus do not impact the protectiveness of the remedy.

6.6.4.2 SPPTS

Because of the SPPTS design and component location, media inspection, plumbing inspection and repair, and media replacement (although infrequently necessary) at the SPPTS is difficult and time-consuming. Approximately 12 to 15 feet of overburden must be excavated just to reach the top of the treatment cells and the top of the media and upper plumbing components. There is another 12 feet of media (including gravel drainage layers and so forth) that must be excavated in any media replacement operation. In addition, the system requires a continuously operable collection well and solar-powered pump system, which requires additional maintenance. A treatability study is underway to determine whether a simpler, more efficient, and less management-intensive system could be designed.

As mentioned in regards to performance monitoring location GS13 above, the clean effluent from the SPPTS is discharged via a long, predominantly perforated line that terminates at the Solar Ponds Plume discharge gallery. Samples of the water discharged at the discharge gallery typically contain higher concentrations of nitrate and uranium than are present even in untreated SPPTS influent. It was never expected that the SPPTS would capture all sources of this contamination, since part of the plume had passed the location of the system by the time it was installed and elevated concentrations of these contaminants continue at the discharge gallery.

6.6.5 Present Landfill Monitoring and Maintenance

The PLF was closed in place to meet CHWA/RCRA applicable requirements of ARARs, with the construction of an approximately 22-acre RCRA-compliant composite cover, monitoring wells, and the PLFTS (completed during 2005). A diversion channel surrounds the landfill and diverts stormwater runoff away from the landfill to No Name Gulch. The PLFTS treats landfill seep water and Ground Water Intercept System water that discharges into the Landfill Pond. A gas extraction system is also built into the landfill and allows subsurface gas to vent to the atmosphere. The landfill final construction site conditions are used as a baseline for comparisons made during site inspections. The PLF M&M Plan-required settlement monuments were installed in 2006 and initial quarterly surveying of the settlement monuments was performed in December 2006.

6.6.5.1 Inspections

Inspections of the PLF in CY 2006 were initially conducted quarterly. Monthly inspections were initiated in June consistent with the requirements contained in the most recent M&M Plan released in May 2006 (DOE 2006c). Since that time, routine M&M has been conducted in accordance with the PLF M&M Plan. It is anticipated that after the first year, the inspection frequency may be reduced to quarterly for an additional four years. The inspection program frequency is evaluated in this second five-year review.

Inspection information includes ground water and surface water monitoring facilities, subsidence/consolidation, slope stability, soil cover, vegetation, stormwater management structures, and erosion in surrounding features so that corrective actions can be taken in a timely manner. Eight inspections were performed at the PLF in CY 2006. No significant problems were observed during these inspections.

6.6.5.2 RCRA Ground Water Monitoring

The ground water monitoring network at the PLF consists of three upgradient and three downgradient wells. A year of quarterly analytical data (i.e., four sets of quarterly samples) are required to determine the baseline, and the same quantity of data are needed to perform the statistical analyses. The 2006 Annual Report represents the first evaluation for the post-closure network meeting these data requirements.

The concentrations of several metals are statistically higher in samples from downgradient wells compared to those from upgradient wells. The comparison is made in accordance with the PLF M&M Plan, using the Analysis of Variance (ANOVA) procedure. These results are summarized in Table 7. All analytes present in the well network samples, including those present at statistically significant higher concentrations in downgradient wells than in upgradient wells, do not exceed the RFLMA Attachment 2, Table 1 standards (Appendix A of this report). Four more quarters of sampling are required to determine whether the downgradient well concentrations are statistically increasing compared to the upgradient well concentrations; results of trend analysis will be included in the Annual Report for 2007.

The RFLMA Attachment 2 decision logic flowchart in Figure 10, "RCRA Wells" (Appendix A of this report), is relevant to these data. Note that for the downgradient OLF RCRA wells only, the Figure 10 evaluation includes a step for an evaluation under RFLMA Figure 8, "Sentinel Wells."

6.6.6 Original Landfill Monitoring and Maintenance

The OLF was closed in place to meet the relevant and appropriate requirements of RCRA/CHWA as ARARs. The OLF consists of approximately 20 acres of an engineered soil cover with a minimum thickness of 2 feet, over a former solid sanitary and construction debris landfill located on the hillside north of Woman Creek. The closure included cutting, filling, and regrading the surface to an 18-percent grade and construction of a 20-foot-high, 1,000-foot-long buttress on the south side of the OLF prior to installing the cover. The cover was completed in August 2005.

Routine M&M has been conducted in accordance with the OLF M&M Plan (DOE 2006d). The OLF M&M Plan-required settlement monuments were installed in the first and second quarter of 2007 and surveyed, except for one monument on the buttress due to continuing wet soil conditions and one on the west side where a slump has developed, as discussed below. It is anticipated the buttress settlement monument will be dry enough to allow installation in the summer, or a new location will be designated. The west side monument will be installed after repairs in accordance with the OLF M&M Plan are made.

6.6.6.1 Inspections

Inspections of the OLF in CY 2006 were initially conducted quarterly. Monthly inspections were initiated in June 2006 consistent with the requirements contained in the final OLF M&M Plan. The inspection program frequency is evaluated in this second five-year review.

Inspection information includes ground water and surface water monitoring facilities, subsidence/consolidation monitoring, slope stability, soil cover, vegetation, stormwater management structures, and erosion in surrounding features so that repairs and corrective actions needed to maintain performance can be taken in a timely manner.

Eight inspections were performed at the OLF in CY 2006. No significant problems were observed during these inspections. However, beginning in late January 2007, several areas of slides and slumps were noted in inspections as discussed below.

While inspections have identified several areas on the cover where seep water is saturating the soil and in some instances expressing from the surface and draining along the berms, this has not resulted in unacceptable ponding, subsidence, or slumping on the cover. Seeps have been observed in this area of the OLF for decades (as well as being suggested on aerial photographs taken before the Rocky Flats Plant came into existence).

A series of east-west berms on the cover direct surface runoff toward perimeter drainage channels east and west of the OLF cover. The channels carry runoff from the cover and surrounding area to below the south side of the buttress. These actions were designed to achieve hillside stability, control precipitation run-on and runoff from eroding the cover, and minimize infiltration of precipitation into the OLF.

The west perimeter channel wall also has some slumping and the east or west ends of some berms that may have extended too far into the perimeter channels are slumping or sliding into the channels. Also, several small areas on berms have experienced erosion. These conditions do not significantly impact runoff and run-on control, and repairs have been made or are ongoing pursuant to the OLF M&M Plan.

Inspections have also identified several small areas of slumping or sliding and cover surface cracking, most notably on the western side of the cover near the western perimeter channel. The settlement monument in this area was not installed, as slumping has occurred before the monument could be installed. This monument is planned for installation after any repairs to this area are made. The slumping is at the edge of the aerial extent of waste in an area where fill was placed. Appendix C contains a photograph of the OLF area.

6.6.6.2 RCRA Ground Water Monitoring

A year of quarterly ground water analytical data (i.e., four sets of quarterly samples) are required to determine the baseline, and the same quantity of data are needed to perform the statistical analyses. The 2006 Annual Report represents the first evaluation for the post-closure network meeting these data requirements (DOE 2007d).

The RFLMA Attachment 2 decision logic flowcharts in Figure 10, “RCRA Wells,” and Figure 12, “Original Landfill Surface Water” (Appendix A of this report), are relevant to these

data. Note that the Figure 10 evaluation includes a step for an evaluation under RFLMA Figure 8, "Sentinel Wells."

Concentrations of several metals are statistically higher in samples from downgradient wells compared to those from the upgradient well. The comparison is made in accordance with the OLF M&M Plan, using the ANOVA procedure. These results are summarized in Table 7. Only uranium exceeds the RFLMA Attachment 2, Table 1 standard (Appendix A of this report), but does not exceed the uranium threshold in RFLMA Attachment 2, Figure 8 (Appendix A of this report). Typically there are higher concentrations of uranium in ground water relative to surface water. The natural uranium concentrations are seen to vary dramatically over very short distances. Special analytical methods (i.e., HR ICP/MS or TIMS) will be employed in 2007 to determine whether the ground water here is affected by anthropogenic (manmade) uranium.

6.6.7 Ecological Sampling

RFLMA Attachment 2, Table 5 (Appendix A of this report) requires a minimum of three quarterly water samples at Ponds A-4, B-5, and C-2 for radium-228, cyanide, and ammonia in support of ecological objectives. The first of these sampling events at Pond C-2 was performed on February 12, 2007, and at Ponds A-4 and B-5 for radium-228 and ammonia on February 12, 2007, and for cyanide on March 19, 2007.

RFLMA also requires one sediment sample at these three ponds for the same analytes. Sediment sampling has not yet been performed for CY 2007.

6.7 Inspection of the Central OU

RFLMA Attachment 2, Sections 5.3 and 5.4, specifies the remedy M&M requirements, which includes the periodic inspections and monitoring of particular aspects of the remedy components, including quarterly and annual inspection.

Since ongoing inspections are required by RFLMA, this five-year review focused on whether the periodic inspections were being conducted and reported, and whether changes to certain inspection frequencies should be recommended. This section briefly summarizes these ongoing inspection activities.

6.7.1 PLF and OLF

Inspections of the OLF and PLF were conducted in accordance with the applicable Landfill M&M Plans, as specified in RFLMA Attachment 2, Table 3, "Present and Original Landfill Inspection and Maintenance Requirements" (Appendix A of this report). The results of these inspections are reported as required in the CY 2006 Annual Report of Site Surveillance and Maintenance Activities (DOE 2007d), and will be reported in subsequent Quarterly and Annual Reports. RFLMA Attachment 2, Table 3 (Appendix A of this report) specifies that the frequency of the following PLF and OLF inspection activities be evaluated during the CERCLA periodic review:

- Final cover inspection and monitoring is performed monthly for the first year, and the vegetation and settlement monuments are inspected monthly from April through September and quarterly the remainder of the year.

- Covers are also inspected after 1 inch or more of rain in 24 hours, or after significant snowmelt of a 10-inch or more snowfall.
- The stormwater management system and erosion control features are also inspected monthly and after significant rainfall or snowmelt.

The recommendations regarding changes to the frequency are discussed in Section 8.0 of this report.

6.7.2 Water Monitoring Network

Inspections of the surface water monitoring stations, ground water monitoring wells, and ground water treatment system components are routinely performed by staff as part of each sampling or maintenance event. The status of any required actions to address deficiencies found during routine operational inspections of the monitoring stations, wells, and treatment systems are also reported as required in the CY 2006 Annual Report of Site Surveillance and Maintenance Activities (DOE 2007d), and will be reported in subsequent Quarterly and Annual Reports.

6.7.3 Slump South of Former Building 991

A slump south of the location of former Building 991 on the south side of FC-4 developed in 2006 and its progression is being monitored. During expansion and development of the Rocky Flats Protected Area in the late 1970s-early 1980s, a valley south of former Building 991 was filled to provide a uniform surface that would be easier to monitor for security purposes. A French drain was installed at the base of the up to 30 feet of fill to stabilize the artificial hillside that was constructed in the former valley, and the drain was equipped with an outfall that was later given the identification SW056. Water samples collected from the outfall showed elevated concentrations of VOCs, including PCE, TCE, cis-1,2-dichloroethene, and vinyl chloride.

As part of Rocky Flats closure it was necessary to address this outfall, because water flowed directly from it into the future FC-4 wetland. The action that was agreed upon by the closure contractor, DOE, and the regulators was to remove the outfall portion of the drain, interrupt the east-west portion of the drain, and backfill the interrupted portion with lower-permeability materials (cement grout) and hydrogen releasing compound (HRC). One additional requirement was to install a monitoring well immediately downgradient (north) of the east-west drain and upgradient (west) of the point at which that drain had been interrupted. That well is Sentinel well 45605. Because the drain outfall has been removed, water that is collected by the remaining portion of the French drain to the west has no defined outlet. This has allowed the collected ground water to saturate the artificial hillside, causing it to become destabilized.

Slumping was first apparent in early January 2006 when small cracks were observed across the surface of the ground where the excavation formed to remove the outfall and interrupt the drain had been backfilled. These cracks broadened, extended, and multiplied throughout the year, accompanied by increasing horizontal and vertical displacement. Appendix C contains a photograph of this area.

A resolution has been devised based on the consultative process with the regulators. Because protecting the integrity of this hillside is not necessary to protect the remedy itself, the slump is being allowed to stabilize. When movement stops or is sufficiently reduced to allow it, the

hillside will be regraded and seeded to address safety and aesthetic concerns. If necessary, Sentinel well 45605 will be replaced after regrading has been completed.

6.7.4 Inspection of Other Remedy Components

In addition to the above inspections and monitoring occurring periodically throughout the year, an annual inspection and monitoring of other remedy components was conducted in accordance with RFLMA Attachment 2 on March 19, 2007, and the results are summarized in this section.

The following three categories were inspected or monitored during the March 19, 2007, inspection:

- Evidence of significant erosion in the Central OU and evaluation of the proximity of significant erosion to subsurface features in RFLMA Attachment 2, Figures 3 and 4 (see Appendix A). This monitoring included visual observation for precursor evidence of significant erosion (cracks, rills, slumping, subsidence, sediment deposition, and so forth);
- The effectiveness of institutional and physical controls as determined through any evidence of the violation of any of these controls; and
- Evidence of adverse biological conditions, such as unexpected morbidity or mortality, observed during the inspection and monitoring activities.

This inspection of the surface of the Central OU was scheduled to allow reporting in the RFLMA-required 2007 First Quarterly Report of Site Surveillance and Maintenance Activities. This inspection was also scheduled to allow adequate observation of surface features after snow cover had melted and the surface was dry enough to avoid muddy conditions and before vegetation growth might obscure land surface features. The results of the annual inspection items are therefore included in this Five-Year Review Report.

The installation of perimeter signs was ongoing at the time of this inspection because the installation of the barbed wire fence on which the signs are mounted was not fully completed along the Woman Creek portion on March 19. Subsequent inspections between March 20 and March 30, 2007, were conducted to ensure that all signs were in place as the fencing was completed. Appendix C contains photographs of the installed signs.

To conduct this work, knowledgeable DOE and S.M. Stoller team staff members (the inspection team) walked down the Central OU surface to observe the conditions. The areas walked down were designated as Areas A through E and are shown on the map included in Appendix B. These areas generally coincided with the location of the subsurface features in RFLMA Attachment 2, Figures 3 and 4 (Appendix A of this report), or afforded adequate viewing of the surface in these locations (for example, sloping areas). Several team members were assigned to walk down a particular area or areas identified on the maps. Reference points, such as well heads and roads, were used to orient the team members within designated inspection areas.

The completed inspection checklists and several photographs illustrating noted conditions are also included in Appendix B of this report.

Marker flags were placed at locations where conditions showed evidence of the three condition categories listed above to track their location for follow-up by site subject matter experts. Rocky

Flats field operations subject matter experts subsequently visited the areas, made minor repairs, collected debris items, and determined that the items were not significant indications of erosion or exposure of the subsurface. Several areas were noted with evidence of erosion, possible depressions, or holes, but these appeared to be minor and of very limited areal extent.

Marker flags were also placed in areas where pieces of debris or trash were noticed so that these could be picked up in the future.

No evidence of violations of institutional or physical controls was observed.

On March 26, 2007, a team member verified that the Environmental Covenant for the Central OU remains in the Administrative Record and on file with the Jefferson County Planning and Zoning Department.

Based on the foregoing recap, it appears that RFLMA-required inspections have been conducted and will be conducted on an ongoing periodic basis in the future.

6.7.5 Adverse Biological Conditions

The March 19, 2007, inspection did not result in any observation of any adverse biological condition, but subsequent to that it was noted that the Central OU fence was a hazard to mule deer apparently unaware of its presence. On March 27, 2007, it was noted that three mule deer became entangled in the fence and died as a result. This was reported to CDPHE in accordance with RFLMA Section 6.0, "Action Determinations." Based on subsequent RFLMA Party consultations, which included site visits by USFWS personnel to observe the fence construction, marker tags designed to make the fence more visible were installed (DOE 2007e). The fence was repaired where damaged and evaluation of this condition is continuing. No adverse conditions have been noted since the flags were installed.

6.7.6 Inspection of RCRA Well Sampling

CDPHE also observed the routine scheduled sampling of RCRA wells associated with the PLF on April 19, 2007. The CDPHE observations are included in Appendix B of this report. O&M Inspections are conducted on a triennial schedule as required by RCRA inspection national core program requirements for Land Disposal Facilities, which CDPHE has agreed to implement in a CDPHE/EPA RCRA Hazardous Waste Program Memorandum of Agreement dated September 11, 2000.

6.8 Review of O&M Costs

The O&M cost of the selected remedy was estimated in the RI/FS and presented in the Proposed Plan. The total annual estimated O&M costs were $2,575,000, with ground water treatment system media replacement estimated at $728,000 every five years. The ETPTS media was replaced in 2006. The actual remedy related-implementation cost for 2006 was approximately $3,000,000, which is not substantially different from the estimated costs.

6.9 Review of New Technologies

The five-year review process includes an evaluation of additional response actions that would reduce the need to rely on institutional controls. Since the remedy has only recently been implemented, and response action alternatives were considered in the 2006 RI/FS, the evaluation for this second five-year review was limited to possible new technologies that could address ground water contamination. Institutional controls related to ground water contamination prohibit the use of surface water for drinking water or agricultural purposes, the construction or operation of ground water wells (except to support the remedy), and the construction of buildings for occupancy purposes.

The CAD/ROD required ground water treatment systems designed to remove VOCs, nitrate, and uranium. Alternatives and enhancements to possibly improve ground water quality and reduce stream loading beyond that achieved by the current ground water treatment systems were evaluated in the IM/IRA for Ground Water (June 2005) (GW IM/IRA). No new treatment technologies or approaches that would take the place of the installed treatment systems were identified.

The GW IM/IRA concluded that enhancements by a one-time application of HRC to accelerate in situ biodegradation of VOCs, and the planting of cottonwood and willow stakes for phytoremediation where appropriate would have a positive long-term impact on ground water and/or surface water quality. These actions were implemented in 2005.

Given the short time period since completion of the IM/IRA evaluation, no significant technology improvements have been identified in literature searches; however, refinements to the existing systems may potentially assist in treating contaminants more cost effectively.

A treatability study is underway to determine whether a simpler, more efficient (from a cost, space, and treatment perspective) and less management-intensive system could be designed and installed at the SPPTS. Potential relocation of the SPPTS to improve plume capture and treatment is also being investigated. This study is discussed in more detail in Section 8.0.

Two items noted in the literature review might prove promising in the future:

- Potential direct injection of HRC, nano-scale zero-valent iron, or chemical oxidation products (e.g., ReGenOx) for treatment of VOCs at identified source areas conducive to direct-push injection technology; and
- Metals reduction bioremediation technologies to enhance in-situ treatment of uranium in ground water. Dissimilatory metal-reducing microorganisms can influence the biogeochemical cycles of some trace metals, including uranium, by using these metals as electron acceptors (ASM 2002). One example product is Metals Reduction Compound marketed by Regenesis.[15] There may be other products in the future that use dissimilar metal-reducing microorganisms that may be useful in treating metals, possibly including uranium.

[15] Website is: http://www.regenesis.com/products/chroImm/mrc.

At this early stage of remedy implementation, there do not appear to be any significant opportunities to improve performance, reduce costs, or reduce the need to rely on institutional controls. However, evaluation of future opportunities will continue and will be identified in subsequent five-year reviews as required by RFLMA.

7.0 Technical Assessment

This section provides the answers, as well as the basis and rationale for those answers, to the following Technical Assessment questions:

- Question A—Is the remedy functioning as intended by the decision documents?
- Question B—Are the exposure assumptions, toxicity data, cleanup levels, and RAOs still valid?
- Question C—Has any other information come to light that would call into question the protectiveness of the remedy?

Relevant information obtained as described in Section 6.0, "Five-Year Review Process," was evaluated to determine the answers to these questions.

7.1 Question A—Is the Remedy Functioning as Intended?

Yes, the remedy is functioning as intended.

Remaining contamination is effectively contained and the institutional and physical controls are in place to prevent unacceptable exposures. The landfill covers are being maintained as required and the ground water treatment systems are operating properly and successfully to collect and treat contaminated ground water, reducing the contamination load to surface water. RFLMA monitoring and inspections are being conducted as required. RFLMA reporting and consultation requirements to develop and conduct timely mitigation if necessary are being followed. A summary of the remedy components and the RFLMA implementation status is presented in Table 8.

The normal performance of the treatment systems meets design requirements for the contaminants selected for treatment, recognizing that periodic repairs, maintenance, and treatment media replacement (except for the PLFTS) will interrupt normal operation for short periods of time. A treatability study is underway to determine whether enhancements or modifications to the SPPTS are feasible, or a simpler, more efficient, and less management-intensive system could be designed and installed in place of the SPPTS. Repairs to the OLF cover and perimeter channel slumping and cover surface cracks and berm erosion are being conducted under the OLF M&M Plan and evaluation of seeps on the cover is ongoing. Improvements to the cover may be possible to enhance performance and reduce the need for repairs in the long term. At this early stage of remedy implementation, there do not appear to be any other significant opportunities to improve performance, reduce costs, or reduce the need to rely on institutional controls.

There are no changes to ARARs or new standards that have been promulgated that call into question the protectiveness of the remedy. ARARs are being met based on the implementation status of ARARs, presented in Table 6.

The costs to conduct the activities identified in the cost estimate from the time of completion of cleanup and closure activities (late 2005) through the end of 2006 are consistent with the estimate, also indicating the remedy is performing as expected.

However, several early indicators of potential issues have been identified during this review, which are discussed in Section 8.0. At this time it does not appear that these items will present significant problems in maintaining continuing remedy protectiveness. DOE will continue to follow the RFLMA consultative process for planning and taking appropriate mitigation actions if necessary.

7.2 Question B—Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Still Valid?

Yes, these aspects of the remedy are still valid.

No changes in exposure pathways or assumptions have been identified that could call into question the protectiveness of the remedy. The Central OU land use is consistent with the Rocky Flats Wildlife Refuge land use assumption in the CAD/ROD. The Wildlife Refuge has been established in the land surrounding the Central OU. There are no significant changes to the Rocky Flats Site physical conditions since the final land surface configuration that removed impermeable surfaces and the stormwater conveyances, constructed FCs, and graded the surface as needed to establish a stable configuration was completed prior to the CAD/ROD. The hydrologic effects of this work are not expected to be fully realized for many years after the usual annual and seasonal ranges of precipitation have occurred. At this early stage of remedy implementation, Rocky Flats conditions appear reasonably consistent with those expected.

The type and extent of worker activities in the Central OU are consistent with the CRA exposure scenario for workers conducting required M&M activities. The duration of time spent on site to perform activities appears to be somewhat less than the duration used in the exposure scenario.

There have not been any changes in standardized risk assessment methodologies. There have not been any changes to toxicity factors for COCs or ECOPCs for which risk was evaluated in the CRA and there are no changes to contaminant characteristics that could call into question the protectiveness of the remedy.

The RAOs and ARARs used at the time of remedy selection are still valid to address the contaminated media and pathways of potential exposure and provide continuing remedy protectiveness. Not all RAOs are currently met; however, the remedy is designed to achieve all RAOs in the long term. The current status of RAOs falls into one of four categories: (1) RAOs met at the time of the CAD/ROD that continue to be met; (2) RAOs not met at the time of the CAD/ROD that are now met through implementation of institutional and physical controls; (3) RAOs that are not met but progress toward meeting them is being monitored; and (4) RAOs that were met at the time of the CAD/ROD and are not met now but progress toward meeting them is being monitored.

The status of each RAO is as follows:

- Ground Water RAO 1—Meet ground water quality standards, which are the Colorado WQCC surface water standards, at ground water AOC wells.

  This RAO was met at the time of the CAD/ROD for the wells identified in the FY 2005 IMP and the RI/FS as AOC wells. The status for those AOC wells has not changed since the CAD/ROD because there are no RFLMA reportable conditions after the CAD/ROD

based on sampling results through December 31, 2006. However, changes to the AOC monitoring network have occurred during remedy implementation and the RAO is not continuously met at all AOC well locations. Two existing wells were identified as Sentinel wells in the FY 2005 IMP, and in the RI/FS, however, these wells were reclassified as AOC wells in RFLMA. During the RI/FS evaluation, ground water samples from one of these wells (well B206989, located east of the Landfill Pond) did not meet the RAO for nitrate and uranium, which is still the case as of the end of 2006. Also, for the most recent semiannual samples as of December 31, 2006, AOC well 10594, which is located below Pond A-1, did not meet the RAO for uranium. Evaluation of the subsequent semiannual AOC sampling results will be made in accordance with RFLMA Attachment 2, Figure 7 (Appendix A of this report).

The status does not call into question the protectiveness of the remedy because the RFLMA Action Determination process is intended to address the need for mitigating actions, if any, in a timely manner. Progress toward meeting this RAO at all AOC locations will continue to be monitored.

- Ground Water RAO 2—Restore contaminated ground water 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 ground water Sentinel wells. Prevent significant risk of adverse ecological effects.

  The status has not changed since the CAD/ROD. The first part of Ground Water RAO 2 (restore contaminated ground water to its beneficial use) is not met at all Sentinel wells. It is not expected to be met for many years, thus RFLMA-required ground water treatment system O&M will continue. However, the final remedy decision recognized that no additional removal, containment, or treatment actions were practicable. Progress toward meeting this RAO will continue to be monitored. The second part of Ground Water RAO 2 (prevent significant risk of adverse ecological effects) was met at the time of the CAD/ROD and contaminant concentrations have not changed significantly since the CAD/ROD.

- Ground Water RAO 3—Prevent domestic and irrigation use of ground water contaminated at levels above MCLs.

  At the time of the CAD/ROD, this RAO technically was not met because there was no formally required control in place to prevent ground water use. Institutional controls required by the CAD/ROD have since been implemented and, thus, this RAO is now met.

- Surface Water RAO—Meet surface water quality standards, which are the Colorado WQCC surface water standards.

  The status has not changed since the CAD/ROD. This RAO was met at the time of the CAD/ROD at the POCs. However, the CAD/ROD also recognized that surface water in the Central OU does not always meet Colorado surface water quality standards at surface water monitoring points upstream of the Rocky Flats terminal ponds, such as at POE GS10 and the performance monitoring station GS13 for uranium. Progress toward meeting this RAO will continue to be evaluated in accordance with RFLMA Attachment 2.

- Soil RAO 1—Prevent migration of contaminants to ground water that would result in exceedances of ground water RAOs.

  This RAO was not met at the time of the CAD/ROD. The status has not changed since the CAD/ROD. This RAO is not met everywhere in the Central OU. Some remaining subsurface contamination has complete pathways to surface water (via ground water) resulting in samples that are above surface water standards at a number of Sentinel wells for VOCs, nitrate, and uranium. However, the final remedy decision recognized that no additional removal, containment, or treatment actions were practicable. Progress toward meeting this RAO will continue to be evaluated in accordance with RFLMA Attachment 2.

- Soil RAO 2—Prevent migration of contaminants that would result in exceedances of surface water RAOs.

  The CAD/ROD recognized that this RAO is met if residual contamination in surface soil is not disturbed, as the fate and transport evaluation found that two soil contaminants (plutonium-239/240 and americium-241) have complete pathways to surface water if soil is allowed to migrate. Institutional controls are now in place to prohibit soil disturbance unless controls are being followed to limit contaminated soil migration. Institutional controls required by the CAD/ROD have been implemented and, thus, this RAO is now met.

- Soil RAO 3—Prevent exposures that result in unacceptable risk to the WRW. The 10^{-6} risk level was used as the point of departure for determining remediation goals for alternatives when ARARs were not available or were not sufficiently protective because of the presence of multiple contaminants at Rocky Flats or multiple pathways of exposure (40 CFR 300.430[e][2][i][A][2]). Prevent significant risk of adverse ecological effects.

  At the time of the CAD/ROD, Soil RAO 3 was determined not to be met for human health unless all exposure assumptions inherent in the CRA are met. In addition, for subsurface soil, the CRA concluded that the indoor air pathway is potentially significant if buildings were constructed and occupied in portions of the Central OU where there are exceedances of volatilization WRW PRGs in subsurface soil and ground water. The ERA indicated that soil conditions do not represent significant risk of adverse ecological effects, so this RAO is met for the environment.

  Institutional and physical controls required by the CAD/ROD have been implemented and exposures are within the scenario assumptions. Thus, this RAO is now met.

7.3 Question C—Has Any Other Information Come to Light That Could Call Into Question the Protectiveness of the Remedy?

No. No other information has come to light that could call into question the protectiveness of the remedy.

8.0 Issues, Recommendations, and Follow-Up Actions

The review identified several issues that are briefly discussed in this section. Recommendations regarding these issues and recommendations regarding continuing, modifying, or discontinuing the remedy components as required by RFLMA Section 7.3 and Attachment 2, Table 3 (Appendix A of this report) are also presented in this section. Follow-up actions are included with the recommendations. Table 9 presents a summary of these issues, recommendations, and follow-up actions.

8.1 Recommendations Resulting From the Review

The issues and recommendations that resulted from this review are described below.

GS10 Uranium Concentrations—The 12-month rolling average uranium concentrations at the POE at GS10 are above the surface water standard. Based on previous studies, the contamination is primarily due to natural uranium in the ground water in this area and the increase in the proportion of ground water in the total flow volume resulting from the post-closure reduction in surface water runoff. It is recommended that the planned HR ICP/MS or TIMS analysis of samples be completed to determine whether natural uranium isotopic signatures have significantly changed. Institutional and physical controls prevent exposure and the GS10 uranium concentrations are well below WRW PRGs; therefore, these levels do not impact the protectiveness of the remedy.

Uranium Concentrations at OLF Wells—By the end of 2007, it is expected that a sufficient number of samples will have been collected from downgradient wells to enable the performance of the required statistical evaluations of water quality. Of the analytes being measured, only uranium at one OLF downgradient location (well 80205) exceeds the surface water standard (but not the ground water threshold). It is recommended that the planned HR ICP/MS or TIMS analysis of samples be completed to determine whether isotopic signatures indicate this is predominantly natural uranium. Based on acceptable downgradient surface water quality there is no impact of the well uranium concentration on the protectiveness of the remedy. If statistical evaluation of future samples triggers further investigation, it is expected that the RFLMA consultative process to determine the appropriate response will ensure the remedy remains protective.

Sentinel Well 45605—The slump south of former Building 991 on the south side of FC-4 has moved the Sentinel well 45605 casing out of vertical. This is expected to eventually damage the well so that it could not be used for monitoring purposes. It is recognized that this slump does not affect the protectiveness of the remedy because it is not in the vicinity of any subsurface contaminated structures, the well is still capable of being sampled, and regrading of this area is anticipated after movement in the area stops. It is recommended that this well be replaced as soon as possible after conditions stabilize to obtain required samples over the long term to evaluate ground water conditions as intended by the remedy.

Water Quality Standards Changes—Changes to RFLMA surface water standards for arsenic, copper, and uranium may be promulgated by the Colorado WQCC upon completion of the triennial review for the Big Dry Creek Basin in 2009. Also, the existing temporary modifications

to the standards for nitrates and certain VOCs incorporated in the RFLMA surface water standards are set to expire in 2009.

While the SPPTS effluent during normal operation of the system meets surface water standards, samples at downstream surface water station GS13 contain nitrates at concentrations that would exceed the basic standard of 10 mg/L when the temporary modification of 100 mg/L expires and contains uranium at concentration above the surface water standard of 10 pCi/L. This is believed to be due to commingling of the treated effluent and contaminated ground water not captured by the plume intercept and treatment system that becomes baseflow in this area.

The impacts of any changes to standards at the time of completion of the WQCC triennial review will depend on the results of continuing remedy implementation activities. Assuming contaminant concentration levels do not substantially change, the most likely impacts will be in relation to meeting the ground water RAOs and surface water RAO for nitrate at some SPPTS monitoring locations, and for arsenic at the PLFTS. Intermittent exceedances of VOC standards after the current temporary modifications expire may also be encountered at the other ground water treatment systems. However, these impacts would not call into question the continuing remedy protectiveness because institutional and physical controls to prevent exposure and the quality of surface water leaving Rocky Flats is still expected to meet standards. It is recommended that DOE should actively participate in the triennial review process to identify issues and collect and provide any necessary data to the WQCC for its decision-making process.

OLF Cover—The OLF cover has two seeps and minor slumps and slides on the surface that need to be addressed and repaired as necessary to continue to meet the cover design criteria. It is recommended that the engineering evaluation of the possible causes and long-term actions be completed and the repairs be made in a timely manner. Inspections should be continued at least on a monthly basis until the cover repairs are determined to be successful. Cover repairs should be made in accordance with the OLF M&M Plan so that design criteria continue to be met. Seeps should be monitored to ensure they are not leading to ponding water on the cover or contributing to unacceptable subsidence or slides that would reduce cover effectiveness. Investigation of options to direct seep flows to assist drainage of these wet areas off the landfill cover and implementation of needed repairs (when or if required) should be made. Implementation of the OLF M&M Plan monitoring, inspection, and repair requirements ensures the continuing protectiveness of the remedy. The results of the engineering evaluation and completion of any actions resulting from the evaluation will ensure that the performance of the cover maintains protectiveness over the long term.

SPPTS Treatability Study—The treatability study should be completed. The possible commingling of treated and untreated ground water at the discharge gallery area should also be considered. It is recommended that if the results of these activities indicate that system improvements and minimizing untreated water at the discharge gallery are feasible, modifications should be proposed in accordance with RFLMA Part 10. However, operation of the current system configuration does not impact the continuing remedy protectiveness because institutional and physical controls prevent exposure, the system continues to reduce uranium and nitrate loading of surface water, and the quality of surface water leaving Rocky Flats is still expected to meet standards. Uranium and nitrate concentrations are well below WRW PRGs and these levels do not impact the protectiveness of the remedy.

8.2 Recommendation Regarding Remedy Components

Because the remedy has been in place for a short period, the remedy components should be continued in accordance with RFLMA implementation requirements with one exception related to the landfills.

RFLMA Attachment 2, Table 3 specifies that the inspection frequency of the final cover and stormwater management systems for the OLF and PLF be evaluated in the CERCLA periodic review. Under the M&M Plans, monthly inspections have been ongoing since June 2006 and were required to be conducted for one year and then evaluated. Because the PLF inspections indicate that the cover and stormwater management systems do not indicate the need for any repairs, it is recommended that the frequency be reduced to quarterly.

Because repairs to the OLF cover are being planned and the repairs and work to address the seeps in the cover are ongoing, no change to the monthly inspection frequency is recommended at this time.

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9.0 Protectiveness Statement

The remedy for the Central OU is protective of human health and the environment, and exposure pathways that could result in unacceptable risks are being controlled.

End of current text

10.0 Next Review

Contaminants at the Central OU are expected to remain at levels that do not allow unrestricted use and will require continued remedy implementation for the foreseeable future. Thus, a third five-year review will be required.

The next five-year review report will be submitted to EPA for concurrence by August 1, 2012.

End of current text

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Figures

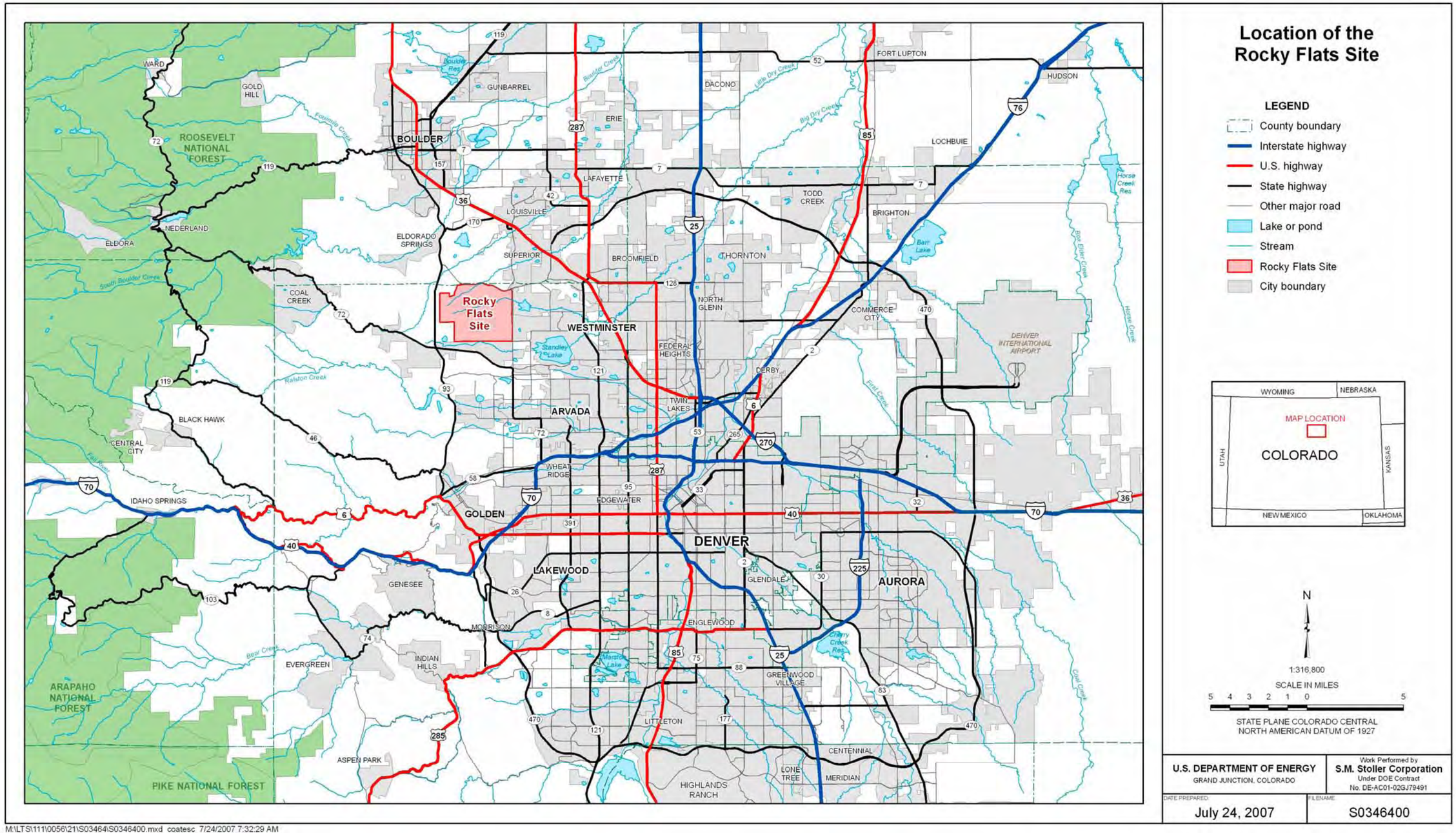

Figure 1. Location of the Rocky Flats Site

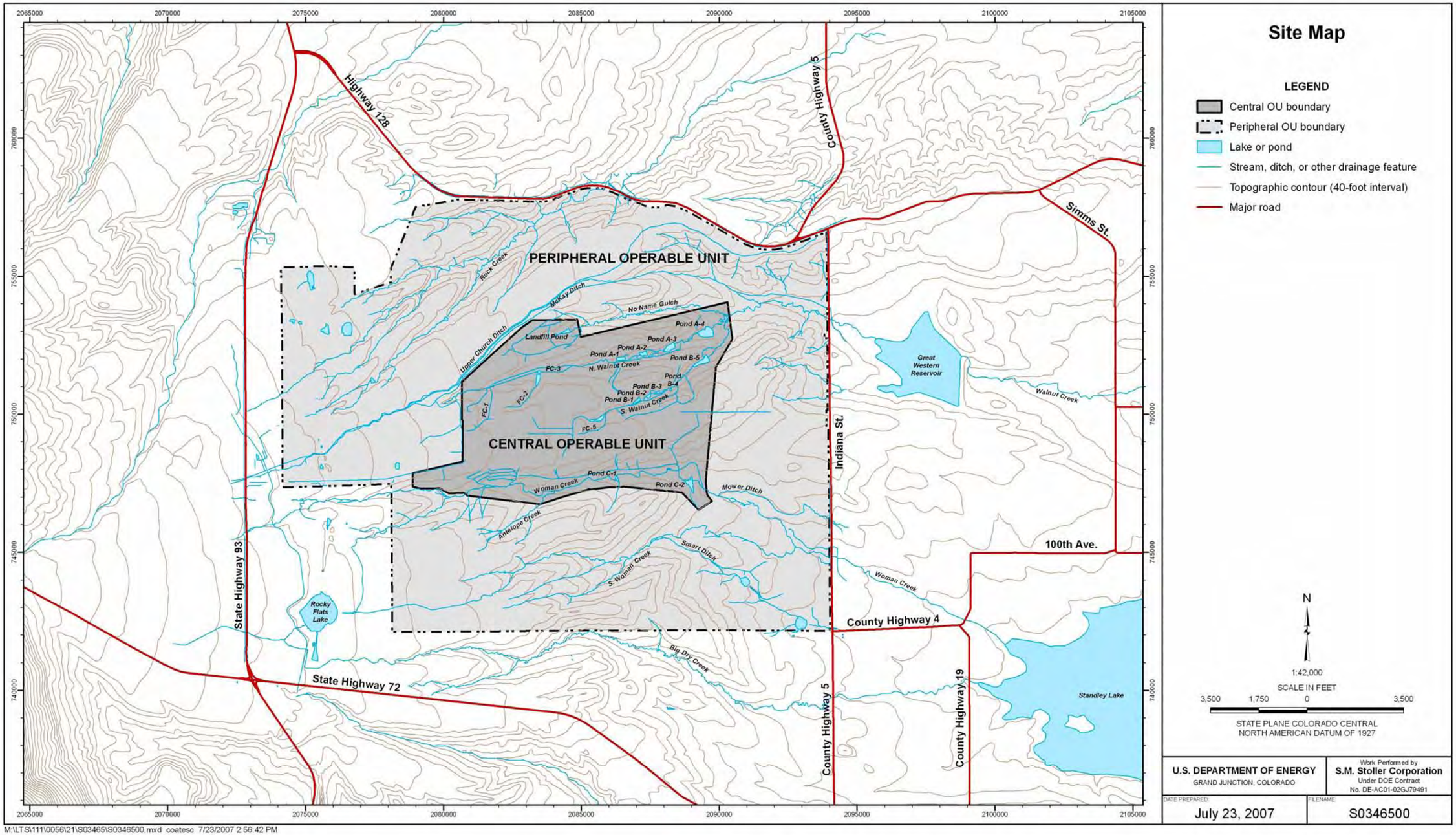

Figure 2. Site Map

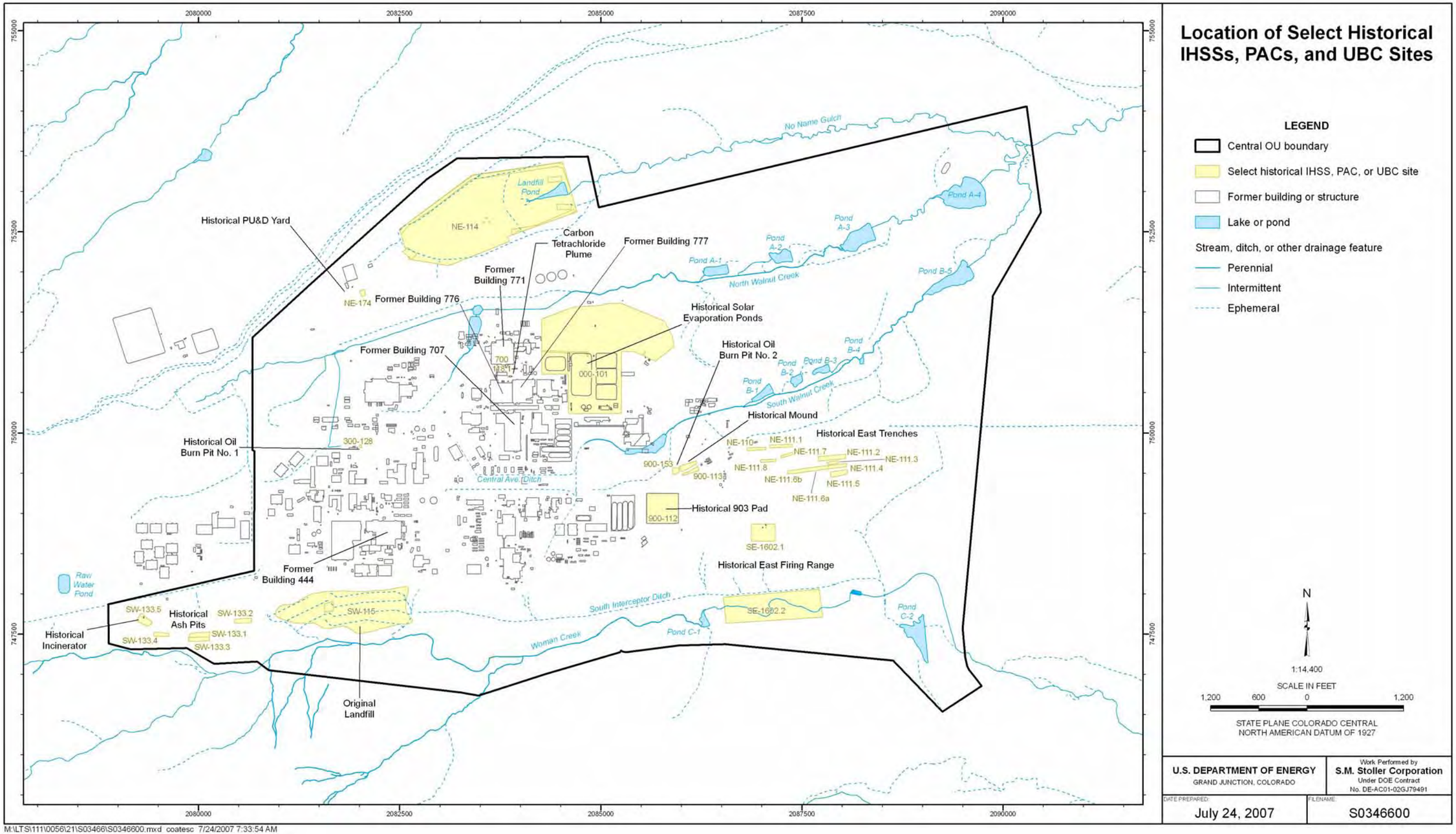

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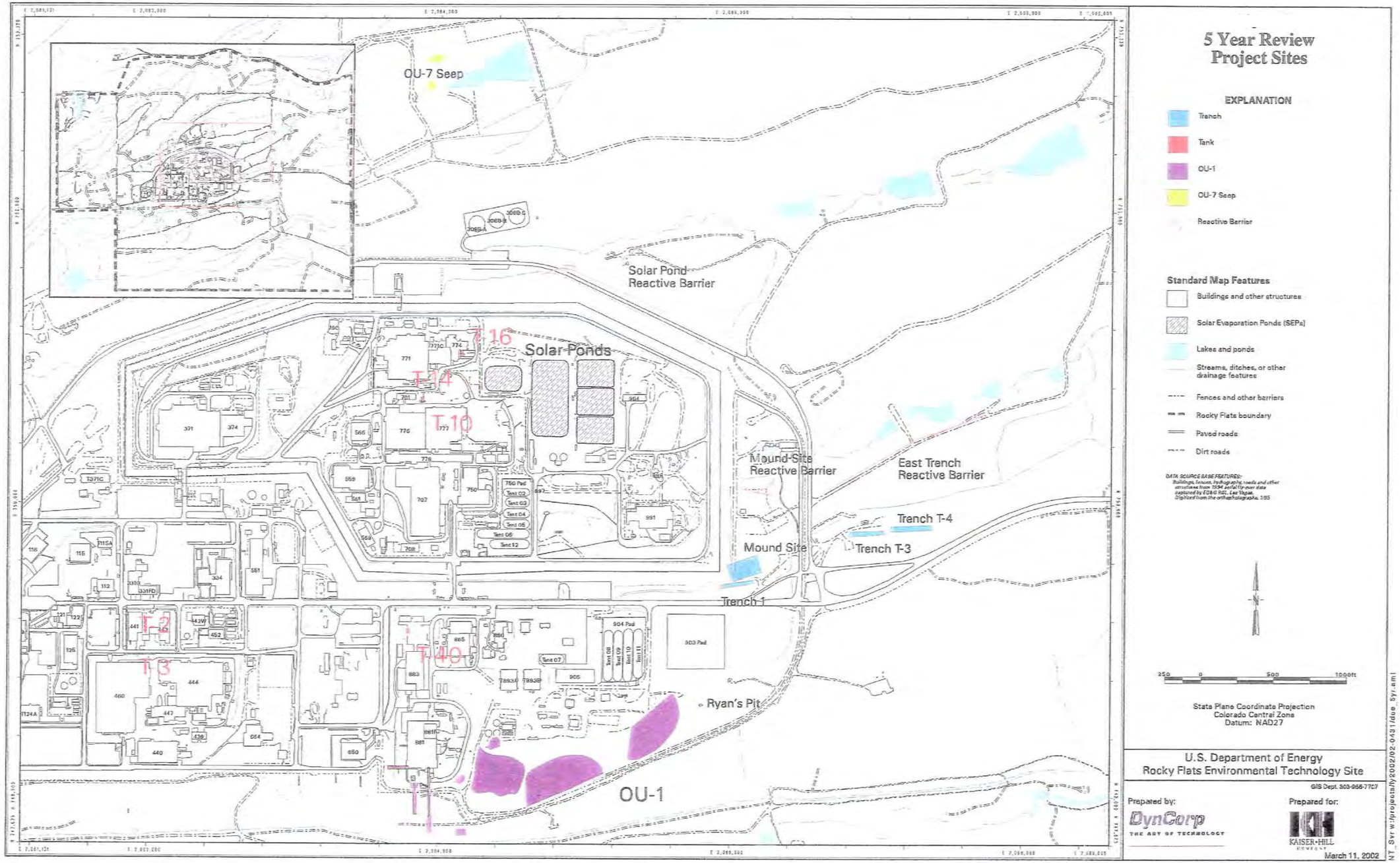
Figure 3. Location of Select Historical IHSSs, PACs, and UBC Sites



Source: First Five-Year Review Report for Rocky Flats Environmental Technology Site, July 2002

Figure 4. Five-Year Review Project Sites

Tables

Table 1. Rocky Flats Site Remediation Chronology

Date	Event
April 1952	Operations began at Rocky Flats on production of a plutonium component for use in atomic weapons.
September 1957	A fire in Building 771 caused extensive contamination to the building and release of some plutonium to the environment.
1967	Waste oil drums being stored outdoors on the 903 Pad leaked, contaminating several acres of soils with plutonium, machining lubricants, and chlorinated solvents.
May 1969	A plutonium glovebox fire that started in Building 776 spread to several hundred connected gloveboxes in Building 776 and Building 777. This caused extensive damage and contamination to the buildings and release of some plutonium to the environment.
1968-1970	Some of the radiologically contaminated material was removed from the 903 Pad and Lip Area, some of the surrounding Lip Area was regraded, and much of the area was covered by an imported base coarse material. Contaminated soil became windborne and contaminated the area east of the 903 Pad. An asphalt cap was placed over the most contaminated area of the Pad.
September 1973	A tritium release was discovered in a water sample collected from Woman Creek by the Colorado Department of Public Health and Environment (CDPHE).[16] A U.S. Environmental Protection Agency (EPA) report indicated that 50 to 100 curies of tritium reached Great Western Reservoir, just east of Rocky Flats.
September 1984	Cleanup of a 0.25-mile strip of soil on the 903 Lip Area was conducted.
July 1986	A Compliance Agreement was entered into between the U.S. Department of Energy (DOE), EPA, and CDPHE that defined roles and established milestones for major environmental operations and response actions at Rocky Flats. These efforts identified over 2,000 waste generation points and 178 Solid Waste Management Units (SWMUs) and Resource Conservation and Recovery Act (RCRA)/Colorado Hazardous Waste Act (CHWA)-regulated closure sites.
June 1989	Federal Bureau of Investigation and EPA agents carried out a search warrant to search for evidence of alleged criminal violations of RCRA and the Federal Water Pollution Control Act.
September 1989	Rocky Flats was added to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List (NPL) of highly polluted sites destined for cleanup. This required DOE to enter into an interagency agreement with EPA for CERCLA site investigations and cleanup.
January 1990	Construction of a system began to remove chemical contaminants from ground water at the Operable Unit (OU) 1 – 881 Hillside Area, a designated high-priority cleanup site at the Plant. The action followed EPA and CDPHE approval of an Interim Measure/Interim Remedial Action Plan for OU 1.
January 1991	An Interagency Agreement (IAG) between DOE, CDPHE, and EPA was signed; the IAG replaced the 1986 Compliance Agreement. The agreement outlined multiyear schedules for environmental restoration investigations and remediation. The IAG designated the SWMUs as Individual Hazardous Substance Sites (IHSSs) and grouped them into 16 larger OUs.
November 1994	A no action Corrective Action Decision/Record of Decision (CAD/ROD) was issued for OU 16 (Low Priority Sites). This was the first OU to be officially closed out under the IAG.
October 1995	No action CAD/RODs were issued for OU 11 (West Spray Field) and OU 15 (Inside Building Closures).
July 1996	The Rocky Flats Cleanup Agreement (RFCA) was signed, which superseded the 1991 IAG. RFCA established the accelerated action framework, described the goals for cleanup and closure, and defined the regulatory approach for review and approval of work to ultimately delist Rocky Flats from the NPL. All buildings and IHSSs were to be dispositioned through accelerated actions. OUs were reconfigured into the Industrial Area and Buffer Zone OUs. Several IAG OUs were retained because progress toward CAD/RODs for those OUs was expected.
March 1997	A CAD/ROD for OU 1 was issued, requiring soil excavation, treatment of contaminated ground water, and institutional controls.
June 1997	A no action CAD/ROD for OU 3 was approved. OU 3 included land east of the Rocky Flats Site, Great Western Reservoir, Standley Lake, and Mower Reservoir.

[16] The Colorado Department of Health was replaced by the successor state agency, CDPHE. For simplicity, CDPHE is used throughout the report.

Table 1 (continued). Rocky Flats Site Remediation Chronology

Date	Event
September 2000	A major modification to the OU 1 CAD/ROD was issued, deleting the soil excavation requirement and providing criteria for ceasing ground water treatment and for continued monitoring based on further investigation results.
September 2002	The First Five-Year Review Report was issued. The review evaluated OU 1, OU 3, and several key accelerated actions at IHSSs, as well as the installed ground water treatment systems for the Mound Site, East Trenches, and Solar Ponds Plumes and the seep at the Present Landfill.
July 2006	The Sitewide Proposed Plan was released for public review and comment, with the supporting Remedial Investigation/Feasibility Study (RI/FS) Report. RFCA OUs were proposed for consolidation into the Central OU and Peripheral OU. The RI/FS Report documented conditions after completion of all RFCA accelerated actions, evaluated three remedial alternatives for the Central OU, and proposed no action for the Peripheral OU.
September 2006	The CAD/ROD for the Central OU was issued, requiring institutional and physical controls and monitoring. The no action CAD/ROD for the Peripheral OU was also issued. Construction completion was approved.
March 2007	EPA issued a Notice of Intent for Partial Deletion for the Rocky Flats Site to delete the Peripheral OU and OU 3 from the NPL.
May 2007	EPA published a Notice of Partial Deletion for the Rocky Flats Site, deleting the Peripheral OU and OU 3 from the NPL.
June 2007	EPA certified completion of cleanup and closure of Rocky Flats in accordance with the Rocky Flats National Wildlife Refuge Act of 2001 and DOE transferred jurisdiction and control of the Peripheral OU land, except for portions with permits for mining by subsurface mineral rights holders, to the U.S. Department of the Interior for refuge purposes under U.S. Fish and Wildlife Service administration.

Table 2. Nature and Extent of Contamination
(as presented in the July 2006 Proposed Plan)

Purpose: Shows the nature and extent of the analytes of interest (AOIs) by specific medium.

Soil—Screened Against Wildlife Refuge Worker (WRW) Preliminary Remediation Goals (PRGs) (Screening methodology, standards, and results are discussed in Section 3.0 of the RI/FS Report [DOE 2006a].)				
Surface soil	**Subsurface soil (0.5-3')**	**Subsurface soil (3-8')**	**Subsurface soil (8-12')**	**Subsurface soil (12-30')**
Radionuclides				
Americium-241 Plutonium-239/240 Uranium-233/234* Uranium-235* Uranium-238*		Americium-241* Plutonium-239/240 Uranium-235* Uranium-238*	Plutonium-239/240* Uranium-235* Uranium-238*	
Metals				
Aluminum Arsenic Chromium (Total) Vanadium*	Lead*	Chromium (Total)* Lead*	Chromium (Total)*	
Volatile Organic Compounds (VOCs)				
		Tetrachloroethene*	Tetrachloroethene*	Tetrachloroethene* Trichloroethene* 1,1,2,2-Tetrachloroethane* Carbon tetrachloride* Chloroform* Methylene chloride*
Semivolatile Organic Compounds (SVOCs)				
Benzo(a)pyrene Dibenz(a,h)anthracene	Benzo(a)pyrene	Benzo(a)pyrene*	Benzo(a)pyrene	
Polychlorinated Biphenyls (PCBs)				
PCB-1254 PCB-1260 Dioxins 2,3,7,8-TCDD TEQ				PCB-1260

Table 2 (continued). Nature and Extent of Contamination (as presented in July 2006 Proposed Plan)

Ground Water—Screened Against Surface Water Standards (Screening methodology, standards, and results are discussed in Section 4.0 of the RI/FS Report [DOE 2006a].)			
Upper Hydrostratigraphic Unit (shallow ground water)			
Radionuclides	**VOCs**	**Metals**	**Water Quality Parameters**
Uranium (sum of isotopes)	cis-1,2-Dichloroethene 1,2-Dichloroethane* 1,1-Dichloroethene Benzene* Carbon tetrachloride Chloroform Chloromethane* Methylene chloride Tetrachloroethene Trichloroethene Vinyl chloride	Arsenic (D) Chromium (T) Nickel (D) Nickel (T)	Fluoride Nitrate/Nitrite, as N Sulfate
Lower Hydrostratigraphic Unit (deep ground water)			
None			
Surface Water—Screened Against Surface Water Standards (Screening methodology, standards, and results are discussed in Section 5.0 of the RI/FS Report [DOE 2006a].)			
Radionuclides	**VOCs**	**Metals**	**Water Quality Parameters**
Americium-241 Plutonium-239/240 Uranium (sum of isotopes) Gross alpha Gross beta	cis-1,2-Dichloroethene Carbon tetrachloride Chloroform Methylene chloride Tetrachloroethene Trichloroethene Vinyl chloride	Aluminum (D) Beryllium (T) Chromium (T) Lead (T) Nickel (T)	Nitrate/Nitrite, as N
Sediment—Screened Against WRW PRGs (Screening methodology, standards, and results are discussed in Section 5.0 of the RI/FS Report [DOE 2006a].)			
Radionuclides	**Metals**	**SVOCs**	
Americium-241	Arsenic	Benzo(a)pyrene	
Plutonium-239/240	Chromium		
Air—Screened Against Air Emission Standards (Screening methodology, standards, and results are discussed in Section 6.0 of the RI/FS Report [DOE 2006a].)			
Radionuclides			
Americium-241 Plutonium-239/240 Uranium-233/234 Uranium-235 Uranium-238			

* = Indicates those soil AOIs that have a frequency of detection less than 1 percent above the designated standard or WRW PRG and were retained based on process knowledge that indicates the analyte is associated with Rocky Flats activities (such as uranium).
T = Total
D = Dissolved

Table 3. Remedial Actions Addressed in the First Five-Year Review Report

Project	IHSSs Involved	Description and Remedial Action Conducted
Operable Unit (OU) 1, 881 Hillside	102, 103, 104, 105.1, 105.2, 106, 107, 119.1, 119.2, 130, and 145	OU 1, also known as the 881 Hillside, was located generally south and east of Building 881 and north of Woman Creek. The primary contaminants of concern (COCs) in ground water at OU 1 are volatile organic compounds (VOCs) that leaked from drums and scrap metal that was stored in the area referred to as Individual Hazardous Substance Site (IHSS) 119.1. During 1992, construction was completed for the OU 1 Interim Measure/Interim Remedial Action French drain to contain, collect, and treat contaminated ground water in the Building 891 Consolidated Water Treatment Facility. In February 1997, a Corrective Action Decision/Record of Decision (CAD/ROD) for OU 1 addressed the contamination at IHSS 119.1 through soil excavation and ground water pumping. A major modification to the CAD/ROD in January 2001 eliminated the excavation of soils due to the contaminants being either nondetectable or present at only very low concentrations. Pumping and treating of ground water was discontinued in April 2002. Decommissioning of the French drain was accomplished in September 2000.
OU 3, Offsite Areas	199, 200, 201, 202, land surfaces, and reservoirs	OU 3 did not have a defined boundary, but rather referred to off-site contamination emanating from Rocky Flats in general, transported off site by wind and water. Plutonium and americium (a radioactive decay product of plutonium) were the COCs for OU 3. For all of OU 3, the highest calculated excess cancer risk was 3 in 1 million (3×10^{-6}), using reasonable maximum exposure for a residential scenario. The May 1997 OU 3 CAD/ROD selected a remedy of no action.
OU 7 Seep Accelerated Action	No IHSS number assigned.	The OU 7 seep accelerated action was located near the base of the east face of the Present Landfill (PLF). The landfill was operated for the purpose of disposal of solid wastes from 1968 until 1998. Slurry walls and a ground water diversion system, leachate collection system, and surface water diversion ditches were developed to control the generation and migration of landfill leachate. Above-background concentrations of VOCs, semivolatile organic compounds, total and dissolved metals, and radionuclides were detected in seep water. A passive ground water/seep collection system was installed with associated plumbing and a treatment vault containing granular activated carbon to remove the organic contaminants before discharging the water to the Landfill Pond. The system operated from May 1996 to October 1998. The primary contaminants detected above the established performance standards were benzene and vinyl chloride. The treatment system was modified in October 1998 to treat the seep water by passive aeration to reduce contaminants to meet surface water standards. (The system was replaced as part of PLF closure in 2005.)
Trench T-1 Source Removal	108	Historical documentation indicated that depleted uranium metal chips (lathe and machine turnings) originating from Building 444 were packed with lathe coolant and buried in the west end and possibly the east end of Trench T-1. A total of 171 drums or containers were removed from T-1 during excavation activities from June through August 1998. Radioactive metal wastes, cemented cyanide wastes, contaminated soils, decanted lathe coolant, debris, and intact drums containing depleted uranium and cemented cyanide were removed from the trench and properly dispositioned. When the removal was completed, approval was obtained from the U.S. Environmental Protection Agency to use the soils contained in 1,434 stored drums of investigation-derived material (soil that was generated during past remedial investigation drilling activities across Rocky Flats) as backfill.

Table 3 (continued). Remedial Actions Addressed in the First Five-Year Review Report

Project	IHSSs Involved	Description and Remedial Action Conducted
Trenches T-3 and T-4 Source Removal	110 and 111.1	Trenches T-3 and T-4 were used from approximately April 1964 to April 1967 to dispose of sanitary sewage sludge contaminated with uranium and plutonium and miscellaneous waste. T-3 and T-4 were sources of VOC (including carbon tetrachloride, tetrachloroethene [PCE], trichloroethene [TCE], and toluene) contamination in ground water. Approximately 3,796 cubic yards (yd^3) of contaminated soil and debris were removed from the trenches and processed using thermal desorption to remove VOCs, primarily carbon tetrachloride, TCE, and PCE. Remediation was completed August 19, 1996. All treated soil was returned to the excavation. Debris, including approximately 300 drum carcasses, was removed from T-3/T-4 and properly dispositioned.
Ryan's Pit, Trench 2 Source Removal	109	Ryan's Pit, also known as Trench 2, was used from approximately 1966 to 1970 for the disposal of VOCs and small quantities of debris (e.g., drum carcasses). It was identified as a significant contributor to the contamination of ground water in this area. The primary chemicals of concern included 1,1,1-trichloroethane, PCE, and TCE. Soil excavation was conducted between September 5 and 12, 1995, removing approximately 180 yd^3 of contaminated soil and debris, which was properly dispositioned. Soil was treated using low-temperature thermal desorption, returned to Ryan's Pit, and covered with the original, untreated topsoil.
Mound Site Source Removal	113	Approximately 1,405 drums containing uranium, beryllium, hydraulic oil, carbon tetrachloride, and PCE were placed at the Mound Site and covered with soil, creating a mound. Prior to the removal of the drums in 1970, some of the drums were known to have leaked, and the resulting contamination began impacting ground water. Approximately 400 to 1,000 yd^3 of soil from the site was excavated, temporarily stockpiled, and then treated using a low-temperature thermal desorption remediation technology. Treated soil was then used as backfill for the excavation. The treated soils were backfilled to the Mound Site between September 3 and 8, 1997, and the area was restored and revegetated. Approximately 3 yd^3 of soil were removed from the excavation on September 26, 1997, for disposition as low-level radioactive waste.
Mound Plume Accelerated Action	No IHSS number assigned.	Drums stored at the Mound Site leaked and VOC-contaminated ground water is found in monitoring wells between the Mound Site and South Walnut Creek, indicating the Mound Site is the primary source area for the plume. While 35 VOCs have been detected in the plume, PCE and TCE are the dominant contaminants. The Mound Site Plume Project employs a ground water barrier/collection and iron filings treatment system to remove chlorinated organic compounds and low levels of radionuclides. The single-membrane, impermeable containment barrier consists of high-density polyethylene (HDPE) that extends approximately 230 feet across the distal portion of the plume. Installation of the collection and treatment system was completed on September 18, 1998.
East Trenches Plume Accelerated Action	No IHSS number assigned.	The plume of VOC-contaminated ground water is derived from the East Trenches area, which includes Trenches T-3 (IHSS 110) and T-4 (IHSS 111.1). A component of the plume may also be derived from the VOC contamination at the 903 Pad where drums containing plutonium- and uranium-contaminated oils and solvents were stored from summer 1958 to January 1967. A ground water collection and treatment system was installed to capture, redirect, and treat contaminated ground water within treatment cells containing zero-valent iron. The system was completed on September 23, 1999. The ground water collection system extends approximately 1,200 feet in an east-west direction and captures and treats the majority of the contaminated ground water plume. The system consists of two HDPE tanks containing reactive iron, which degrades the dissolved chlorinated VOCs in ground water.

Table 3 (continued). Remedial Actions Addressed in the First Five-Year Review Report

Project	IHSSs Involved	Description and Remedial Action Conducted
Solar Ponds Plume Accelerated Action	No IHSS number assigned.	Operation of the Solar Evaporation Ponds (SEPs) resulted in contamination of the underlying and adjacent soils and shallow ground water with nitrates and uranium. The Solar Ponds Plume is a discontinuous area of ground water contamination that extends northeast from the SEPs to North Walnut Creek and southeast toward South Walnut Creek. The primary contaminants associated with the plume are uranium and nitrate. An interceptor trench system was constructed in 1981 and collected water was treated in Building 910 or Building 374. The current Solar Ponds Plume collection and treatment system was installed and placed into operation in 1999. The 1,100-foot-long collection system was installed within a ditch excavated 20 to 30 feet below land surface and approximately 10 feet into the underlying claystone. The Solar Ponds Plume system passes collected water through a two-stage treatment cell containing iron filings and wood chips, and discharges to a gallery near Walnut Creek. The final location of the treatment vessel was dictated by the nearby Preble's meadow jumping mouse habitat. The proximity of the habitat resulted in placing the treatment system directly adjacent to and on grade with the deepest portion of the collection system. This was a modification to the original planned location for the treatment cell. The resultant grade requires the accumulation of approximately 11 feet of water within the collection system before water will flow into the treatment vessel.
Solar Ponds Sludge Source Removal	101	The five SEPs were located in the northeastern portion of the former Industrial Area, and were used to process the Rocky Flats liquid waste streams from 1953 to 1986. The ponds were emptied and relined several times since their construction. The SEPs stored and evaporated process wastewater containing nitrates, neutralized acidic process waste, and low-level radioactive isotopes. The removal of sludge and water from all five ponds was conducted as a routine operation within a Resource Conservation and Recovery Act (RCRA) Interim Status Unit Undergoing Closure. This removed the potential continuing source of nitrate and uranium contamination that exists in soils and ground water beneath and adjacent to the SEPs. The material was transported via vacuum trucks to RCRA-permitted, 10,000-gallon plastic, double-walled tanks installed on the 750 Pad. The sludge was subsequently processed at the 750 Pad and disposed of off site.
Underground Storage Tank (UST) Source Removals	Tank 10 (IHSS Group 700-3), Tank 2 (IHSS Group 400-8), Tank 3 (IHSS Group 400-8), Tank 40 (IHSS Group 800-6), Tank 16 (IHSS Group 700-4), and Tank 14 (IHSS Group 700-4)	Six USTs were located within what was formerly known as OU 9, Original Process Waste Lines (OPWL). They were part of the OPWL network of tanks and underground pipes to transport and temporarily store process waste prior to treatment in Building 774. The tank contents (residual liquids and sludge) were removed and properly dispositioned. The tanks were filled with an inert closed-cell foam (polyurethane) to stabilize potential residual contamination, prevent ground water and surface water infiltration, and preserve tank integrity. The source removal actions were completed by September 30, 1996.

Table 4. Protectiveness Summary From the First Five-Year Review Report

OU/Accelerated Action	Protectiveness Assessment
Operable Unit (OU) 1, 881 Hillside	The remedy is protective.
OU 3, Offsite Areas	The remedy of no action is protective.
OU 7, Leachate Seep Treatment System	The accelerated action is protective and functioning as intended. Additional action is being planned for the Present Landfill itself which may impact the leachate treatment system.
Trench 1	The source removal action is protective. The depleted uranium waste contaminated with polychlorinated biphenyls currently does not have a treatment/disposal option identified.
Trench 3/Trench 4	The source removal action is protective.
Ryan's Pit, Trench T-2	The source removal action is protective.
Mound Site	The source removal action is protective.
Mound Plume	The reactive barrier and treatment system is protective and functioning as intended.
East Trenches Plume	The reactive barrier and treatment system is protective and functioning as intended.
Solar Ponds Plume	The existing configuration currently protects human health and the environment because there has been no impact to surface water compliance, but a change to the system is desirable to address the potential to bypass the treatment cell.
Solar Ponds Sludge Removal	The source removal action is protective. Additional action is being planned for the final remedy of the Solar Pond area.
Interagency Agreement Underground Storage Tank Source Removal	The source removal action is protective.

Table 5. Status of the First Five-Year Review Report Recommendations

Issue	Near-Term Recommendation	Long-Term Recommendation	Milestone Date	Affects Protectiveness?	Status
(Sitewide) Lack of definition of areas requiring access restrictions	Current access restrictions across the site are effective. However, new accelerated actions should provide a better description of areas above unrestricted use levels and should describe future long-term controls.	Unrestricted use levels and boundaries, and implementing mechanisms, should be defined in the Remedial Investigation/Feasibility Study (RI/FS), Comprehensive Risk Assessment (CRA), and the final Corrective Action Decision/Record of Decision (CAD/ROD).	2007	Not currently. Could affect long-term protectiveness.	Near-term and long-term recommendations were fully implemented through the completion of cleanup and closure under the Rocky Flats Cleanup Agreement (RFCA). The boundaries of the Peripheral Operable Unit (OU) and Central OU are established in the CAD/ROD. The Peripheral OU remedy is no action, because it poses no current or potential future threat to human health and the environment. The Peripheral OU (and OU 3) deletion from the National Priorities List (NPL) is noted in this Second Five-Year Review Report. The CAD/ROD and the Rocky Flats Legacy Management Agreement (RFLMA) establish required controls for the Central OU. This item is now closed.
(Sitewide) Ecological risk	Conduct site-specific and a site-wide Ecological Risk Assessment (ERA). Analyze if action levels based on the ERA drive cleanup levels for specific accelerated actions.		12/31/02	Possibly. An ERA is pending and action to address the ecological risk will be taken as necessary.	The near-term recommendation was implemented in accordance with the CRA Methodology (DOE 2005b) An ecological screen was conducted to determine whether additional actions were warranted to protect ecological receptors for specific accelerated actions. An ERA was completed as part of the CRA. This item is now closed.
(Sitewide) Land transfer and management responsibilities	Negotiate the memorandum of understanding to identify management arrangements and their protectiveness for existing and anticipated remedies.	Implement land management that adequately considers long-term effectiveness and continued protectiveness for each remedy.	6/30/2003	Not at this time. DOE expects this issue will be resolved satisfactorily.	The memorandum of understanding was a requirement of the Rocky Flats National Wildlife Refuge Act of 2001. The Refuge Act was amended by the 2006 Defense Authorization Act, deleting the memorandum of understanding requirement. The CAD/ROD adequately considered the long-term effectiveness and continued protectiveness of the remedial alternatives and the selected remedy. Appropriate land management controls for the Central OU to implement the selected remedy (institutional and physical controls) are in place. The Peripheral OU remedy is no action, because it poses no current or potential future threat to human health and the environment. Administrative jurisdiction and control of the Peripheral OU have been transferred to the U.S. Fish and Wildlife Service in accordance with the Refuge Act. This item is now closed.

Table 5 (continued). Status of the First Five-Year Review Report Recommendations

Issue	Near-Term Recommendation	Long-Term Recommendation	Milestone Date	Affects Protectiveness?	Status
Post-closure enforcement	RFCA currently provides an adequate mechanism for regulatory enforcement.	Define post-closure enforcement in the CAD/ROD and any follow-on orders and/or permits, to link enforceable requirements to future protectiveness for each remedy.	2007	Not at this time. DOE expects this issue will be resolved satisfactorily.	The near-term recommendation is completed. The long-term recommendation is implemented through RFLMA Part 8, "Enforceability." This item is now closed.
Funding for long-term activities	DOE currently expects to rely on the annual funding cycle through closure.	Complete budget cost estimates to accurately reflect the actual costs of specific actions. In addition, evaluate alternative funding mechanisms to provide adequate funds over the long term.	12/31/2005	Not at this time. DOE expects this issue will be resolved satisfactorily.	The near-term recommendation continues to be implemented. For the long-term recommendation, budget cost estimates for the remedial alternatives, including the selected remedy, were included in the RI/FS. Alternative funding mechanisms have not been evaluated, and the recommendation was not carried forward in RFLMA. This item is now closed.
Containerized wastes from Trench 1 containing depleted uranium contaminated with polychlorinated biphenyls do not have an identified treatment or disposal option	Continue to store these materials in compliant storage areas until treatment/disposal options are identified and implemented.		6/30/2005	Not at this time. DOE expects this issue will be resolved satisfactorily.	The near-term recommendation is completed. This waste material was properly disposed of during completion of cleanup and closure activities. This item is now closed.
Solar Ponds Plume reactive barrier operability	Monitoring will track this concern in the near term. Evaluate and implement corrective actions to address the potential to bypass the treatment cell.	Continue long-term monitoring to appropriately evaluate the effectiveness of corrective actions.	6/30/2003	Not in the near term. Could affect long-term protectiveness.	The recommended monitoring is being implemented. The status of the evaluation of the system and the need for and implementation of corrective actions is discussed in this Second Five-Year Review Report and further recommendations are included in the Issues, Recommendations, and Follow-Up Actions section. This item is now closed.
Reactive barrier operation and maintenance (O&M) requirements	Develop long-term O&M requirements based on current operations.	Continue long-term monitoring to implement an effective O&M program.	12/31/2005	Not at this time. DOE expects this issue will be resolved satisfactorily.	The recommended monitoring is being implemented and long-term O&M requirements have been developed and are being implemented. The status of the system operations are discussed in this Second Five-Year Review Report. This item is now closed.

Table 6. ARARs Status

ARAR	Requirement	RFLMA—Remedy Performance Standards/Implementation[a]
Clean Air Act, 42 U.S. Code (USC) 7401 et seq.		
National Emission Standard for Asbestos, 40 Code of Federal Regulations (CFR) 61, Subpart M Subpart M is only an applicable or relevant and appropriate requirement (ARAR) for the Present Landfill.	Reg. 61.151(a)(3)—Cover	The *Present Landfill Monitoring and Maintenance Plan and Post-Closure Plan* (DOE 2006c) is incorporated into Rocky Flats Legacy Management Agreement (RFLMA) Attachment 2, Section 5.3, "Remedy Monitoring and Maintenance." RFLMA Attachment 2, Section 4.0, "Institutional Controls," Table 3, "Present and Original Landfill Inspection and Maintenance Requirements," and Table 4, "Institutional Controls for the Central Operable Unit," also address requirements. Deed notation is met through the Environmental Covenant granted by the U.S. Department of Energy (DOE) to the Colorado Department of Public Health and Environment (CDPHE), and recorded in Jefferson County, Colorado, on December 15, 2006, Reception #2006148295 (DOE and CDPHE 2006).
	Reg. 61.151(b)—Signage	
	Reg. 61.151(d)—Notification to Administrator in writing at least 45 days prior to excavating or otherwise disturbing any asbestos-containing waste material	
	Reg. 61.151(e)—Notation on Deed	
Federal Water Pollution Control Act, 33 USC 1251 et seq.		
Colorado Basic Standards and Methodologies for Surface Water, 5 Code of Colorado Regulations (CCR) 1002-31	Reg. 31.7—Process for Assigning Standards and Granting, Extending, or Removing Temporary Modifications	RFLMA Attachment 2, Section 2.0, "Remedy Performance Standards and Requirements," and Table 1, "Surface Water Standards," are based on these requirements.
	Reg. 31.10—Mixing Zones	
	Reg. 31.11—Basic Standards Applicable to Surface Waters of the State	
Classification and Numeric Standards South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin, 5 CCR 1002-38	Reg. 38.6—Classification Tables	
Colorado Basic Standards for Ground Water, 5 CCR 1002-41	Reg. 41.6—Point of Compliance	
Site-Specific Water Quality Classifications and Standards for Ground Water, 5 CCR 1002-42	Reg. 42.7(1)—Rocky Flats Area, Jefferson and Boulder Counties	
Permits for Dredged or Fill Material; Discharges of Dredged or Fill Material Into Waters of the United States, 33 USC 1344; 33 CFR 323	33 CFR 323.2—Definitions; 33 CFR 323.3—Discharges Requiring Permits	RFLMA Attachment 2, Sections 4.0 and 5.0 specify use of Legacy Management (LM) work procedures and operational documents to identify and mediate environmental, health, and safety risks to ensure all work is done in a safe and environmentally protective manner. These documents include requirements for evaluation of discharges requiring permits. The U.S. Army Corps of Engineers reissued all existing nationwide permits (NWPs), general conditions, and definitions in effect on the date of the Corrective Action Decision/Record of Decision (CAD/ROD) and added 6 new NWPs, 2 new conditions, and 13 new definitions, effective March 19, 2007. The implementation of the remedy is not impacted because all activities subject to this ARAR are conducted in accordance with the March 19, 2007, substantive requirements.
DOE Compliance with Floodplain/Wetlands Environmental Review Requirements, 10 CFR 1022	10 CFR 1022.11—Floodplain/Wetlands Determination; 1022.12 - Floodplain/Wetlands Assessment; 1022.13 - Applicant Responsibilities	RFLMA Attachment 2, Sections 4.0 and 5.0 specify use of LM work procedures and operational documents to identify and mediate environmental, health, and safety risks to ensure all work is done in a safe and environmentally protective manner. These documents include requirements for evaluation of impacts to wetlands. The *Rocky Flats, Colorado, Site Wetland Mitigation Monitoring and Management Plan* (DOE 2006f) is being implemented.
National Pollutant Discharge Elimination System (NPDES), 33 USC 1342; 40 CFR 122 and 445	40 CFR 122.26—Stormwater Permit for Construction Activities	RFLMA Attachment 2, Sections 4.0 and 5.0 specify use of LM work procedures and operational documents to identify and mediate environmental, health, and safety risks to ensure all work is done in a safe and environmentally protective manner. These documents include the Erosion Control Plan specified in RFLMA Attachment 2, Table 3, Use Restrictions. Landfill effluent limitations are addressed in the *Present Landfill Monitoring and Maintenance Plan and Post-Closure Plan* (DOE 2006c), which is incorporated into RFLMA Attachment 2, Section 5.3, "Remedy Monitoring and Maintenance."
	40 CFR 122.28—General Permits	
	40 CFR 445.11— Resource Conservation and Recovery Act (RCRA) Subtitle C Hazardous Waste Landfill Effluent Limitations 40 CFR 445.11 is only an ARAR for the Present Landfill.	
Natural Resource and Wildlife Protection Laws		
Endangered Species Act (ESA), 16 USC 1531 et seq.	50 CFR 402.11—Early Consultation	RFLMA Attachment 2, Sections 4.0 and 5.0 specify use of LM work procedures and operational documents to identify and mediate environmental, health, and safety risks to ensure all work is done in a safe and environmentally protective manner. These documents include requirements for evaluation of impacts to threatened and endangered species. The April 2004 USFWS *Biological Opinion* for the threatened PMJM (DOE 2004c) is being implemented.
	50 CFR 402.12—Biological Assessment	
	50 CFR 402—Interagency Cooperation	
	50 CFR 402.13—Informal Consultation	
	50 CFR 402.14—Formal Consultation	
Migratory Bird Treaty Act, 16 USC 701-715	50 CFR 10—Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants	RFLMA Attachment 2, Sections 4.0 and 5.0 specify use of LM work procedures and operational documents to identify and mediate environmental, health, and safety risks to ensure all work is done in a safe and environmentally protective manner. RFLMA Section 5.4, "Operational Monitoring," and Section 6.0, "Action Determinations," include requirements to monitor for and report adverse biological conditions. In 2006, the Colorado Wildlife Commission modified the legal methods of take for game species, including the black-tailed prairie dogs, where necessary to control damage on privately owned land. The change was effective on November 1, 2006.
Colorado Wildlife Statutes, Colorado Revised Statutes (CRS) 33-1-101 to 33-6-209	CRS 33-1-101, 102(34) and (43); CRS 33-2-104, 105; CRS 33-6-109—Compliance With the Colorado Wildlife Statutes, Including Nongame, Endangered, or Threatened Species Conservation Act and the State Statutes Regarding Illegal Possession	

Table 6 (continued). ARARs Status

ARAR	Requirement	RFLMA—Remedy Performance Standards/Implementation[a]
Federal Noxious Weed Act, Pub. L. 93-629; 7 USC 2814 et seq.	7 USC 2814 (a)(3), (a)(4), (c)(1), (c)(2) - Management of Undesirable Plants on Federal Lands, Duties of Federal Agencies	RFLMA Attachment 2, Sections 4.0 and 5.0 specify use of LM work procedures and operational documents to identify and mediate environmental, health, and safety risks to ensure all work is done in a safe and environmentally protective manner. These documents include requirements for evaluation of weed control. The *Rocky Flats, Colorado, Site Vegetation Management Plan* (DOE 2006e) addressing noxious weed control is being implemented.
Colorado Noxious Weed Act, CRS 35-5.5-101 et seq.	Section 104—Duty to Manage Noxious Weeds	
	Section 111—Cooperation with Federal and State Agencies	
National Wildlife Refuge System Administration Act, 16 USC 668dd(c)		RFLMA Attachment 2, Sections 4.0 and 5.0 specify use of LM work procedures and operational documents to identify and mediate environmental, health, and safety risks to ensure all work is done in a safe and environmentally protective manner. RFLMA Section 5.4, "Operational Monitoring," and Section 6.0, "Action Determinations," include requirements to monitor for and report adverse biological conditions.
Colorado Radiation Control CRS §§ 25-1-108, 25-1.5-101(1)(k) and (1)(l), and 25-11-104 (Atomic Energy Act, 42 USC 2011 et seq.)		
6 CCR 1007-1 Part 3 – Licensing of Radioactive Material; Part 4—Standards for Protection Against Radiation.	RH 3.16.7—License Termination; Completion Criteria	RFLMA Attachment 2, Section 4.0, "Institutional Controls," and Table 4, "Institutional Controls for the Central Operable Unit," implement the completion and restricted use criteria. New information is evaluated under Section 6.0, "Action Determinations," and Section 7.3, "CERCLA 5-Year Review." Deed notation is met through the Environmental Covenant granted by DOE to CDPHE, and recorded in Jefferson County, Colorado, on December 15, 2006, Reception #2006148295 (DOE and CDPHE 2006).
	RH 3.16.8—Additional Cleanup; New Information	
	RH 4.61.3.2 and .3—Radiological Criteria for License Termination; Criteria for Restricted Use	
Subtitle C: Hazardous Waste Management (Colorado Hazardous Waste Act [CHWA] [CRS § 25-15-101 to -217]) Solid Waste Disposal Act (RCRA) (42 USC § 6901 et seq.) CHWA/RCRA requirements are listed as ARARs, but they also apply independently.		
General, 6 CCR 1007-3, Part 261, Subpart A	.4(a)(2)—Exclusions	The *Present Landfill Monitoring and Maintenance Plan and Post-Closure Plan* (DOE 2006c) and the *Final Landfill Monitoring and Maintenance Plan, Rocky Flats Environmental Technology Site Original Landfill* (DOE 2006d) are incorporated into RFLMA Attachment 2, Section 5.3, "Remedy Monitoring and Maintenance." RFLMA Attachment 2, Section 4.0, "Institutional Controls," Table 3, "Present and Original Landfill Inspection and Maintenance Requirements," and Table 4, "Institutional Controls for the Central Operable Unit," also address certain requirements. Plat and deed notation is met through the Environmental Covenant granted by DOE to CDPHE, and recorded in Jefferson County, Colorado, on December 15, 2006, Reception #2006148295 (DOE and CDPHE 2006). RFLMA Attachment 2, Section 2.0, "Remedy Performance Standards and Requirements," and Table 1, "Surface Water Standards," also apply to surface water and ground water monitoring. RFLMA Attachment 2, Sections 4.0 and 5.0 specify use of LM work procedures and operational documents to identify and mediate environmental, health, and safety risks to ensure all work is done in a safe and environmentally protective manner. These documents include requirements for evaluation and implementation of hazardous waste management requirements. RFLMA Attachment 2, Section 5.3, "Remedy Monitoring and Maintenance," incorporates the East Trenches Plume Treatment System, Solar Ponds Plume Treatment System, and Mound Site Plume Treatment System monitoring and maintenance requirements.
Identification and Listing of Hazardous Wastes, 6 CCR 1007-3, 261	.11—Hazardous Waste Determinations	
Generator Standards, 6 CCR 1007-3 Part 262	.34—Hazardous Waste Accumulation Areas	
General, 6 CCR 1007-3, Part 265, Subpart A	.1(c)(10)—Purpose, Scope, and Applicability	
General Facility Standards, 6 CCR 1007-3 Part 265, Subpart B	.14—Security	
	.15—General Inspection Requirements	
	.16—Personnel Training Requirements	
	.17—Requirements for Ignitable, Reactive or Incompatible Wastes	
Preparedness and Prevention, 6 CCR 1007-3 Part 265, Subpart C	.32—Required Equipment	
	.33—Testing and Maintenance of Equipment	
	.34—Access to Communications or Alarm System	
	.37—Arrangement with Local Authorities	
Contingency Plan and Emergency Procedures, 6 CCR 1007-3 Part 265, Subpart D	.51—Purpose and Implementation	
	.55—Emergency Coordinator	
	.56—Emergency Procedures	
	264.101—Corrective Action for SWMUs This ARAR only applies to ground water.	
Groundwater Monitoring, 6 CCR 1007-3 Part 265, Subpart F This ARAR only applies to the Present and Original Landfills.	265.90—Applicability	
	265.91—Groundwater Monitoring System	
	265.92—Sampling and Analysis	
	265.93—Preparation, Evaluation, and Response	
	265.94—Recordkeeping and Reporting	
Closure and Post-Closure, 6 CCR 1007-3 Part 265, Subpart G This ARAR only applies to the Present and Original Landfills.	265.110—Applicability	
	265.111—Closure Performance Standard	
	265.114—Disposal or Decontamination of Equipment, Structures, or Soils	
	265.116—Survey Plat	
	265.117—Post-Closure Care and Use of Property	
	265.118—Post-Closure Plan	
	265.119—Post-Closure Notices	
	265.120—Certification of Completion of Post-Closure Care	
	265.121—Post-Closure Requirements for Facilities That Obtain Enforceable Documents in Lieu of Post-Closure Permits	

Table 6 (continued). ARARs Status

ARAR	Requirement	RFLMA—Remedy Performance Standards/Implementation[a]
Landfills, 6 CCR 1007-3 Part 265, Subpart N	265.309—Surveying and Recordkeeping	*The Present Landfill Monitoring and Maintenance Plan and Post-Closure Plan* and the *Final Landfill Monitoring and Maintenance Plan Rocky Flats Environmental Technology Site Original Landfill* are incorporated into RFLMA Attachment 2, Section 5.3, "Remedy Monitoring and Maintenance." RFLMA Attachment 2, Section 4.0, "Institutional Controls, Table 3, "Present and Original Landfill Inspection and Maintenance Requirements," and Table 4, "Institutional Controls for the Central Operable Unit" also address certain requirements. Plat and deed notation is met through the Environmental Covenant granted by DOE to CDPHE, and recorded in Jefferson County, Colorado, on December 15, 2006, Reception #2006148295 (DOE and CDPHE 2006).
	265.310(a), (2), (3), and (4) (applies to the Original Landfill) 265.310(b)(1)-(6) (applies to the Present Landfill)—Closure and Post-Closure Care	
Toxic Substances Control Act, 15 USC 2605 et seq.		
Polychlorinated Biphenyl (PCB) Storage and Disposal, 40 CFR 761 Subpart D	761.62(c)—PCB Bulk Product Waste	RFLMA Attachment 2, Sections 4.0 and 5.0 specify use of LM work procedures and operational documents to identify and mediate environmental, health, and safety risks to ensure all work is done in a safe and environmentally protective manner.
Environmental Covenants, CRS 25-15-317 et seq.		
	25-15-318—Nature of Environmental Covenants	An Environmental Covenant was granted by DOE to CDPHE and recorded in Jefferson County, Colorado, on December 15, 2006, Reception #2006148295 (DOE and CDPHE 2006).
	25-15-319—Contents	
	25-15-320—When Required	
	25-15-321—Creation, Modification, and Termination of an Environmental Covenant	

[a]ARARs for the Central OU were established in the CAD/ROD (DOE et al. 2006). The CAD/ROD states that requirements of the remedy, including ARARs, are implemented through RFLMA as well as through an Environmental Covenant for the Central OU granted by DOE to CDPHE (DOE and CDPHE 2006).

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Table 7. Results of Ground Water ANOVA at the Present and Original Landfills

Present Landfill				
Analyte	**Well 73005**	**Well 73105**	**Well 73205**	**Comments**
Antimony	x	x	x	
Arsenic	x	x	x	
Barium		x		
Beryllium		x	x	
Boron	x	x	x	
Cadmium	x			
Chromium		x	x	
Copper	x	x	x	
Lead	x	x	x	
Lithium	--	x	x	Insufficient data for statistical evaluation at 73005
Manganese		x	x	
Molybdenum	--	x	x	Insufficient data for statistical evaluation at 73005
Nickel			x	
Selenium	x		x	
Silver	x	x	x	
Strontium	--	x	x	Insufficient data for statistical evaluation at 73005
Thallium	x	x	x	
Tin	--	x	x	Insufficient data for statistical evaluation at 73005
Uranium	--	x	x	Insufficient data for statistical evaluation at 73005

Note: x = analyte is present in ground water at a statistically significant higher concentration in the indicated downgradient well compared to upgradient wells.
-- = see comment.

Original Landfill			
Analyte	**Well 80005**	**Well 80105**	**Well 80205**
Boron	x	x	x
Lithium	x	x	x
Manganese		x	
Strontium		x	x
Uranium			x

Note: x = analyte is present in ground water at a statistically significant higher concentration in the indicated downgradient well compared to upgradient wells.

Table 8. Remedy Summary

Final Rocky Flats CAD/ROD Remedy Requirement	RFLMA—Remedy Performance Standards/Implementation	Status
Monitoring and Maintenance (M&M) at the Present Landfill (PLF) Cover and Seep Treatment System	The *Present Landfill Monitoring and Maintenance Plan and Post-Closure Plan* is incorporated into Rocky Flats Legacy Management Agreement (RFLMA) Attachment 2, Section 5.3, "Remedy Monitoring and Maintenance." Also, see RFLMA Attachment 2, Section 4.0, "Institutional Controls," Table 2, "Water Monitoring Locations and Sampling Criteria," Table 3, "Present and Original Landfill Inspection and Maintenance Requirements," and Table 4, "Institutional Controls for the Central Operable Unit."	Response action is operating properly and successfully and the remedy is protective of human health and the environment. Routine inspections conducted in accordance with RFLMA have not identified any significant problems. Seep treatment system: Effluent monitoring results show three analytes (arsenic, boron, manganese) as periodically above standards. See Section 8 for recommendations. Resource Conservation and Recovery Act (RCRA) ground water monitoring: No volatile organic compounds (VOCs) were found to be present in downgradient wells at statistically higher concentrations than in upgradient wells. The concentrations of several metals are statistically higher in samples from downgradient wells compared to those from upgradient wells. However, none of those constituents are higher than surface water standards.
M&M at the Original Landfill (OLF) Cover	The *Final Landfill Monitoring and Maintenance Plan, Rocky Flats Environmental Technology Site, Original Landfill* is incorporated into RFLMA Attachment 2, Section 5.3, "Remedy Monitoring and Maintenance." Also, see RFLMA Attachment 2, Section 4.0, "Institutional Controls," Table 2, "Water Monitoring Locations and Sampling Criteria," Table 3, "Present and Original Landfill Inspection and Maintenance Requirements," and Table 4, "Institutional Controls for the Central Operable Unit."	Response action is operating properly and successfully. Assuming repairs will be made in a timely manner in accordance with the OLF M&M Plan so that design criteria continue to be met, the remedy is protective of human health and the environment. Routine inspections conducted in accordance with RFLMA have identified small areas of slumps and slides of the cover material and two seeps on or near the OLF cover, Seep #7 and Seep #4. Both seeps were evaluated on September 7, 2006. Both seeps still showed areas of active ground water seepage that is being drained by Diversion Berm #3. See Section 8 for recommendations. RCRA ground water monitoring: No VOCs were found to be present in downgradient wells at statistically higher concentrations than in upgradient wells. The concentrations of several metals are statistically higher in samples from downgradient wells compared to those from upgradient wells. However, of those constituents, only uranium concentrations are higher than surface water standards. See Section 8 for recommendations.
M&M at the Mound Site Plume Treatment System	RFLMA Attachment 2, Section 5.3, "Remedy Monitoring and Maintenance." See also RFLMA Attachment 2, Section 4.0, "Institutional Controls," Table 1, "Surface Water Standards," and Table 2, "Water Monitoring Locations and Sampling Criteria."	Response action is operating properly and successfully and the remedy is protective of human health and the environment.

Table 8 (continued). Remedy Summary

Final Rocky Flats CAD/ROD Remedy Requirement	RFLMA—Remedy Performance Standards/Implementation	Status
M&M at the East Trenches Site Plume Treatment System	RFLMA Attachment 2, Section 5.3, "Remedy Monitoring and Maintenance." See also RFLMA Attachment 2, Section 4.0, "Institutional Controls," Table 1, "Surface Water Standards," and Table 2, "Water Monitoring Locations and Sampling Criteria."	Response action is operating properly and successfully and the remedy is protective of human health and the environment.
M&M at the Solar Ponds Plume Treatment System	RFLMA Attachment 2, Section 5.3, "Remedy Monitoring and Maintenance." See also RFLMA Attachment 2, Section 4.0, "Institutional Controls," Table 1, "Surface Water Standards," and Table 2, "Water Monitoring Locations and Sampling Criteria."	Response action is operating properly and successfully and the remedy is protective of human health and the environment. During fall 2005, effluent monitoring results were above standards due to clogging of treatment media. After change-out of media and plumbing repairs, effluent monitoring results are below standards. See Section 8 for recommendations.
Environmental Monitoring Based on the IMP		
Surface Water - Point of Compliance (POC) - Point of Evaluation (POE) - Performance Monitoring Locations	RFLMA Attachment 2, Section 2.0, "Remedy Performance Standards and Requirements," Section 2.1, "Surface Water Standards," and Section 5.1, "Monitoring Surface Water." See also RFLMA Attachment 2, Table 1, "Surface Water Standards" and Figure 1, "Water Monitoring at Rocky Flats."	There have been no changes in the Rocky Flats Site configuration that would require a change to POC locations. All results have remained below the surface water standards for specified analytes during the post-closure period. POE location GS10 continued to show reportable values for total uranium. Evaluation has suggested that these reportable values are due to changes in hydrologic conditions resulting in ground water with naturally occurring uranium making up a larger proportion of streamflow at GS10. All other POEs, and all other analytes at GS10, showed acceptable water during the post-closure period. Performance monitoring location GS13 periodically exceeded the uranium standard. Surface water quality shows generally acceptable quality at all other locations, but occasionally a standard may be exceeded. See Section 8 for recommendations.
Ground Water - Area of Concern (AOC) - Sentinel - Evaluation	RFLMA Attachment 2, Section 2.0, "Remedy Performance Standards and Requirements," Section 2.1, "Surface Water Standards," and Section 5.2, "Monitoring Groundwater." See also RFLMA Attachment 2, Table 1, "Surface Water Standards" and Figure 1, "Water Monitoring at Rocky Flats."	Ground water quality and flow in the Central Operable Unit (OU) was consistent with previous years at AOC, Sentinel, and Evaluation wells. Former Sentinel well B206989 is now an AOC well and exceeds standard for nitrate. This area does not impact surface water quality.

Table 8 (continued). Remedy Summary

Final Rocky Flats CAD/ROD Remedy Requirement	RFLMA—Remedy Performance Standards/Implementation	Status
Sampling for Ecological Risk Assessment	RFLMA Attachment 2, Section 5.3.7, "Ecological Sampling" and Table 5, "Ecological Sampling"	Surface water sampling initiated; remaining surface water sampling and sediment sampling are scheduled for completion in 2007. See Section 8 for recommendations.
Residual Subsurface Contamination	RFLMA Attachment 2, Section 5.3.4, "Residual Subsurface Contamination"	Inspections revealed no significant evidence of erosion or precursor evidence of erosion in the proximity of subsurface features.
Institutional Controls	RFLMA Attachment 2, Section 4.0, "Institutional Controls" and Table 4, "Institutional Controls for the Central Operable Unit"	Institutional controls are in place. Environmental Covenant granted by the U.S. Department of Energy (DOE) to the Colorado Department of Public Health and Environment (CDPHE), recorded in Jefferson County, Colorado, on December 15, 2006, Reception #2006148295. The inspection in March 2007 revealed no significant problems.
Physical Controls	RFLMA Attachment 2, Section 3.0, "Physical Controls"	DOE maintains administration jurisdiction over the Central OU. Signs along the perimeter of the Central OU are in place; the inspection in March 2007 revealed no significant problems. Engineered components of the remedy, monitoring locations, and survey points are protected by DOE. Physical inspections are performed when system monitoring, maintenance, or sampling is performed. Inspections for these activities revealed no significant problems. DOE has provided regular reports on remedy performance and site conditions to the U.S. Environmental Protection Agency, CDPHE and the public.

Table 9. Issues, Recommendations, and Follow-Up

Issue	Currently Affects Protectiveness (Y/N)?	Affects Future Protectiveness (Y/N)?	Recommendation, Follow-Up, and Expected Completion Date
GS10 Uranium Concentrations GS10, the surface water monitoring Point of Evaluation in South Walnut Creek at Pond B-1 Bypass, showed total uranium above surface water standards in 2006. Surface water discharged from the Central OU meets surface water standards. Evaluation suggests that these reportable values are due to changes in hydrologic conditions resulting in ground water with naturally occurring uranium making up a larger proportion of stream flow at GS10.	N	N	Continue to monitor in accordance with RFLMA requirements. Employ special analytical methods to determine if natural uranium isotopic signatures have significantly changed from the levels prior to closure. This sampling and analysis are expected to be completed by the end of 2008.
Uranium Concentrations at OLF Wells Uranium analytical results are higher than surface water standard in one of three downgradient wells.	N	N	Continue to monitor the OLF in accordance with RFLMA requirements. Employ special analytical methods to determine if isotopic signatures indicate this to be predominantly natural uranium. This sampling and analysis are expected to be completed by the end 2008.
Sentinel Well 45605 A Sentinel Well is located within a hillside slump south of former B991, which has moved the well casing out of vertical and the serviceability of the well is uncertain.	N	N	Continue to monitor in accordance with RFLMA. If necessary, after movement in the area stops, replace the well after regrading of the hillside has been completed. This is expected to be completed by the end of 2008.
Water Quality Standards Changes Changes to RFLMA surface water standards for arsenic, copper and uranium may be promulgated by the Colorado Water Quality Control Commission (CWQCC) on the completion of the triennial review for the Big Dry Creek Basin in 2009. Also, the existing temporary modification to the standards for nitrates and certain VOCs incorporated in the RFLMA surface water standards are set to expire in 2009. The impacts of any changes to standards at the time of completion of the CWQCC triennial review will depend on the results of continuing remedy implementation activities.	N	N	DOE should actively participate in the triennial review process to identify issues and collect and provide any necessary data to the WQCC for its decision making process. The triennial review is expected to be completed by mid-2009.
Original Landfill Cover *Issue*: Routine inspections have identified historical seeps and small areas of slumps and slides on the cover that need to be addressed and repaired as necessary to continue to meet cover design criteria.	N	N	Continue to monitor the OLF in accordance with RFLMA requirements. Cover repairs should be made in accordance with the OLF Monitoring and Maintenance Plan so that design criteria continue to be met. Engineering evaluation to identify possible causes and approaches to address the causes should be completed. The engineering evaluation is expected to be completed by the end of 2008.
Solar Ponds Plume Treatment System Treatability Study Routine maintenance is difficult and costly.	N	N	Complete treatability study to determine whether a simpler, more efficient, and less management-intensive system could be designed and installed. Based on the results, proposed modifications should be developed in accordance with RFLMA Part 10. The study is expected to be completed by the end of 2007. Evaluation of alternatives and any proposal for recommended modifications is expected to be completed by the end of 2008.

End of current text

Appendix A

RFLMA Attachment 2 Figures and Tables

Table 1. Surface Water Standards

Analyte	CAS Reference Number	Standards [a] (mg/L)	Basis [b]	Temporary Modifications [c] (mg/L)	PQLs [d] (mg/L)
Acenaphthene	83-32-9	4.20E-01	W+F, WS		
Acrolein	107-02-8	3.50E-03	W+F, WS		2.50E-02
Acrylamide	79-06-1	7.80E-06	WS		3.20E-04
Acrylonitrile	107-13-1	5.10E-05	W+F		2.50E-02
Alachlor	15972-60-8	2.00E-03	W+F, WS		
Aldicarb	116-06-3	7.00E-03	WS		
Aldicarb sulfone	1646-88-4	7.00E-03	WS		
Aldicarb sulfoxide	1646-87-3	7.00E-03	WS		
Aldrin	309-00-2	4.90E-08	W+F		5.00E-05
Ammonia, un-ionized	7664-41-7	[e]	[e]		
Aniline	62-53-3	6.10E-03	WS		1.00E-02
Anthracene	120-12-7	2.10E+00	W+F, WS		
Aramite	140-57-8	1.40E-03	WS		2.00E-02
Arsenic, total recoverable	7440-38-2	5.00E-02	SS		
Atrazine	1912-24-9	3.00E-03	WS		
Azobenzene	103-33-3	3.20E-04	WS		3.00E-02
Benzene	71-43-2	2.20E-03	W+F	5.00E-03	
Benzidine	92-87-5	8.60E-08	W+F		4.00E-02
alpha-BHC	319-84-6	2.60E-06	W+F		3.00E-05
beta-BHC	319-85-7	9.10E-06	W+F		6.00E-05
gamma-BHC [Lindane]	58-89-9	8.00E-05	AL		
Benzo(a)anthracene	56-55-3	3.80E-06	W+F		2.00E-02
Benzo(a)pyrene	50-32-8	3.80E-06	W+F		1.00E-02
Benzo(b)fluoranthene	205-99-2	3.80E-06	W+F		1.00E-02
Benzo(g,h,i)perylene	191-24-2	3.80E-06	W+F		1.00E-02
Benzo(k)fluoranthene	207-08-9	3.80E-06	W+F		1.00E-02
Benzotrichloride	98-07-7	2.70E-06	WS		1.00E-02
Benzyl chloride	100-44-7	2.10E-04	WS		1.00E-03
Beryllium	7440-41-7	4.00E-03	SS		
Boron, total	7440-42-8	7.50E-01	AG, SS		
Bromate	15541-45-4	5.00E-05	WS		1.00E-03
Bromodichloromethane	75-27-4	5.50E-04	W+F [f]		1.00E-03
Bromoform [Tribromomethane]	75-25-2	4.30E-03	W+F [f]		
Bromomethane [Methyl Bromide]	74-83-9	9.80E-04	W+F		1.00E-03
Butylbenzylphthalate	85-68-7	1.40E+00	W+F, WS		
Cadmium, dissolved	7440-43-9	1.50E-03	TVS [g]		
Carbofuran	1563-66-2	4.00E-02	WS		
Carbon tetrachloride	56-23-5	2.30E-04	W+F	5.00E-03	1.00E-03
Chlordane	57-74-9	8.00E-07	W+F		2.00E-04
Chlorobenzene	108-90-7	1.00E-01	W+F, WS		
Chlorodibromomethane (HM)	124-48-1	5.40E-02	W+F		
bis(2-Chloroethyl)ether	111-44-4	3.00E-05	W+F		1.00E-02
Chloroform [Trichloromethane]	67-66-3	3.40E-03	W+F [f]		
bis(2-Chloroisopropyl)ether	108-60-1	2.80E-01	W+F, WS		
Chloromethane [Methyl chloride]	74-87-3	5.60E-03	W+F		

Table 1 (continued). Surface Water Standards

Analyte	CAS Reference Number	Standards [a] (mg/L)	Basis [b]	Temporary Modifications [c] (mg/L)	PQLs [d] (mg/L)
Bis(chloromethyl)ether (BCME)	542-88-1	1.00E-07	W+F		1.00E-02
4-Chloro-3-methylphenol	59-50-7	3.00E-02	AL		
Chloronaphthalene	91-58-7	5.60E-01	W+F, WS		
2-Chlorophenol	95-57-8	3.50E-02	W+F, WS		
Chloropyrifos	2921-88-2	4.10E-05	AL		5.00E-03
Chromium III, Total Recoverable	16065-83-1	5.00E-02	SS		
Chromium VI, dissolved	18540-29-9	1.10E-02	TVS [g]		2.00E-02
Chrysene	218-01-9	3.80E-06	W+F		1.00E-02
Copper, dissolved	7440-50-8	1.60E-02	TVS [g]		2.50E-02
Cyanide	57-12-5	5.00E-03	SS		
4,4-DDD	72-54-8	3.10E-07	W+F		1.10E-04
4,4-DDE	72-55-9	2.20E-07	W+F		5.00E-05
4,4-DDT	50-29-3	2.20E-07	W+F		1.20E-04
Dalapon	75-99-0	2.00E-01	WS		
Demeton	8065-48-3	1.00E-04	AL		1.00E-02
Dibenzo(a,h)anthracene	53-70-3	3.80E-06	W+F		1.00E-02
Dibromochloromethane	124-48-1	8.00E-02	W+F, WS [f]		
1,2-Dibromo-3-chloropropane	96-12-8	2.00E-04	WS		1.00E-03
Di-n-butylphthalate	84-74-2	7.00E-01	W+F, WS		
Dichloroacetic acid	79-43-6	7.00E-04	WS		5.00E-04
1,2-Dichlorobenzene	95-50-1	4.20E-01	W+F		
1,3-Dichlorobenzene	541-73-1	9.40E-02	W+F, WS		
1,4-Dichlorobenzene	106-46-7	6.30E-02	W+F		
3,3-Dichlorobenzidine	91-94-1	2.10E-05	W+F		2.00E-02
1,2-Dichloroethane	107-06-2	3.80E-04	W+F	5.00E-03	1.00E-03
1,1-Dichloroethene	75-35-4	7.00E-03	W+F, WS	7.00E-03	
1,2-Dichloroethene (cis)	156-59-2	7.00E-02	WS		
1,2-Dichloroethene (trans)	156-60-5	1.00E-01	W+F, WS		
2,4-Dichlorophenol	120-83-2	2.10E-02	W+F, WS		
Dichlorophenoxyacetic acid [2,4-D]	94-75-7	7.00E-02	WS		
1,2-Dichloropropane	78-87-5	5.00E-04	W+F		1.00E-02
1,3-Dichloropropylene	542-75-6	3.40E-04	W+F		1.00E-02
Dichlorvos	62-73-7	1.20E-04	WS		1.00E-02
Dieldrin	60-57-1	5.20E-08	W+F		2.00E-05
Di(2-ethylhexyl)adipate	103-23-1	4.00E-01	WS		
Diethylphthalate	84-66-2	5.60E+00	W+F, WS		
Diisopropyl methyl phosphonate	1445-75-6	8.00E-03	WS		1.00E-02
2,4-Dimethylphenol	105-67-9	1.40E-01	W+F, WS		
Dimethylphthalate	131-11-3	7.00E+01	W+F, WS		
4,6-Dinitro-2-methylphenol	534-52-1	2.70E-04	WS		5.00E-02
2,4-Dinitrophenol	51-28-5	1.40E-02	W+F, WS		5.00E-02
2,4-Dinitrotoluene	121-14-2	1.10E-04	W+F, WS		1.00E-02
2,6-Dinitrotoluene	606-20-2	2.30E-01	AL		
Dinoseb	88-85-7	7.00E-03	WS		

Table 1 (continued). Surface Water Standards

Analyte	CAS Reference Number	Standards [a] (mg/L)	Basis [b]	Temporary Modifications [c] (mg/L)	PQLs [d] (mg/L)
1,4-Dioxane	123-91-1	6.10E-03	WS [m]		1.00E-02
Dioxin (2,3,7,8 TCDD)	1746-01-6	5.00E-12	W+F		1.00E-05
1,2-Diphenylhydrazine	122-66-7	3.60E-05	W+F		1.00E-02
Diquat	85-00-7	2.00E-02	WS		
Endosulfan	115-29-7	5.60E-05	AL		
Endosulfan, alpha	959-98-8	5.60E-05	AL		2.00E-04
Endosulfan, beta	33213-65-9	5.60E-05	AL		
Endosulfan sulfate	1031-07-8	5.60E-05	AL		6.60E-04
Endothall	145-73-3	1.00E-01	WS		
Endrin (technical)	72-20-8	3.60E-05	AL		6.00E-05
Endrin aldehyde	7421-93-4	2.90E-04	W+F		
Epichlorohydrin	106-89-8	3.50E-03	WS		1.00E-02
Ethylbenzene	100-41-4	5.30E-01	W+F		
Ethylene dibromide [1,2-Dibromomethane]	106-93-4	5.00E-05	WS		1.00E-03
bis(2-Ethylhexyl)phthalate	117-81-7	1.20E-03	W+F		1.00E-02
Fluoranthene	206-44-0	1.30E-01	W+F		
Fluorene	86-73-7	2.80E-01	WS		
Folpet	133-07-3	1.00E-02	WS		
Furmecyclox	60568-05-0	1.20E-03	WS		1.00E-02
Glyphosate	1071-83-6	7.00E-01	WS		
Guthion	86-50-0	1.00E-05	AL		1.00E-01
Heptachlor	76-44-8	7.80E-08	W+F		5.00E-05
Heptachlor epoxide	1024-57-3	3.90E-08	W+F		1.00E-03
Hexachlorobenzene	118-74-1	2.80E-07	W+F		1.00E-02
Hexachlorobutadiene	87-68-3	4.40E-04	W+F		5.00E-03
Hexachlorocyclohexane, Technical	608-73-1	1.20E-05	W+F		1.00E-02
Hexachlorocyclopentadiene	77-47-4	5.00E-03	AL		1.00E-02
Hexachlorodibenzo-p-dioxin (1,2,3,7,8,9-hcdd)	19408-74-3	5.60E-09	WS		2.50E-05
Hexachloroethane	67-72-1	4.00E-04	W+F		1.00E-03
Hydrazine/Hydrazine sulfate	302-01-2	1.20E-05	WS		1.00E-02
Indeno(1,2,3-cd)pyrene	193-39-5	3.80E-06	W+F		1.00E-02
Isophorone	78-59-1	1.30E-01	W+F		
Lead, dissolved	7439-92-1	6.50E-03	TVS [g]		
Malathion	121-75-5	1.00E-04	AL		1.00E-02
Mercury, total	7439-97-6	1.00E-05	SS		1.00E-03
Methoxychlor	72-43-5	3.00E-05	AL		1.80E-03
4,4-Methylene bis (N,N'-dimethyl)aniline	101-61-1	7.60E-04	WS		1.00E-02
Methylene chloride [Dichloromethane]	75-09-2	4.60E-03	W+F		
Mirex	2385-85-5	1.00E-06	AL		1.00E-02
Naphthalene	91-20-3	1.40E-01	W+F, WS		
Nickel, dissolved	7440-02-0	1.23E-01	TVS [g]		
Nitrate	14797-55-8	1.00E+01	AG, SS	100 [h]	

Table 1 (continued). Surface Water Standards

Analyte	CAS Reference Number	Standards [a] (mg/L)	Basis [b]	Temporary Modifications [c] (mg/L)	PQLs [d] (mg/L)
Nitrite	14797-65-0	5.00E-01	AL [i], SS	4.5 [h]	
Nitrobenzene	98-95-3	3.50E-03	W+F, WS		
Nitrophenol 4	100-02-7	5.60E-02	WS, W+F		
Nitrosodibutylamine N	924-16-3	4.30E-06	W+F		1.00E-02
N-Nitrosodiethanolamine	1116-54-7	1.30E-05	WS		1.00E-02
Nitrosodiethylamine N	55-18-5	2.30E-07	W+F, WS		1.00E-02
Nitrosodimethylamine N	62-75-9	6.90E-07	W+F, WS		2.00E-02
n-Nitrosodiphenylamine	86-30-6	3.30E-03	W+F		1.00E-02
n-Nitrosodipropylamine	621-64-7	5.00E-06	W+F, WS		1.00E-02
N-Nitroso-N-methylethylamine	10595-95-6	1.60E-06	WS		1.00E-02
Nitrosopyrrolidine N	930-55-2	1.60E-05	W+F		4.00E-02
Oxamyl(vydate)	23135-22-0	2.00E-01	WS		
PCBs	1336-36-3	6.40E-08	W+F [j]		5.00E-04
Parathion	56-38-2	1.30E-05	AL		1.00E-02
Pentachlorobenzene	608-93-5	1.40E-03	W+F		1.00E-02
Pentachlorophenol	87-86-5	2.70E-04	W+F		5.00E-02
Phenol	108-95-2	2.10E+00	W+F, WS		
Picloram	1918-02-1	4.90E-01	WS		
Propylene oxide	75-56-9	1.50E-04	WS		1.00E-02
Pyrene	129-00-0	2.10E-01	W+F, WS		
Quinoline	91-22-5	1.20E-05	WS		
Selenium	7782-49-2	4.60E-03	AL		
Silver, dissolved	7440-22-4	6.00E-04	TVS [g]		1.00E-03
Simazine	122-34-9	4.00E-03	WS		
Sulfide	18496-25-8	2.00E-03	SS		
Styrene	100-42-5	1.00E-01	WS		
1,2,4,5-Tetrachlorobenzene	95-94-3	9.70E-04	W+F		1.00E-03
1,1,2,2-Tetrachloroethane	79-34-5	1.70E-04	W+F		1.00E-03
Tetrachloroethene	127-18-4	6.90E-04	W+F	5.00E-03	1.00E-03
Toluene	108-88-3	1.00E+00	W+F, WS		
Toxaphene	8001-35-2	2.00E-07	AL		2.50E-03
Tributyltin (TBT)	56573-85-4	7.20E-05	AL		1.00E-02
1,2,4-Trichlorobenzene	120-82-1	3.50E-02	W+F		
1,1,1-Trichloroethane	71-55-6	2.00E-01	WS		
1,1,2-Trichloroethane	79-00-5	2.70E-03	W+F		
Trichloroethene	79-01-6	2.50E-03	W+F	5.00E-03	
2,4,6-Trichlorophenol	88-06-2	1.40E-03	W+F		1.00E-02
Trichlorophenol 2,4,5	95-95-4	7.00E-01	WS, W+F		
Trichlorophenoxyproprionic acid	93-72-1	5.00E-02	WS		
Vinyl chloride	75-01-4	2.30E-05	W+F		2.00E-04
Xylene (total)	1330-20-7	1.00E+01	WS		
Zinc, dissolved	7440-66-6	1.41E-01	TVS [g]		
PHYSICAL PARAMETERS:					
Dissolved oxygen (minimum)		5.0 mg/L	SS		
pH		6.5-9.0	SS		

Table 1 (continued). Surface Water Standards

Analyte	CAS Reference Number	Standards [a] (mg/L)	Basis [b]	Temporary Modifications [c] (mg/L)	PQLs [d] (mg/L)
RADIONUCLIDES (pCi/L)					
Americium 241	14596-10-2	0.15	BS		
Plutonium 239/240	10-12-8	0.15	BS		
Radium 226/228		5 [k]	BS		
Strontium 89/90	11-10-9	8	BS		
Tritium	10028-17-8	500	SS		
Uranium, total	7440-61-1	11(10) [l]	SS		
Gross alpha, total	14127-62-9	7(11) [l]	SS		
Gross beta, total	12587-47-2	8(19) [l]	SS		

NOTES:

[a] The values in this table reflect the classifications and standards approved by the Colorado WQCC effective December 31, 2005. Standards for chloride, dissolved iron, dissolved manganese, and sulfate are Secondary Drinking Water Standards, which are based on aesthetic considerations. They have been removed as site-specific standards since Segments 4a, 4b, and 5 waters will not be used for drinking water supply.

[b] Acronyms: AG = Agriculture; AL = Aquatic Life; BS = Basic Standard; PRG = Preliminary Remediation Goal for residential groundwater ingestion; SS = Site Specific Standard; TVS = Table Value Standard; WS = Water Supply; W+F = Water plus Fish

[c] Temporary modifications affect Segment 5 only and apply until December 31, 2009.

[d] Whenever the practical quantitation level (PQL) for a pollutant is higher (less stringent) than a standard or temporary modification, "less than" the PQL will be used as the compliance threshold.

[e] There is no un-ionized ammonia standard for Segment 5 or Segment 4b. A standard of 0.1 mg/L applies to Segment 4a, which begins in Walnut Creek downstream of Indiana Street.

[f] Per the Basic Standards, the Total Trihalomethane (TTHM) standard applies to the sum of the four TTHM compounds. For dibromochloromethane the TTHM value for water supply, 80 parts per billion, was applied.

[g] Table value standards for metals are based on a toxicity equation which uses a hardness value of 143 mg/L.

[h] The temporary modifications for nitrate and nitrite apply to the Walnut Creek portions of Segment 5 only.

[i] The listed nitrite value is the chronic aquatic life standard based on chloride levels in excess of 22 mg/L in Segment 4.

[j] The total PCB standard in the Basic Standards is based on the sum of the Araclor analytes.

[k] Per the basic standard, this value applies to the sum of the two radium isotopes.

[l] Radiological parameters are distinguished by drainage basin in Table 2 of 5 CCR 1002-38. The first value is the standard for Woman Creek and the paranthetical value is the standard for Walnut Creek.

[m] Effective through 3/21/2010; starting 3/22/2010 standard is 3.20E-03 mg/L

The scientific notation used in this table indicates the power of ten by which the two-decimal-place number is multiplied (e.g., 2.52E-02 = 2.52 X 10-2 = .0252).

Table 2. Water Monitoring Locations and Sampling Criteria

General Objective	Classification	Media	Location ID (1)	Location Description	Frequency	Analytes (4)
Points of Compliance (POCs)						
	POC (5)	SW	GS01	Woman Creek at Indiana Street	Flow-paced (varies)	Pu, Am, isotopic U**, flow rate
	POC (5)	SW	GS03	Walnut Creek at Indiana Street	Flow-paced (varies)	Pu, Am, isotopic U**, nitrate (pond discharges only), flow rate
	POC (5)	SW	GS08	Pond B-5 outlet	Flow-paced (varies)	Pu, Am, isotopic U**, nitrate, flow rate
	POC (5)	SW	GS11	Pond A-4 outlet	Flow-paced (varies)	Pu, Am, isotopic U**, nitrate, flow rate
	POC (5)	SW	GS31	Pond C-2 outlet	Flow-paced (varies)	Pu, Am, isotopic U**, flow rate
Points of Evaluation (POEs)						
	POE (6)	SW	GS10	S. Walnut Creek at B-Series Bypass	Flow-paced (varies)	Pu, Am, isotopic U**, dissolved Ag and Cd, total Be and Cr, flow rate
	POE (6)	SW	SW027	SID at Pond C-2	Flow-paced (varies)	Pu, Am, isotopic U**, dissolved Ag and Cd, total Be and Cr, flow rate
	POE (6)	SW	SW093	N. Walnut Creek at end of FC-3	Flow-paced (varies)	Pu, Am, isotopic U**, dissolved Ag and Cd, total Be and Cr, flow rate
Boundary Wells						
	Boundary (7)	GW	10394	Woman Creek at Indiana Street	Annual	VOCs, U, nitrate
	Boundary (7)	GW	41691	Walnut Creek at Indiana Street	Annual	VOCs, U, nitrate
Present Landfill (PLF) Area (2)						
	RCRA (10)	GW	70193	Upgradient	Quarterly	VOCs, metals
	RCRA (10)	GW	70393	Upgradient	Quarterly	VOCs, metals
	RCRA (10)	GW	70693	Upgradient	Quarterly	VOCs, metals
	RCRA (10)	GW	73005	Downgradient	Quarterly	VOCs, metals
	RCRA (10)	GW	73105	Downgradient	Quarterly	VOCs, metals
	RCRA (10)	GW	73205	Downgradient	Quarterly	VOCs, metals
	AOC (7)	GW	4087	Below East Landfill Pond	Semiannual	VOCs, U, nitrate
	AOC (7)	GW	B206989	Below East Landfill Pond	Semiannual	VOCs, U, nitrate
	Treatment System (11)	GW	PLFSEEPINF	Seep influent to treatment system	Quarterly	VOCs, isotopic U**, metals, instantaneous flow rate
	Treatment System (11)	GW	GWISINFNORTH	North GWIS influent to treatment system	Quarterly	VOCs, isotopic U**, metals, nitrate
	Treatment System (11)	GW	GWISINFSOUTH	South GWIS influent to treatment system	Quarterly	VOCs, isotopic U**, metals, nitrate
	Treatment System (11)	SW	PLFSYSEFF	Treatment system effluent	Quarterly; Monthly (if required by decision)	VOCs, SVOCs, isotopic U**, metals
	Treatment System (11)	SW	PLFPONDEFF	East Landfill Pond at outlet	As required by decision rule	As required by decision rule
Original Landfill (OLF) Area (3)						
	RCRA (10)	GW	P416589	Upgradient	Quarterly	VOCs, metals, SVOCs
	RCRA (10)	GW	80005	Downgradient	Quarterly	VOCs, metals, SVOCs
	RCRA (10)	GW	80105	Downgradient	Quarterly	VOCs, metals, SVOCs
	RCRA (10)	GW	80205	Downgradient	Quarterly	VOCs, metals, SVOCs
	AOC (7)	GW	11104	Downgradient, downstream	Semiannual	VOCs, U
	OLF SW (12)	SW	GS05	Woman Creek at west property line (upstream)	Quarterly; Monthly (if required by decision)	VOCs, isotopic U**, metals
	OLF SW (12)	SW	GS59	Woman Creek 700 feet east of OLF (downstream)	Quarterly; Monthly (if required by decision)	VOCs, isotopic U**, metals
Mound Site Plume and Treatment System (MSPTS)						
	Evaluation (9)	GW	00897	Source area	Biennial	VOCs
	Sentinel (8)	GW	15699	Downgradient of intercept trench	Semiannual	VOCs
	Treatment System (11)	GW	MOUND R1-0	Treatment system influent	Semiannual	VOCs
	Treatment System (11)	GW	MOUND R2-E	Treatment system effluent	Semiannual	VOCs
	Treatment System (11)	SW	GS10	S. Walnut Creek at B-Series Bypass	Semiannual	VOCs

Table 2 (continued). Water Monitoring Locations and Sampling Criteria

General Objective	Classification	Media	Location ID (1)	Location Description	Frequency	Analytes (4)
East Trenches Plume and Treatment System (ETPTS)						
	Evaluation (9)	GW	3687	Source area	Biennial	VOCs
	Evaluation (9)	GW	05691	Source area	Biennial	VOCs
	Evaluation (9)	GW	03991	East of source area	Biennial	VOCs
	Sentinel (8)	GW	04091	East of source area	Semiannual	VOCs
	Sentinel (8)	GW	95299	Downgradient of intercept trench	Semiannual	VOCs
	Sentinel (8)	GW	95199	Downgradient of intercept trench	Semiannual	VOCs
	Sentinel (8)	GW	95099	Downgradient of intercept trench	Semiannual	VOCs
	Sentinel (8)	GW	23296	Downgradient of intercept trench	Semiannual	VOCs, U
	Sentinel (8)	GW	TH046992	Downgradient of intercept trench	Semiannual	VOCs
	Treatment System (11)	GW	ET INFLUENT	Treatment system influent	Semiannual	VOCs
	Treatment System (11)	GW	ET EFFLUENT	Treatment system effluent	Semiannual	VOCs
	Treatment System (11)	SW	POM2	S. Walnut Creek at Pond B-4 outlet	Semiannual	VOCs
Solar Ponds Plume and Treatment System (SPPTS)						
	Evaluation (9)	GW	P210189	VOC plume source area	Biennial	VOCs, U, nitrate
	Evaluation (9)	GW	79102	SPP source area - north	Biennial	VOCs, U, nitrate
	Evaluation (9)	GW	79202	SPP source area - north	Biennial	VOCs, U, nitrate
	Evaluation (9)	GW	P208989	SPP source area - north	Biennial	VOCs, U, nitrate
	Evaluation (9)	GW	79302	SPP source area - northeast	Biennial	U, nitrate
	Evaluation (9)	GW	79402	SPP source area - northeast	Biennial	U, nitrate
	Evaluation (9)	GW	79502	SPP source area - east	Biennial	U, nitrate
	Evaluation (9)	GW	79605	SPP source area - east	Biennial	U, nitrate
	Evaluation (9)	GW	00203	SPP source area - south	Biennial	VOCs, U, nitrate
	Evaluation (9)	GW	22205	SPP downgradient plume - north	Biennial	VOCs, U, nitrate
	Sentinel (8)	GW	P210089	SPP downgradient plume - north	Semiannual	VOCs, U, nitrate
	Sentinel (8)	GW	70099	Northwest of system	Semiannual	U, nitrate
	Treatment System (11)	GW	SPIN	Treatment system influent	Semiannual	U, nitrate
	Treatment System (11)	GW	SPPMM01	Treatment system effluent	Semiannual	U, nitrate
	Treatment System (11)	SW	GS13	N. Walnut Creek at A-Series Bypass	Semiannual	U, nitrate
	Evaluation (9)	GW	B210489	Downgradient of treatment system	Biennial	U, nitrate
	Evaluation (9)	GW	51605	Downgradient, adjacent to GS13	Biennial	U, nitrate

Table 2 (continued). Water Monitoring Locations and Sampling Criteria

General Objective	Classification	Media	Location ID (1)	Location Description	Frequency	Analytes (4)
Other Areas of Interest						
ainages Below Impacted Areas	AOC (7)	GW	10594	N. Walnut Creek downstream of Pond A-1	Semiannual	VOCs, U, nitrate
	AOC (7)	GW	00997	S. Walnut Creek upstream of Pond B-5	Semiannual	VOCs, U, nitrate
	AOC (7)	GW	00193	Woman Creek upstream of Pond C-2	Semiannual	VOCs, U
Former Building 371/374	Sentinel (8)	GW	37505	North part of former B371 area	Semiannual	VOCs, U, nitrate
	Sentinel (8)	GW	37405	North/northeast part of former B371/374 area	Semiannual	VOCs, U, nitrate, Pu*, Am*
	Sentinel (8)	GW	37705	East/southeast of former B371/374 area at foundation drain confluence	Semiannual	VOCs, U, nitrate, Pu*, Am*
Former Building 771/774	Sentinel (8)	GW	20705	North/northwest of former B771 area	Semiannual	VOCs, U, nitrate, Pu*, Am*
	Sentinel (8)	GW	20505	North of former B771/774 area	Semiannual	VOCs, U, Pu*, Am*
	Sentinel (8)	GW	20205	North/northeast of former B771/774 area	Semiannual	VOCs, U, Pu*, Am*
Former North-Central IA	Evaluation (9)	GW	P114689	Southwest of former B559 area	Biennial	VOCs
	Evaluation (9)	GW	P115589	West part of former B551 Warehouse area	Biennial	VOCs
	Evaluation (9)	GW	70705	East part of former B707 area	Biennial	VOCs, U
	Evaluation (9)	GW	33905	North of former 231 Tanks area	Biennial	VOCs
	Evaluation (9)	GW	21505	West of former B776/777 area	Biennial	VOCs
	Sentinel (8)	GW	52505	West of former IHSS 118.1 area	Semiannual	VOCs
	Evaluation (9)	GW	20902	Northwest of former IHSS 118.1	Biennial	VOCs
	AOC (7)	GW	42505	Terminus of FC-2	Semiannual	VOCs
Former Building 559	Evaluation (9)	GW	55905	North part of former B559 area	Biennial	VOCs, U, nitrate
	Evaluation (9)	GW	56305	West part of former B559 area	Biennial	VOCs, U, nitrate
Former IHSS 118.1	Evaluation (9)	GW	18199	North of former IHSS 118.1 area	Biennial	VOCs
	SW Performance [SW018]	SW	SW018	Upstream of FC-2 wetland	Semiannual	VOCs
Former Building 444 Complex	Evaluation (9)	GW	40005	West part of former B444 area	Biennial	VOCs, U
	Evaluation (9)	GW	40205	South part of former B444 end	Biennial	VOCs, U
	Evaluation (9)	GW	P419689	Southeast of former B444 area	Biennial	VOCs, U
	Sentinel (8)	GW	40305	East part of former B444 area	Semiannual	VOCs, U
	Evaluation (9)	GW	P416889	Southeast of former B444 area	Biennial	VOCs, U
	Sentinel (8)	GW	11502	Southeast of former B444 area	Semiannual	VOCs, U
Former Building 881	Evaluation (9)	GW	88205	South part of former B881 area	Biennial	VOCs, U
	Sentinel (8)	GW	88104	South part of former B881 area	Semiannual	VOCs, U
	Sentinel (8)	GW	00797	South of former B881 area	Semiannual	VOCs, U
Former Building 886	Evaluation (9)	GW	22996	East/northeast part of former B886 area	Biennial	VOCs, U
Former Building 991	Sentinel (8)	GW	99305	East part of former B991 area	Semiannual	VOCs, U, nitrate
	Sentinel (8)	GW	99405	Southeast part of former B991 area	Semiannual	VOCs, U, nitrate
	Sentinel (8)	GW	91305	South of confluence of FC-4 and FC-5	Semiannual	VOCs, U, nitrate
Former Oil Burn Pit No. 1	Evaluation (9)	GW	33502	Source area	Biennial	VOCs
	Evaluation (9)	GW	33604	Source area	Biennial	VOCs
	Sentinel (8)	GW	33703	Downgradient of source area	Semiannual	VOCs
Former Oil Burn Pit No. 2	Evaluation (9)	GW	91105	Source area	Biennial	VOCs
	Sentinel (8)	GW	91203	Downgradient of source area	Semiannual	VOCs
Former SW056	Sentinel (8)	GW	45605	Adjacent to French drain remnants and drain interruption	Semiannual	VOCs
OU1 Plume	Evaluation (9)	GW	891WEL	Source area	Biennial	VOCs
	AOC (7)	GW	89104	Downgradient at Woman Creek	Semiannual	VOCs
903 Pad/Ryan's Pit Plume	Evaluation (9)	GW	00191	East of former 903 Pad area	Biennial	VOCs
	Evaluation (9)	GW	50299	East of former 903 Pad area	Biennial	VOCs
	Evaluation (9)	GW	90402	Southeast of former 903 Pad area	Biennial	VOCs
	Evaluation (9)	GW	00491	Southeast of former 903 Pad area	Biennial	VOCs
	Evaluation (9)	GW	07391	Ryan's Pit source area	Biennial	VOCs, U
	Evaluation (9)	GW	90804	Southeast part of 903 Pad/Ryan's Pit Plume	Biennial	VOCs
	Sentinel (8)	GW	90399	Southeast part of 903 Pad/Ryan's Pit Plume at SID	Semiannual	VOCs
	Sentinel (8)	GW	90299	Southeast part of 903 Pad/Ryan's Pit Plume at SID	Semiannual	VOCs
	AOC (7)	GW	10304	Southeast of 903 Pad/Ryan's Pit Plume at Woman Creek	Semiannual	VOCs, U, nitrate
PU&D Yard Plume	Evaluation (9)	GW	30900	Source area	Biennial	VOCs
	Sentinel (8)	GW	30002	Downgradient at N. Walnut Creek	Semiannual	VOCs

Table 2 (continued). Water Monitoring Locations and Sampling Criteria

General Objective	Classification	Media	Location ID (1)	Location Description	Frequency	Analytes (4)
Pre-discharge						
	Pre-discharge (13)	SW	Pond A-4	A-Series terminal pond on N. Walnut Creek	Prior to routine discharge	Pu, Am, isotopic U**, nitrate
	Pre-discharge (13)	SW	Pond B-5	B-Series terminal pond on S. Walnut Creek	Prior to routine discharge	Pu, Am, isotopic U**, nitrate
	Pre-discharge (13)	SW	Pond C-2	C-Series terminal pond in Woman Creek	Prior to routine discharge	Pu, Am, isotopic U**

Notes

(1) See Figure 1 for monitoring locations
(2) Laboratory analytes are limited to those listed in Appendix C of the Present Landfill Monitoring and Maintenance Plan and Post-Closure Plan
(3) Laboratory analytes are limited to those listed in Appendix C of the Landfill Monitoring and Maintenance Plan, RFETS Original Landfill
(4) Analysis and evaluation for metals and VOCs will be performed for some or all of the analytes listed in Table 1
(5) Results for POCs are evaluated using Figure 5.
(6) Results from POEs are evaluated using Figure 6.
(7) Results from AOC and Boundary wells and SW018 are evaluated using Figure 7.
(8) Results from Sentinel wells are evaluated using Figure 8.
(9) Results from Evaluation wells are evaluated using Figure 9.
(10) Results from RCRA wells are evaluated using Figure 10.
(11) Results from Treatment System locations are evaluated using Figure 11.
(12) Results from OLF SW locations are evaluated using Figure 12.
(13) Results from Predischarge locations are evaluated using Figure 13.
* Samples of ground water collected for Pu and Am analysis will be filtered in the field using a 0.45 um in-line filter.
** Isotopes U-233,234; U-235; U-238

Acronyms and Abbreviations

Ag: silver
Am: americium-241
AOC: Area of Concern
B (followed by numerals): Building (e.g., B371)
Be: beryllium
Cd: cadmium
Cr: chromium
FC: Functional Channel (e.g., FC-2)
GW: ground water
IA: Industrial Area
N/A: not applicable
OLF: Original Landfill
OU1: Operable Unit 1
PLF: Present Landfill
POC: Point of Compliance
POE: Point of Evaluation
PU&D: Property Utilization and Disposal
Pu: plutonium-239,240
RCRA: Resource Conservation and Recovery Act
SID: South Interceptor Ditch
SPP: Solar Ponds Plume
SVOCs: semi-volatile organic compounds
SW: surface water
U: uranium
VOCs: volatile organic compounds

Table 3. Present and Original Landfill Inspection and Maintenance Requirements

Present Landfill

Requirement	Description of activity	Frequency	Documentation/Reporting	Exit strategy
Final cover inspection and monitoring	- inspect/monitor slope stability, soil cover - visually inspect surface of landfill cover for cracks, depressions, heaving, and sinkholes - monitor settlement monuments and side slope stability monuments - vegetation monitoring	- monthly for first year (settlement monuments and vegetation quarterly for first year); evaluate frequency during CERCLA periodic review - additional weather-related inspections after storm event of one inch or more of rain in a 24-hour period or significant melt of 10-inch or more snowstorm	- conditions affecting effectiveness of landfill cover to be reported per note 1 below - document on inspection checklist; submit to parties within one month of inspection; include in quarterly and annual reports	- Consultative process or periodic CERCLA review
Inspection and monitoring of stormwater management system and erosion control features	- Visually inspect stormwater management structures (channels/lining, culverts, and outfalls); erosion control features (perimeter channels and natural drainages); and seep treatment system	- monthly for first year; evaluate frequency during CERCLA periodic review - additional weather-related inspections after storm event of one inch or more of rain in a 24-hour period or significant melt of 10-inch or more snowstorm	- conditions affecting effectiveness of landfill cover to be reported per note 1 below - document on inspection checklist; submit to parties within one month of inspection; include in quarterly and annual reports	- Consultative process or periodic CERCLA review
GW monitoring	Included in Table 2, Figure 1, and Figure 10	Included in Table 2, Figure 1, and Figure 10	Included in Table 2, Figure 1, and Figure 10	Included in Table 2, Figure 1, and Figure 10
Landfill seep and pond monitoring	Included in Table 2, Figure 1, and Figure 11	Included in Table 2, Figure 1, and Figure 11	Included in Table 2, Figure 1, and Figure 11	Included in Table 2, Figure 1, and Figure 11
Maintenance and repairs	Perform minor or major repairs as needed; for major damage or repairs, consult with parties and develop appropriate actions for approval by CDPHE	- as needed	- minor/routine repairs and maintenance report on inspection form - conditions affecting effectiveness of landfill cover to be reported per note 1 below	Consultative process or periodic CERCLA review
Institutional and physical controls	Fence around perimeter of Central OU, signs at entry points to Central OU, warning signs in accordance with 6 CCR 1007-3 Part 265.14		- failure of physical controls to be reported per note 1 below - failure of institutional controls to be per note 2 below	Consultative process or periodic CERCLA review

Table 3 (continued). Present and Original Landfill Inspection and Maintenance Requirements

Original Landfill

Requirement	Description of activity	Frequency	Documentation/Reporting	Exit strategy
Final cover inspection and monitoring	- inspect/monitor slope stability and soil cover - visually inspect surface of landfill cover for cracks, depressions, heaving, sinkholes; visually inspect diversion berms; measure height and gradient if indicated - monitor settlement monuments	- Quarterly; evaluate frequency during CERCLA periodic review - Additional weather-related monitoring within 2 days after a storm event of one inch or more or rain in a 24-hour period or significant melt of a 10-inch or more snowstorm - quarterly for the first year and annually thereafter	- conditions affecting effectiveness of landfill cover to be reported per note 1 below - document on inspection checklist; submit to parties within one month of inspection; include in quarterly and annual reports	- Consultative process or periodic CERCLA review
Inspection and monitoring of stormwater management system, seeps, and erosion controls	- Visually inspect/monitor stormwater management structures, seeps, and erosion controls	- Quarterly; evaluate frequency during CERCLA periodic review - Additional weather-related monitoring within 2 days after a storm event of one inch or more or rain in a 24-hour period or significant melt of a 10-inch or more snowstorm	- conditions affecting effectiveness of landfill cover to be reported per note 1 below - document on inspection checklist; submit to parties within one month of inspection; include in quarterly and annual reports	- Consultative process or periodic CERCLA review
Vegetation monitoring	- Visually inspect vegetation and perform maintenance as necessary	- monthly from April to September and quarterly the rest of the year for 2006 and 2007; quarterly beginning in 2008	- Document on inspection forms and in annual report	- Consultative process or periodic CERCLA review
GW monitoring	Included in Table 2, Figure 1, and Figure 10	Included in Table 2, Figure 1, and Figure 10	Included in Table 2, Figure 1, and Figure 10	Included in Table 2, Figure 1, and Figure 10
SW monitoring	Included in Table 2, Figure 1, and Figure 12	Included in Table 2, Figure 1, and Figure 12	Included in Table 2, Figure 1, and Figure 12	Included in Table 2, Figure 1, and Figure 12
Maintenance and repairs	- Perform minor or major repairs and maintenance - For major damage or repairs, consult with parties and develop appropriate actions for approval by CDPHE	- as needed	- minor/routine repairs and maintenance, report on inspection form - conditions affecting effectiveness of landfill cover to be reported per note 1 below	Consultative process or periodic CERCLA review
Institutional and physical controls	- inspection for evidence that institutional controls were violated or physical controls damaged	- document on inspection forms	- failure of physical controls to be reported per note 1 below - failure of institutional controls to be reported per note 2 below	Consultative process or periodic CERCLA review

Table 3 (continued). Present and Original Landfill Inspection and Maintenance Requirements

Note 1: For reportable conditions as defined in RFLMA Attachment 2, Section 6.0 (except in the case of failure of institutional controls), DOE will inform CDPHE and EPA within 15 days of receiving the inspection reports or validated data. Evaluation and planning for mitigating actions, if any, will be prepared and submitted as defined in RFLMA, Attachment 2, Section 6.0.

Note 2: In case of failure of institutional controls, DOE will notify EPA and CDPHE within 2 days of discovering evidence and will perform evaluation, consultation, and actions as defined in RFLMA, Attachment 2, Section 6.0.

Table 4. Institutional Controls for the Central Operable Unit

Controls	Use Restrictions
1	The construction and use of buildings that will be occupied on a permanent or temporary basis (such as for residences or offices) is prohibited. The construction and use of storage sheds or other, non-occupied structures is permitted, consistent with the restrictions contained in controls 2 and 3 below, and provided such use does not impair any aspect of the response action at Rocky Flats.
2	Excavation, drilling, and other intrusive activities below a depth of three feet are prohibited, except for remedy-related purposes and routine or emergency maintenance of existing utility easements, in accordance with pre-approved procedures.
3	No grading, excavation, digging, tilling, or other disturbance of any kind of surface soils is permitted, except in accordance with an erosion control plan (including Surface Water Protection Plans submitted to EPA under the Clean Water Act) approved by CDPHE or EPA. Any such soil disturbance will restore the soil surface to preexisting grade.
4	Surface water may not be used for drinking water or agricultural purposes.
5	The construction or operation of groundwater wells is prohibited, except for remedy-related purposes.
6	Digging, drilling, tilling, grading, excavation, construction of any sort (including construction of any structures, paths, trails or roads), and vehicular traffic are prohibited on the covers of the Present Landfill and the Original Landfill, except for authorized response actions.
7	Activities that may damage or impair the proper functioning of any engineered component of the response action, including but not limited to any treatment system, monitoring well, landfill cap, or surveyed benchmark, are prohibited.

Table 5. Ecological Sampling

Requirement	Description of Activity	Frequency	Documentation/Reporting	Exit Strategy
Sample surface water and sediment for: Ammonia Cyanide Radium-228	Collect surface water and sediment samples from Ponds A4, B5, and C2	Surface water: Quarterly (minimum of 3) Sediment: Once	Report data in quarterly and annual reports; evaluate in CERCLA Periodic Review for relevance of the data to the ecological risks and uncertainty identified in the CAD/ROD	Consultative process or periodic CERCLA review

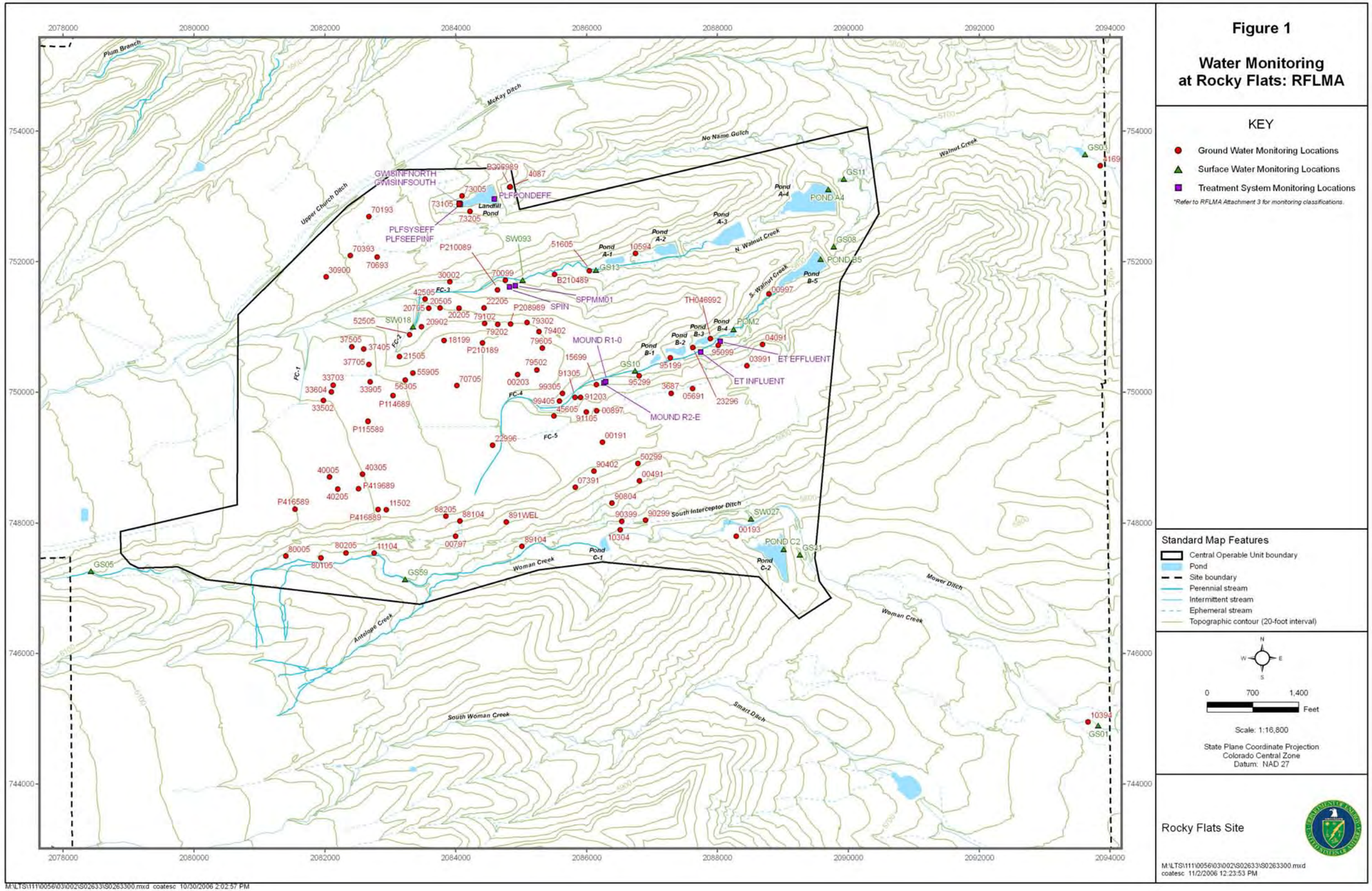


Figure 1. Water Monitoring Locations

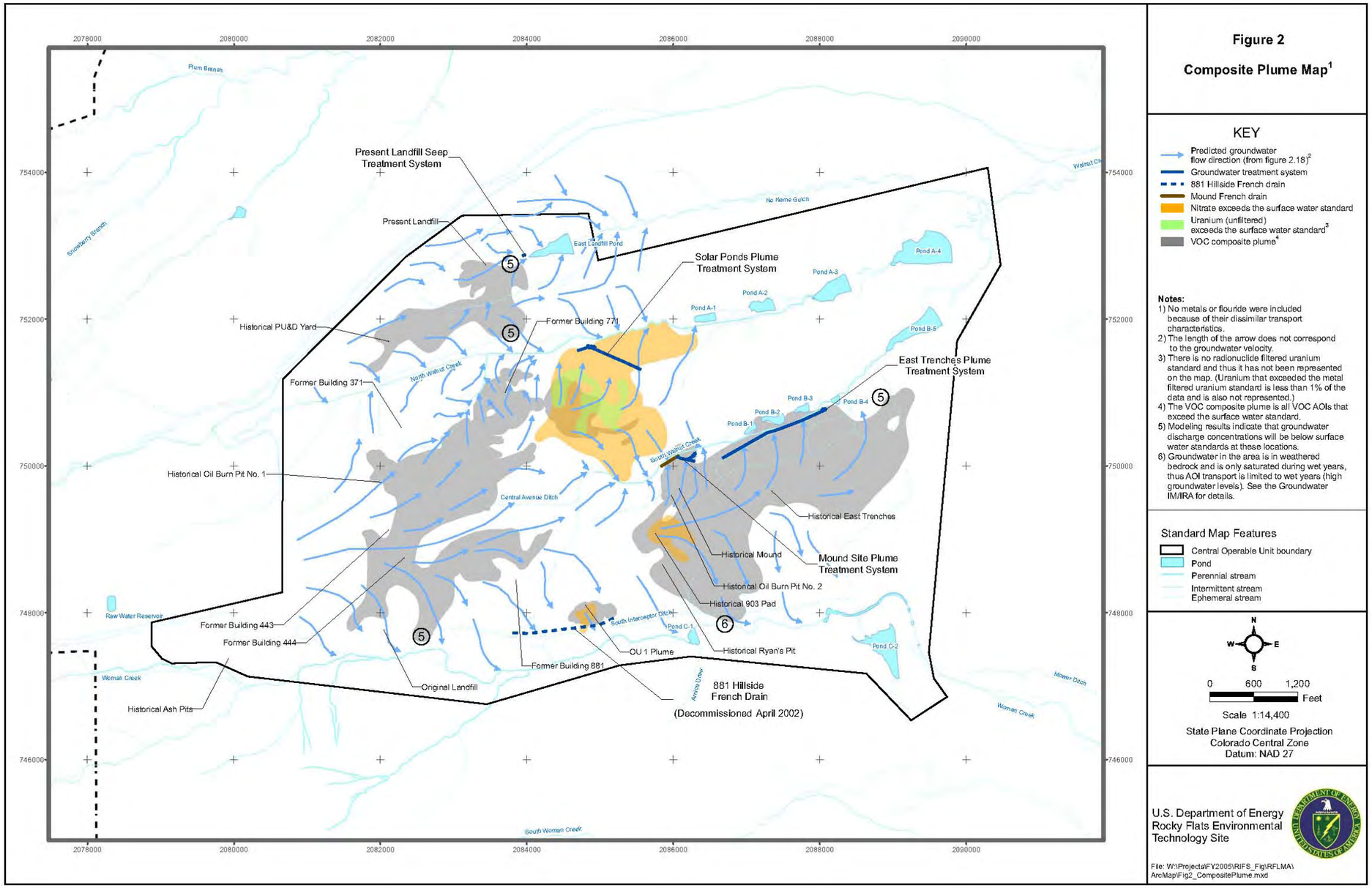


Figure 2. Composite Plume Map

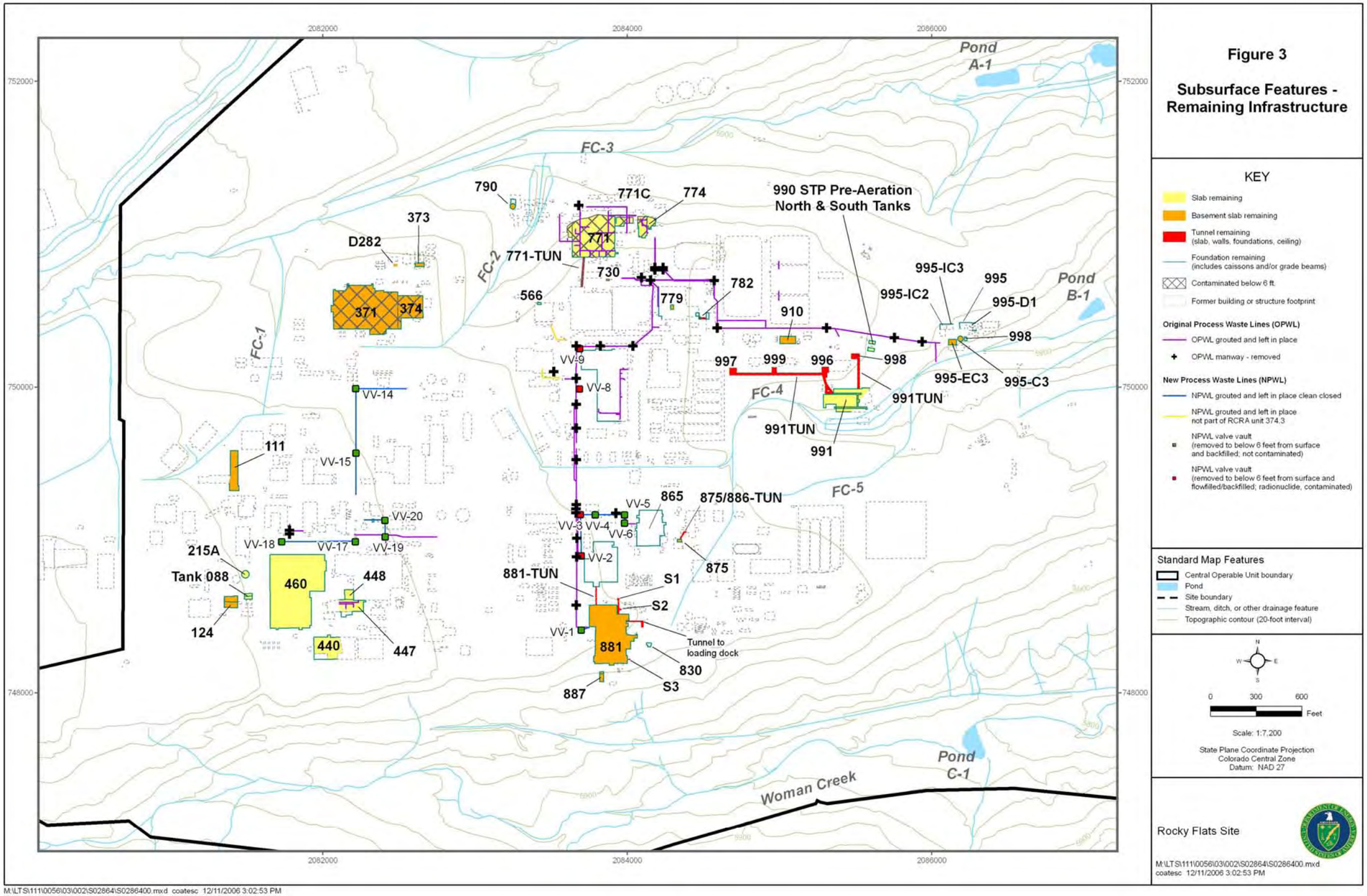


Figure 3. Subsurface Features – Remaining Infrastructure

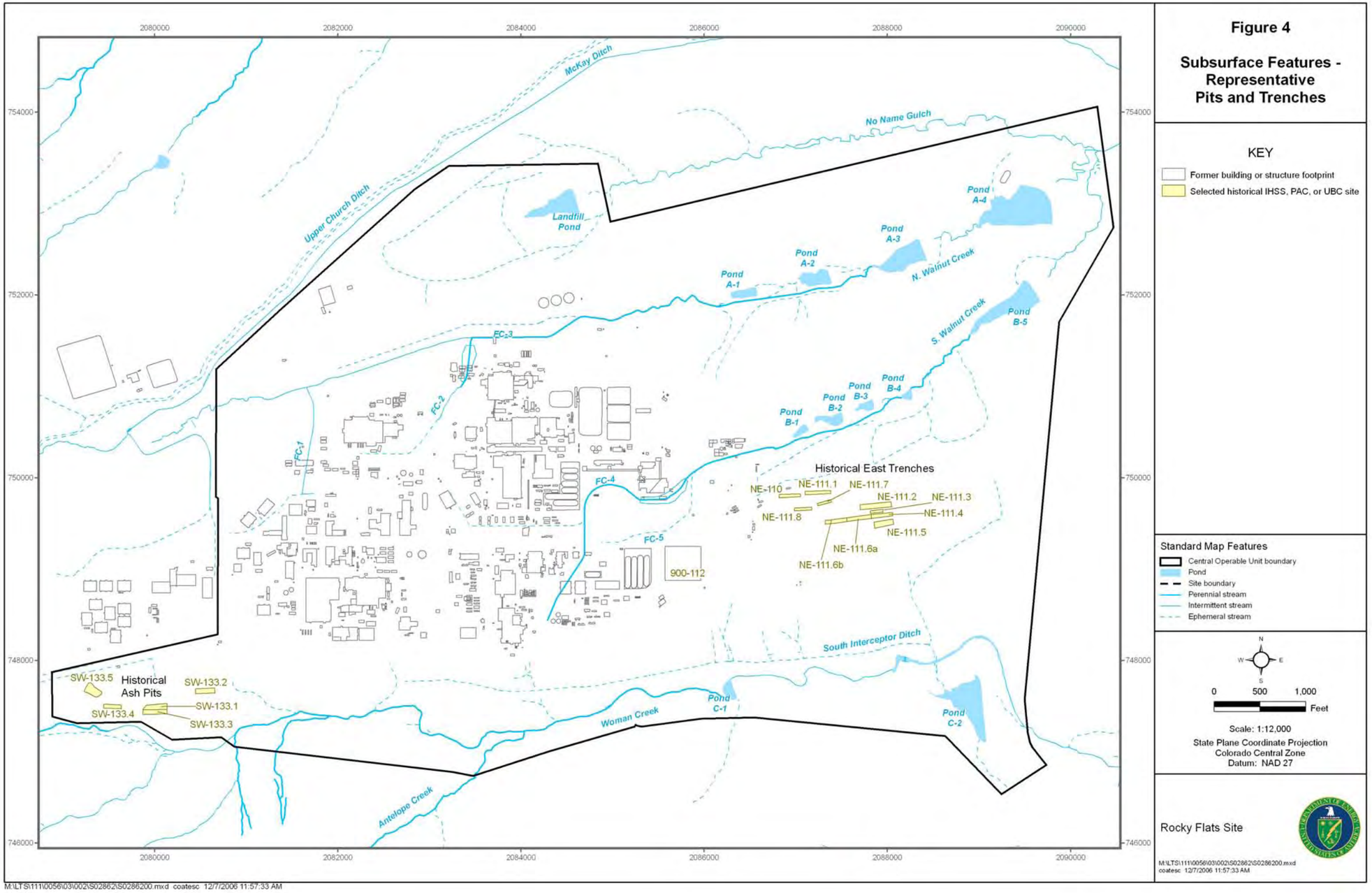
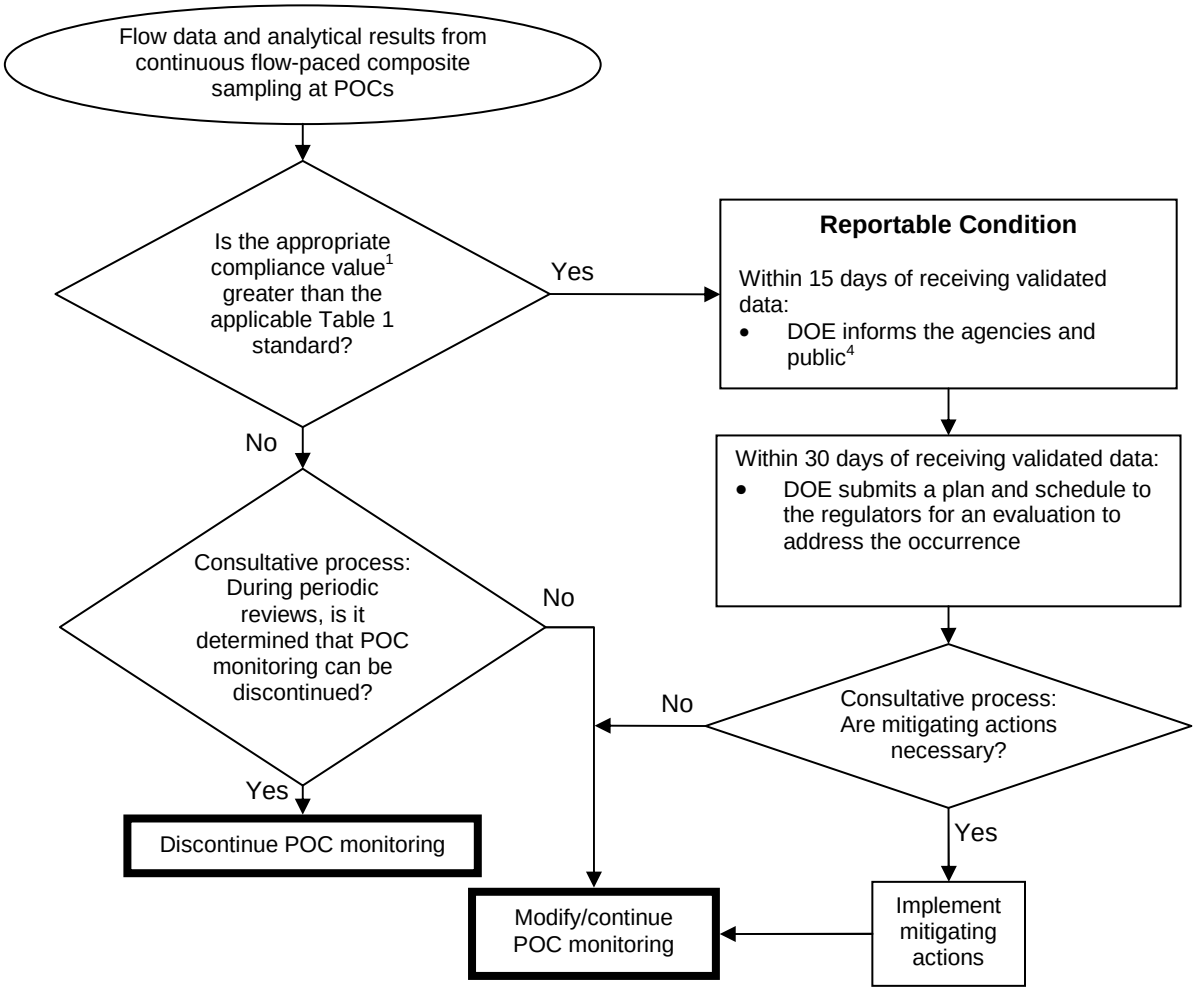


Figure 4. Subsurface Features – Representative Pits and Trenches



Notes: see Fig. 1 and Tables 1 and 2 for locations, standards, and sampling criteria.

[1] Appropriate Compliance Values by locations and analytes (see Table 2 for reference)

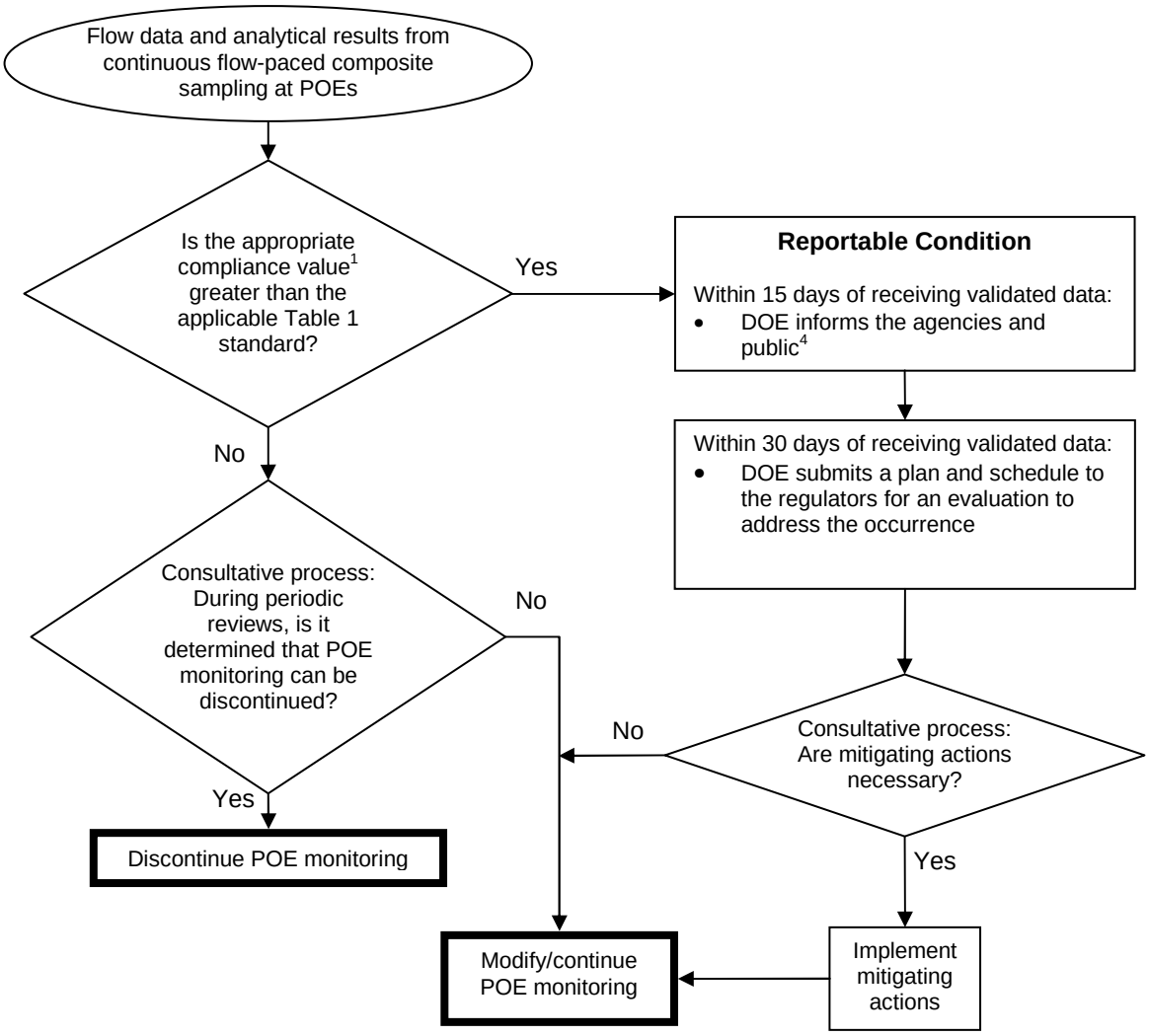
- All Indiana Street POCs:
  - plutonium, americium, uranium → 30-day average[2]
- All Terminal Pond POCs:
  - plutonium, americium, uranium → 12-month rolling average[3]
- Walnut Creek at Indiana Street POCs:
  - nitrate → 85th percentile of 30-day averages[3] for previous calendar year
- Walnut Creek Terminal Pond POCs:
  - nitrate → 12-month rolling average[2]

[2] The 30-day average for a particular day is calculated as a volume-weighted average of a "window" of time containing the previous 30 days with measurable flow. Each day has its own discharge volume (measured with a flow meter) and activity/concentration (from the sample carboy in place at the end of that day). Therefore, there are 365 30-day moving averages for a location that flows all year. At locations that have intermittent flows, 30-day averages are reported as averages of the previous 30 days of greater than zero flow. For days where no analytical result is available, either due to failed laboratory analysis or non-sufficient quantity (NSQ) for analysis, no 30-day average is reported.

[3] The 12-month rolling average for the last day of a particular month is calculated as a volume-weighted average of a "window" of time containing the previous 12 months. Each 12-month "window" includes daily discharge volumes (measured with a flow meter) and daily activities/concentrations (from the sample carboy in place at the end of that day). Therefore, there are twelve 12-month rolling averages for a given calendar year. Days with no flow or no analytical result, either due to failed laboratory analysis or NSQ for analysis, are not included in the average. When no flow has occurred in the previous 12 months, no 12-month rolling average is reported.

[4] Agencies: EPA, CDPHE, and USFWS
Public: Cities of Broomfield, Northglenn, Thornton, and Westminster; Rocky Flats Stewardship Council (RFSC)

Figure 5. Points of Compliance



Notes: see Fig. 1 and Tables 1 and 2 for locations, standards, and sampling criteria.

[1] Appropriate Compliance Values by analytes (see Table 2 for reference)

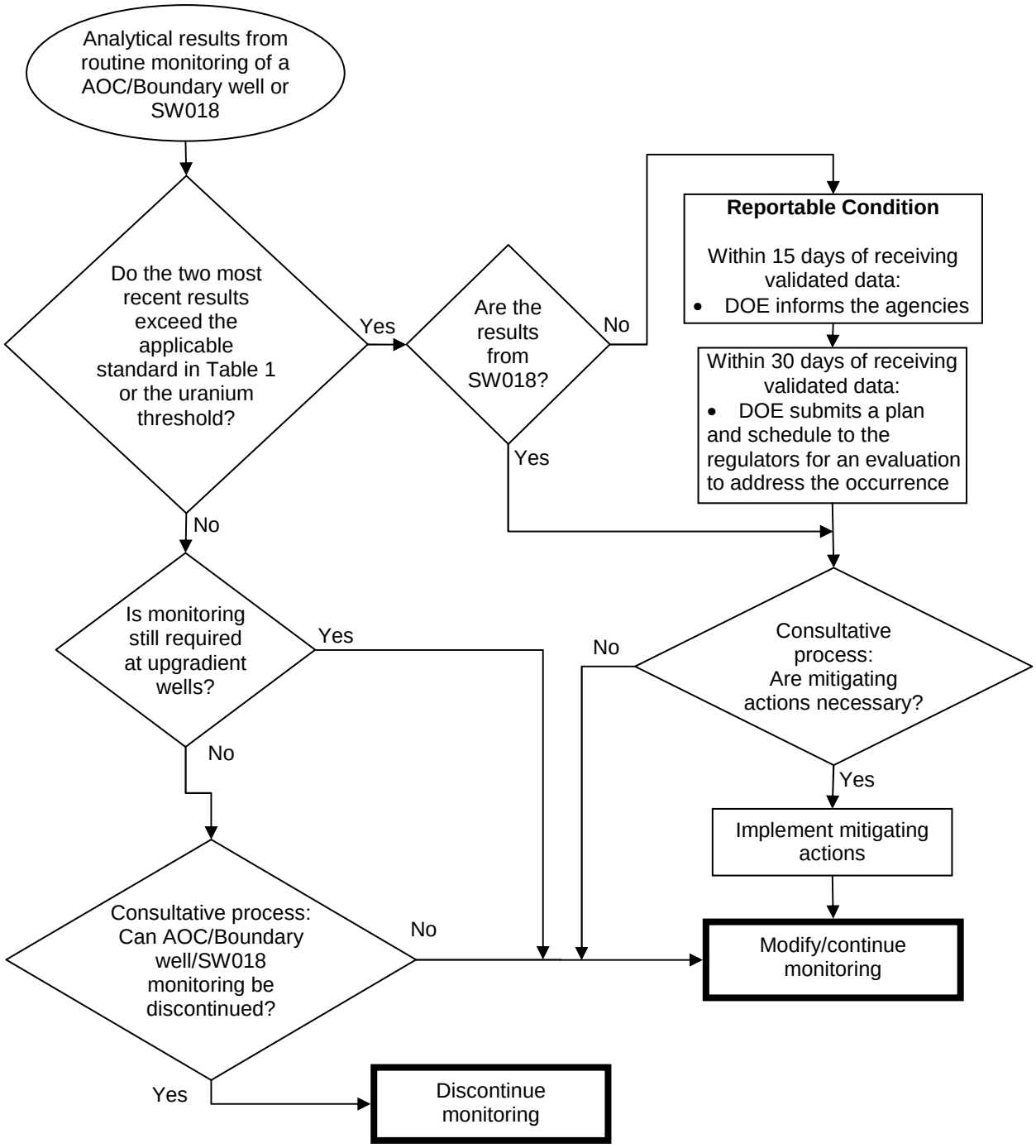
- plutonium, americium, uranium → 12-month rolling average[2]
- dissolved Cd and Ag, total Be and Cr → 85th percentile of 30-day averages[3] for previous calendar year

[2] The 30-day average for a particular day is calculated as a volume-weighted average of a "window" of time containing the previous 30-days with measurable flow. Each day has its own discharge volume (measured with a flow meter) and activity/concentration (from the sample carboy in place at the end of that day). Therefore, there are 365 30 day moving averages for a location that flows all year. At locations that have intermittent flows, 30-day averages are reported as averages of the previous 30 days of greater than zero flow. For days where no analytical result is available, either due to failed laboratory analysis or NSQ for analysis, no 30-day average is reported.

[3] The 12-month rolling average for the last day of a particular month is calculated as a volume-weighted average of a "window" of time containing the previous 12 months. Each 12-month "window" includes daily discharge volumes (measured with a flow meter) and daily activities/concentrations (from the sample carboy in place at the end of that day). Therefore, there are twelve 12-month rolling averages for a given calendar year. Days with no flow or no analytical result, either due to failed laboratory analysis or NSQ for analysis, are not included in the average. When no flow has occurred in the previous 12 months, no 12-month rolling average is reported.

[4] Agencies: EPA, CDPHE, and USFWS
Public: Cities of Broomfield, Northglenn, Thornton, and Westminster; Rocky Flats Stewardship Council (RFSC)

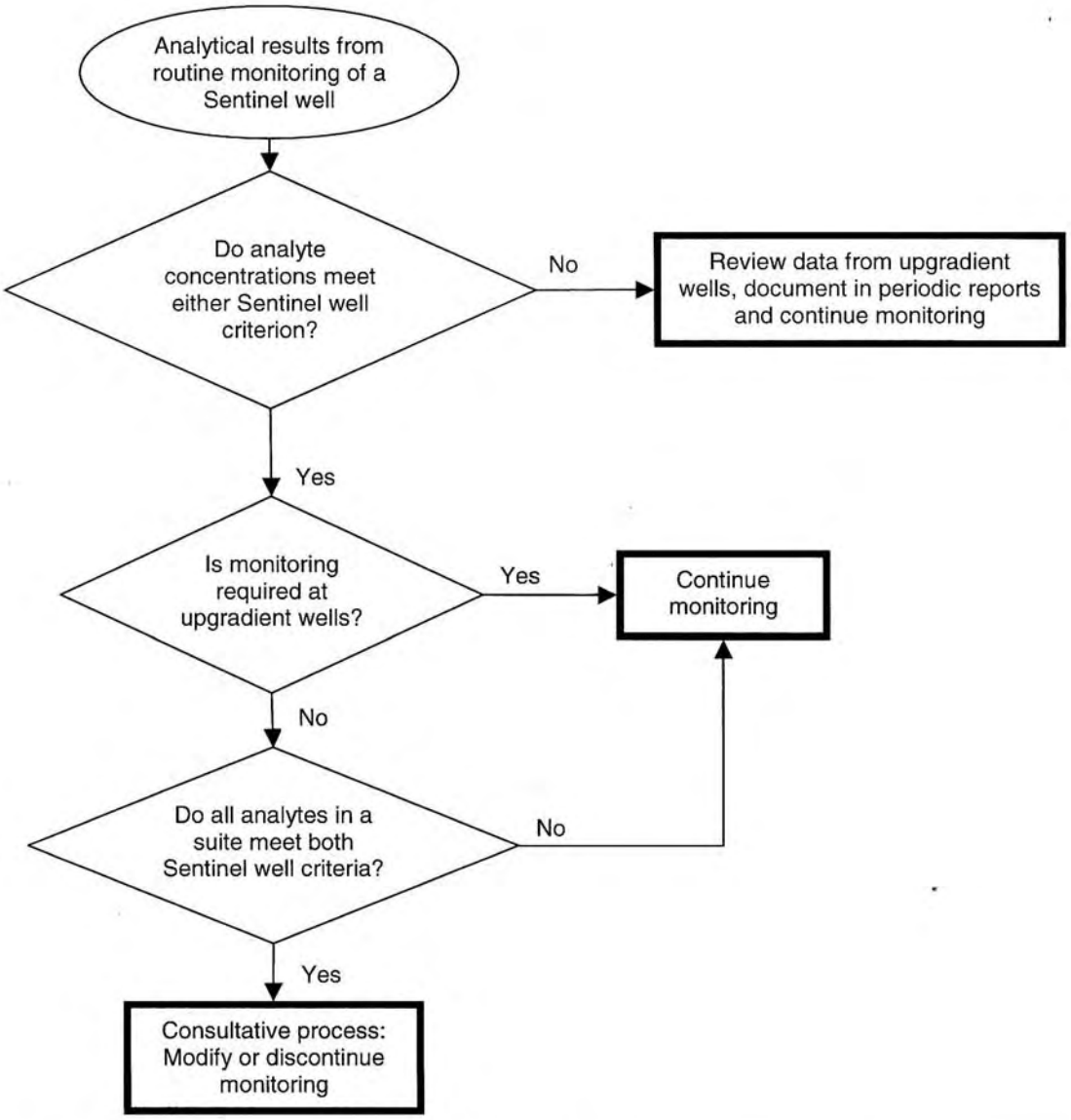
Figure 6. Points of Evaluation



Notes: see Fig. 1 and Tables 1 and 2 for locations, standards, and sampling criteria.

- AOC wells and location SW018 are sampled twice each year; see Table 2.
- Boundary wells are sampled once each year; see Table 2. These wells are not part of the remedy, but are a component of operational monitoring.
- Decisions related to uranium in ground water are based upon a 16 ug/L threshold for Boundary wells (basis: the 11 pCi/L standard) and a 120 ug/L threshold for AOC wells (basis: a grand mean of results from Site-wide high-resolution uranium analyses performed in the late 1990s through mid-2000s), rather than the standard in Table 1.

Figure 7. Area of Concern Wells, Boundary Wells, and SW018



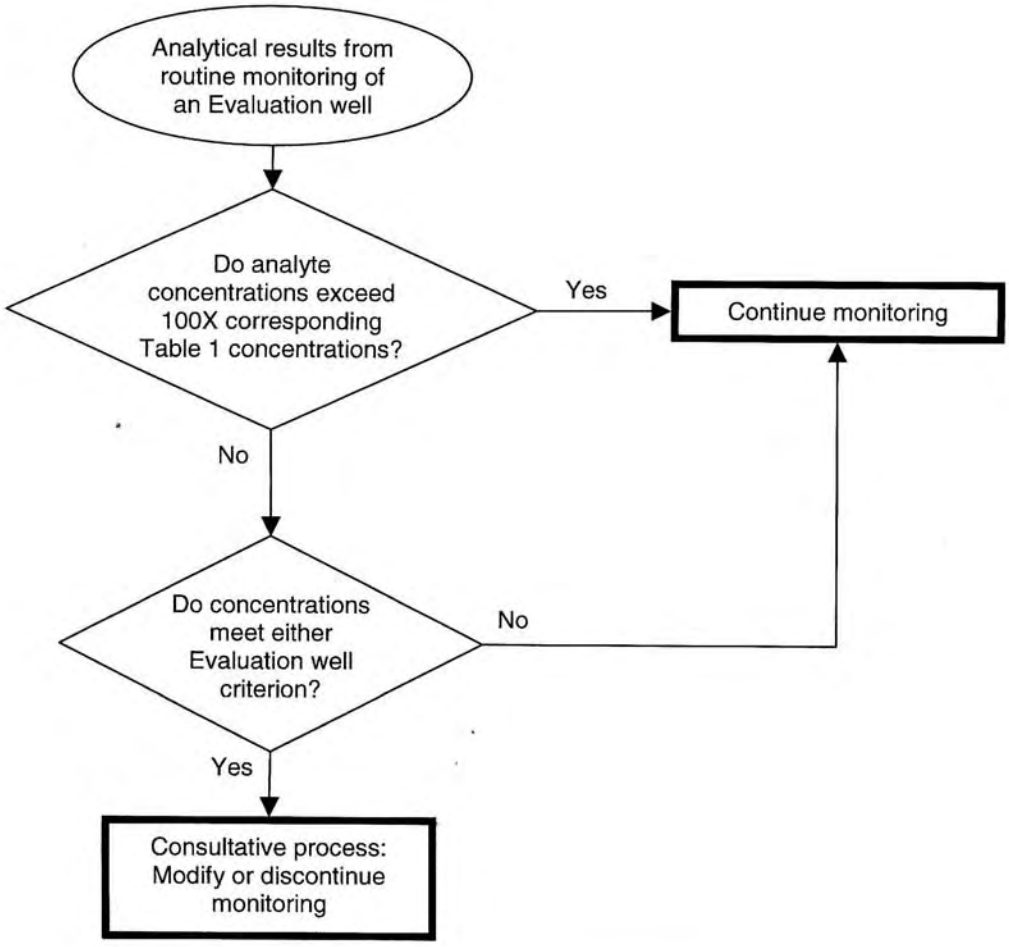
Notes: see Fig. 1 and Tables 1 and 2 for locations, standards, and sampling criteria.

- Sentinel wells are sampled twice each year; see Table 2.
- Decisions related to uranium are based upon a 120 ug/L threshold for AOC wells (basis: a grand mean of results from Site-wide high-resolution uranium analyses performed in the late 1990s through mid-2000s), rather than the standard in Table 1.

Sentinel Well Criteria

1. The 85th percentile concentration of an analyte *is less than or equal to* the corresponding concentration in Table 1 or, for uranium, the 85th percentile concentration does not exceed 2x120 ug/L or the highest calendar year 2005 concentration, whichever is higher.
2. Analyte concentrations exhibit an indeterminate or statistically-significant *decreasing* trend at the 95% confidence level.

Figure 8. Sentinel Wells



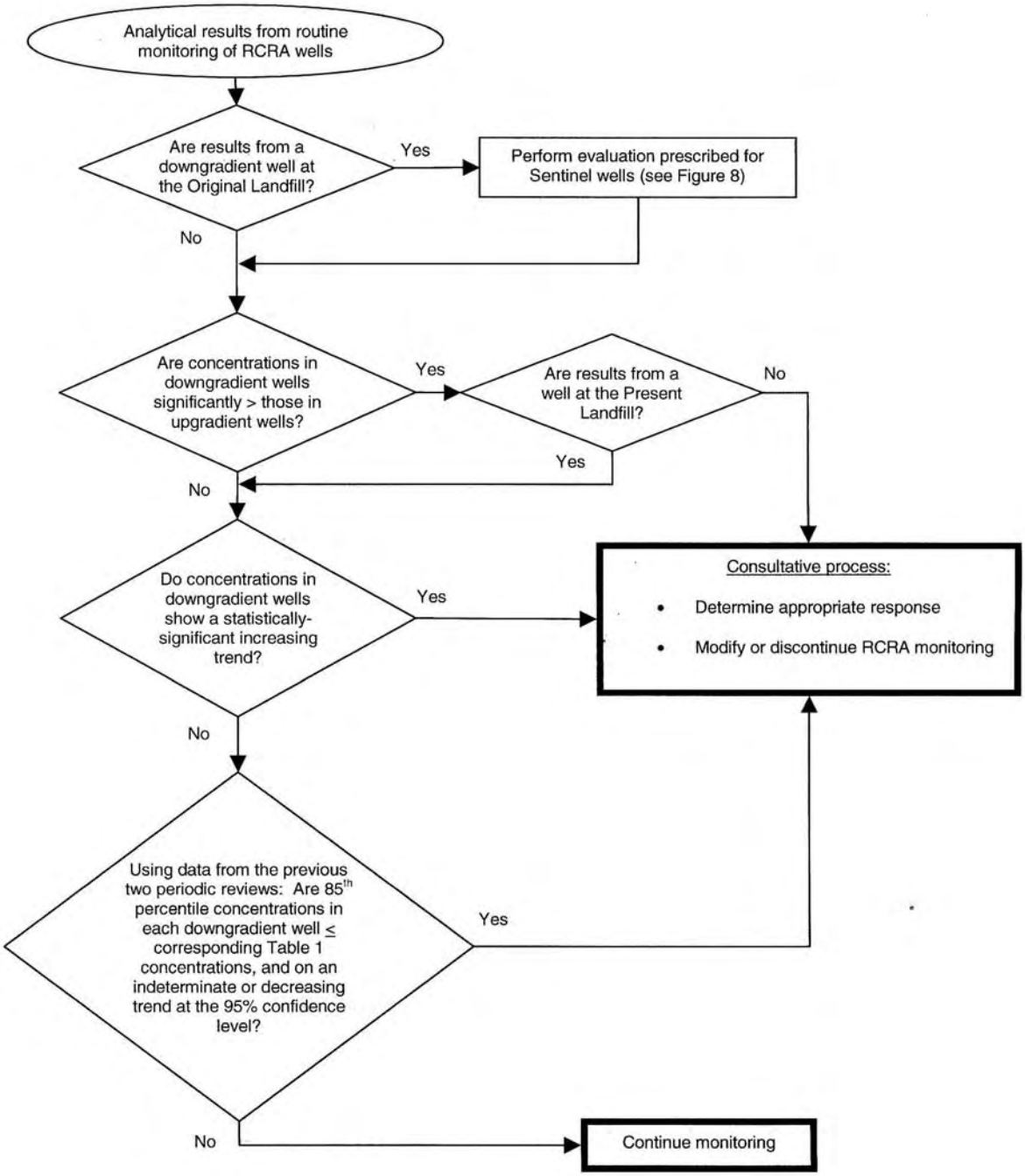
Notes: see Fig. 1 and Tables 1 and 2 for locations, standards, and sampling criteria.

- Evaluation wells are listed in Table 2.

Evaluation Well Criteria:

1. The 85th percentile concentration of an analyte *is less than or equal to* the corresponding concentration in Table 1, or, for uranium, 240 ug/L or highest pre-CY05 concentration, whichever is higher.
2. Analyte concentrations exhibit an indeterminate or statistically-significant *decreasing* trend at the 95% confidence level.

Figure 9. Evaluation Wells



Notes: see Fig. 1 and Tables 1 and 2 for locations, standards, and sampling criteria.
RCRA wells are sampled quarterly; see Table 2.

Figure 10. RCRA Wells

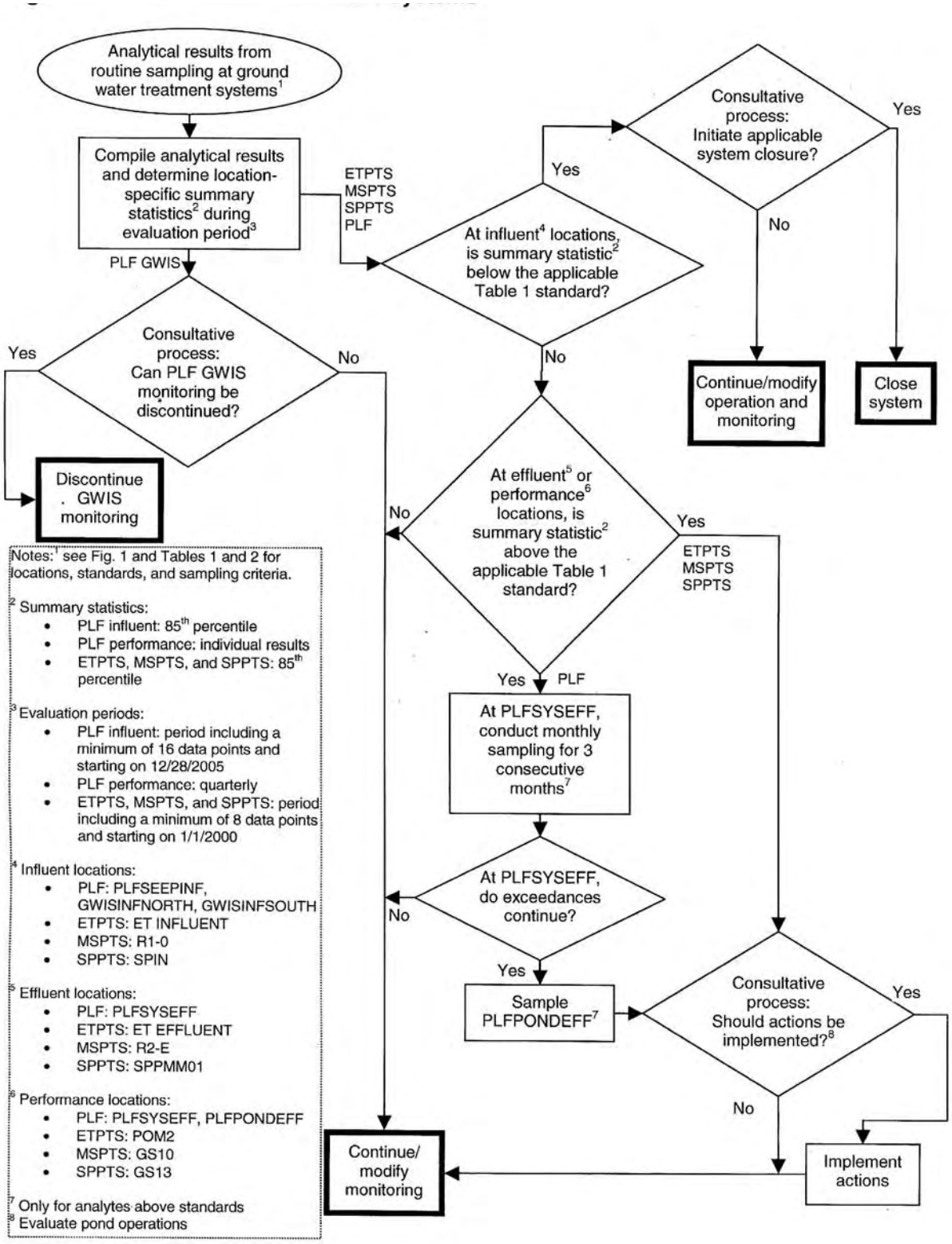


Figure 11. Groundwater Treatment Systems

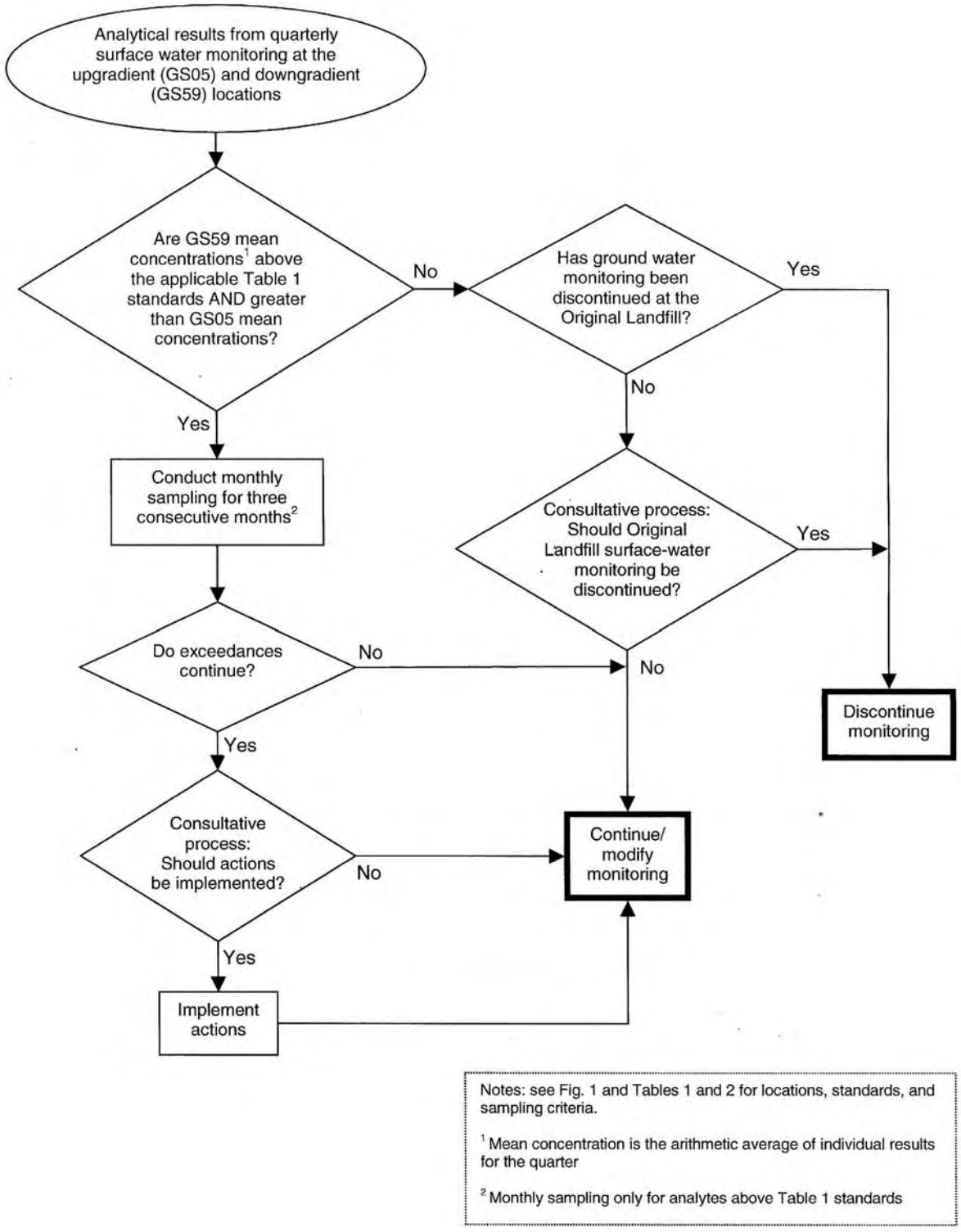


Figure 12. Original Landfill Surface Water

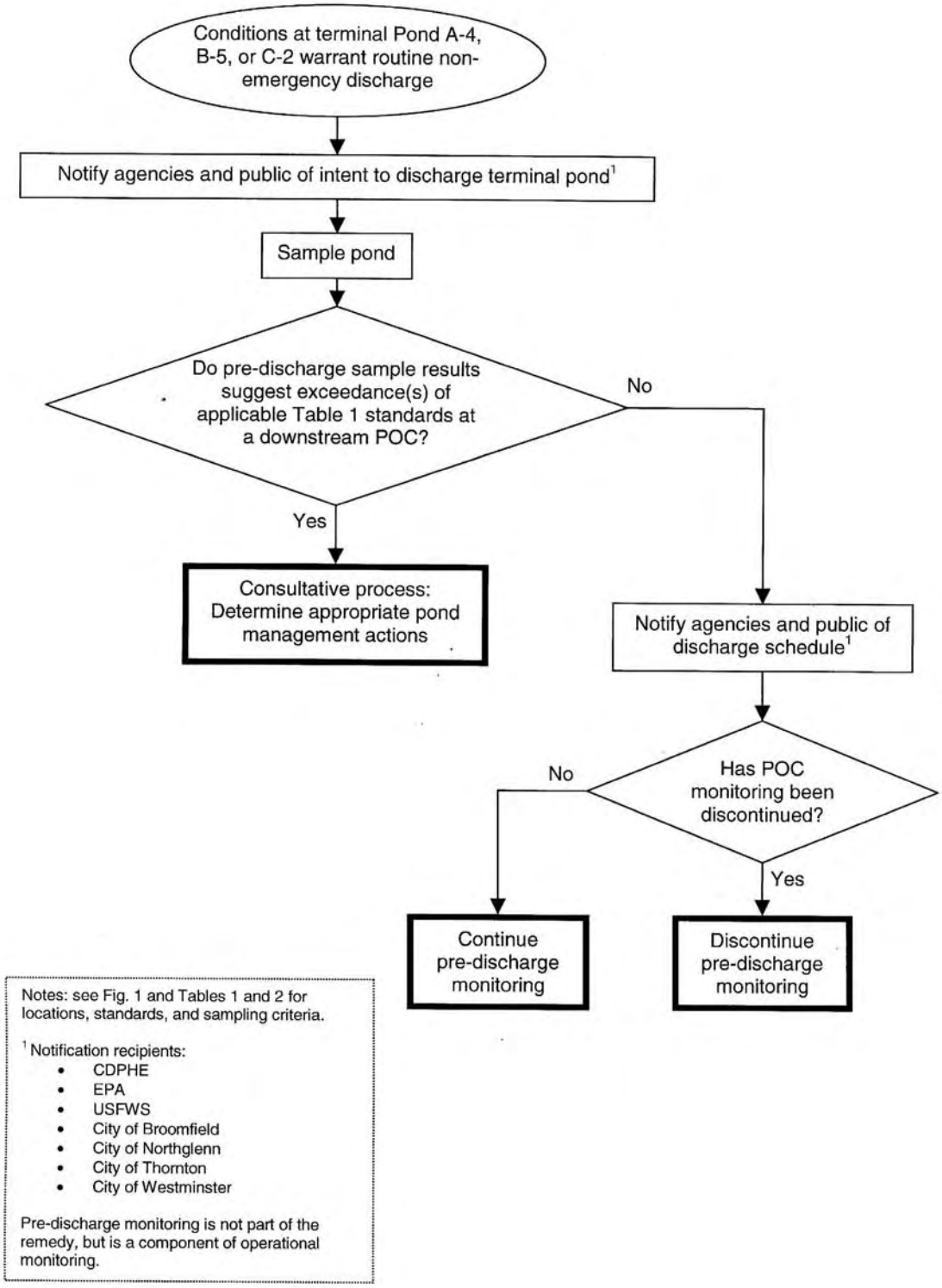


Figure 13. Pre-discharge Pond Sampling

Appendix B

Inspection Information

Date 3/18/2007 Donna, Mike, Jay

Inspection Area A

INSPECTION PERFORMED By: Mike Volle

Flag ID#	GIS Location	Evidence of Soil Erosion or Deposition	Evidence of Cracks, Rills, Gullies	Evidence of Sink Holes or Burrows	Evidence of Depression/ Subsidence	Sign, Fence, Phys. Control unsat?	Evidence of IC Violation*	Evidence of Bio Resource Problem	Trash
		CHECK ALL BOXES THAT APPLY. PLACE FLAG MARKER TO ID LOCATION.							
1									Pipe
2									Pipe 4"x48"
3									" 3" Buried
4									Rebar
5			Looking NE Gully						
6			Gully						
7		X							
8			Rill						
9					1.5 Deep, 6 Dia				
10									Steel Bar
11					1' Deep, 2' Dia				Rebar Several
12					1' Deep, 4" Dia				
13					3" Deep, 1.5 Dia				
14									1" Dia Wire @ 8'

LIST FLAG ID# REFERENCE AND PROVIDE SHORT NARRATIVE BELOW. STATE WHETHER PHOTOS TAKEN.

13 is gone @ 3/18/07 FW

5 Gully, large eroded area west of well 21505
6 Small gully located between two trees north of well 37405
7 Erosion control material washed out @ 40 feet south east of well 37705
8 Rill on south east slope @ 50 feet south east of well 37705
9 Depression south of well 37705 @ 50 feet
11 Depression east of well 33905 @ 30 feet. Several large sections of rebar in same location
12 Depression east of well 33705 @ 200 feet
13 Small sinkhole north East of well 33502 @ 30 feet
15 Long depression between wells 40205 and P419689, depression runs east/west

1 of 2

* Indicate the RFLMA IC# (1-7) for which violation is indicated.

Date 3/18/2007

Inspection Area A

INSPECTION PERFORMED By: Michael Wolfe

Flag ID#	GIS Location	CHECK ALL BOXES THAT APPLY. PLACE FLAG MARKER TO ID LOCATION. Evidence of Soil Erosion or Deposition	Evidence of Cracks, Rills, Gullies	Evidence of Sink Holes or Burrows	Evidence of Depression/ Subsidence	Sign, Fence, Phys. Control unsat?	Evidence of IC Violation*	Evidence of Bio Resource Problem
13				1-1.5 Deep, @ 50 ft long and 4 feet wide				

LIST FLAG ID# REFERENCE AND PROVIDE SHORT NARRATIVE BELOW. STATE WHETHER PHOTOS TAKEN.

* Indicate the RFLMA IC# (1-7) for which violation is indicated.

Date 3/19/07

Inspection Area B

INSPECTION PERFORMED By: Michelle Hanson

Flag ID#	GIS Location	CHECK ALL BOXES THAT APPLY. PLACE FLAG MARKER TO ID LOCATION. Evidence of Soil Erosion or Deposition	Evidence of Cracks, Rills, Gullies	Evidence of Sink Holes or Burrows	Evidence of Depression/ Subsidence	Sign, Fence, Phys. Control unsat?	Evidence of IC Violation*	Evidence of Bio Resource Problem	Notes
MH-1									rebar, concrete
MH-2									Concrete
MH-3									3' concrete
MH-4									concrete plug a
MH-5					X (+ rebar 30' N)				
MH-6					X				
MH-7									Concrete b
MH-8									3' metal pipe
MH-9									3' concrete
MH-10									3' concrete c

LIST FLAG ID# REFERENCE AND PROVIDE SHORT NARRATIVE BELOW. STATE WHETHER PHOTOS TAKEN.

Flag IDs MH-1 through MH-4 are trash (i.e., concrete pieces, rebar), MH-7 through MH-10 are also trash/debris.

Flag ID MH-5 marks a small depression — rebar piece is present ~ 30' north.

Flag ID MH-6 marks a substantial subsidence area — with cracks along both edges.

a Second concrete plug ~ 50' west.

b Also metal pipe pieces

c Second concrete piece ~ 60' northwest.

* Indicate the RFLMA IC# (1-7) for which violation is indicated.

Date 3-19-07

Inspection Area B

INSPECTION PERFORMED By: DOUG HANSEN

Flag ID#	GIS Location	CHECK ALL BOXES THAT APPLY. PLACE FLAG MARKER TO ID LOCATION. Evidence of Soil Erosion or Deposition	Evidence of Cracks, Rills, Gullies	Evidence of Sink Holes or Burrows	Evidence of Depression/ Subsidence	Sign, Fence, Phys. Control unsat?	Evidence of IC Violation*	Evidence of Bio Resource Problem	OTHER
DH-1									RE-BAR
-2									CHANNEL IRON
-3									CONCRETE & CABLE
-4									RE-BAR
-5									POWERPOLE CABLE
-6									CONCRETE DEBRIS
-7									MULT. CONCRETE
-8									CABLE
-9									CONCRETE DEBRIS
-10									SEEP/SUBSIDENCE

LIST FLAG ID# REFERENCE AND PROVIDE SHORT NARRATIVE BELOW. STATE WHETHER PHOTOS TAKEN.

LOCATIONS 1→9 INDICATE DEMOLITION DEBRIS

LOCATION 10 INDICATES SMALL AREA OF SUBSIDENCE AT A SEEP.

SEEP IS LOCATED NORTH/NORTHWEST OF WELL 79302.

* Indicate the RFLMA IC# (1-7) for which violation is indicated.

Date 3/19/07

Inspection Area ~~E~~ RD D

INSPECTION PERFORMED By: Nick Malczyk

Flag ID#	GIS Location	Evidence of Soil Erosion or Deposition	Evidence of Cracks, Rills, Gullies	Evidence of Sink Holes or Burrows	Evidence of Depression/ Subsidence	Sign, Fence, Phys. Control unsat?*	Evidence of IC Violation*	Evidence of Bio Resource Problem
903 1				X	X			
1B				X	X			
2				X	X			
3						X		
3B					X			
4						X		
3C						X		
3D						X		
5						X		
6						X		

CHECK ALL BOXES THAT APPLY. PLACE FLAG MARKER TO ID LOCATION.

* trash, debris, unrecognizable structure

LIST FLAG ID# REFERENCE AND PROVIDE SHORT NARRATIVE BELOW. STATE WHETHER PHOTOS TAKEN.

#1/#1B hollow stem auger borings, 903 pad area 12" diameter, 12-36" deep, E, NE
#2 200' SW of E Shed, open drain pipe former 12" storm water culvert
#3 rebar area 1000' E of E shed, 150' S of road
#3B 75' E of #3, debris, trash
#4 exposed pipe, NW corner of "gravel quarry," 500' S of E access road + E trenches
#3C along T-Trench
#3D trash, valves, open pipe
#5 concrete pads 100' S of ~~road~~ E Access Rd, 500' E of E trenches
#6 N face of solar ponds, concrete structure, 100' north of 79302 looks like 12" steel casing filled w/ concrete

* Indicate the RFLMA IC#-(1-7) for which violation is indicated.

Date 3-19-07

Inspection Area B

INSPECTION PERFORMED By: Betty Cordova

Flag ID#	GIS Location	CHECK ALL BOXES THAT APPLY. PLACE FLAG MARKER TO ID LOCATION.						
		Evidence of Soil Erosion or Deposition	Evidence of Cracks, Rills, Gullies	Evidence of Sink Holes or Burrows	Evidence of Depression/ Subsidence	Sign, Fence, Phys. Control unsat?	Evidence of IC Violation*	Evidence of Bio Resource Problem
BC-1								
BC-2								
BC-3								
BC 4								
BC-5								
BC-6								
BC7								
BC8								
BC-9								
BC-10								
BC-11								
BC-12								
BC-13								

LIST FLAG ID# REFERENCE AND PROVIDE SHORT NARRATIVE BELOW. STATE WHETHER PHOTOS TAKEN.

BC-1 - POOR DRAINAGE BANK ERODING
BC-2 - LARGE ELECTRICAL CABLE STICKING UP
BC 3 - LARGE METAL PIPE PROTRUDING
BC4 - LARGE REBAR PROTRUDING
BC5 - LARGE PIPE PROTRUDING
BC6 - CONCRETE RUBBLE
BC7 - LARGE ELECTRICAL CABLE
BC8 - LARGE CONCRETE PIECE/SUSPICIOUS hole
BC9 - ROUND CRATER SOIL collapse
BC10 - CABLE PROTRUDING
BC11 - LARGE PIPE PROTRUDING
BC12 - LARGE PIPE PROTRUDING
BC13 - hole with grounding rod.

* Indicate the RFLMA IC# (1-7) for which violation is indicated.

Date 3/19/07

Inspection Area E - ASH PITS

INSPECTION PERFORMED By: RICK DiSALVO

Flag ID#	GIS Location	CHECK ALL BOXES THAT APPLY. PLACE FLAG MARKER TO ID LOCATION. Evidence of Soil Erosion or Deposition	Evidence of Cracks, Rills, Gullies	Evidence of Sink Holes or Burrows	Evidence of Depression/ Subsidence	Sign, Fence, Phys. Control unsat?	Evidence of IC Violation*	Evidence of Bio Resource Problem
E1		✓			✓ DEPRESS			
E2		✓						
E-3		✓			✓ DEPRESS			
E-4		✓						
E-5					✓ DEPRESS			
E-6		✓						
E-7		✓			✓ DEPRESS			
E-8		✓	✓					

LIST FLAG ID# REFERENCE AND PROVIDE SHORT NARRATIVE BELOW. STATE WHETHER PHOTOS TAKEN.

E-1 - JUST EAST OF CENTRAL OU - TRUCK TIRE DAMAGE TO SURFACE SOIL

E-2 - EROSION ON NORTH SIDE OF ROAD, LOOKS LIKE IT IS ALRADY MARKED WITH FLAGS, PLACED FLAG E-2 RIGHT AT FENCE POST BESIDE ROAD (FORMER ROAD - NOW BEING REVEGED).

E-3 - TRUCK TIRE DAMAGE TO SURFACE SOIL.

E-4 - EROSION CONTROL WATTLES DAMAGED OR MISSING - 25'-30' LENGTH - SOUTH SIDE OF FORMER ROAD,

E-5 - TRUCK TIRE DEPRESSIONS - JUST SOUTH OF STAND OF TREES. LOOKS LIKE ALREADY MARKED WITH FLAGS.

E-6 - ABOUT 5' OF WATTLES MISSING - SMALL AREA OF DEPOSITION

E-7 - ABOUT 100' OF FORMER ROAD - DEEP TIRE DEPRESSIONS - SOME DEPOSITION.

E-8 - SOME GULLIES FORMING ON STEEP SLOPE. SOIL DEPOSITING AT SHALLOWER SLOPE.

* Indicate the RFLMA IC# (1-7) for which violation is indicated.

Date 3/19/07

Inspection Area B

INSPECTION PERFORMED By: RICK DiSALVO

Flag ID#	GIS Location	CHECK ALL BOXES THAT APPLY. PLACE FLAG MARKER TO ID LOCATION. Evidence of Soil Erosion or Deposition	Evidence of Cracks, Rills, Gullies	Evidence of Sink Holes or Burrows	Evidence of Depression/ Subsidence	Sign, Fence, Phys. Control unsat?	Evidence of IC Violation*	Evidence of Bio Resource Problem
RD-1				✓ SINK HOLE				
RD-2				✓ SINK HOLES				
RD-3					✓ DEPRESSION			
RD-4					✓ SUBSIDENCE			
RD-5		✓			✓ DEPRESSION			
RD-6		✓ OVERBURDEN						
RD-7							NOTE	

LIST FLAG ID# REFERENCE AND PROVIDE SHORT NARRATIVE BELOW. STATE WHETHER PHOTOS TAKEN.

RD-1 - WHAT APPEARS TO BE SMALL SINK HOLE - ABOUT 100' ~~EAST~~ WEST OF WELL P210189.

RD-2 - WHAT APPEARS TO BE SMALL SINK HOLES - ABOUT 100' EAST OF WELL P210189. AREAS EXTEND EAST IN THE BOULDERS STREWN OVER SURFACE ANOTHER 50' EAST FROM FLAG

RD-3 - WHAT APPEARS TO BE SMALL ~ 30' DIAMETER DEPRESSION - PERHAPS 1' LOWER THAN SURROUNDING SOIL - ~150' NW OF WELL 20205

RD-4 - SMALL SLUMPING AREA ON HILLSIDE JUST WEST OF SW-018 . PUT FLAG ON EAST SIDE LOOKING TOWARDS SLUMP

RD-5 SMALL DEPRESSION AND MINOR EROSION. ABOUT 25' SOUTH OF WELL 52505. LOOKING WEST, ACROSS CHANNEL, ALSO EVIDENCE OF SLUMPING/SLIDING ON HILLSIDE. ACROSS (WEST) FROM WELL 21505.

RD-6 - LOOKS LIKE SOIL OVERBURDEN PILES JUST WEST OF RESEEDED AREA. PERHAPS 2-3 TRUCKLOADS. MAY BE FLAGGED ALREADY.

RD-7 NOTE - PLASTIC SURVEY MARKER SIGN FOUND BUT COULD NOT SEE THE ACTUAL SURVEY PIN.

* Indicate the RFLMA IC# (1-7) for which violation is indicated.

Date 3/19/07

Inspection Area C

INSPECTION PERFORMED By: Scott Raynes

Flag ID#	GIS Location	CHECK ALL BOXES THAT APPLY. PLACE FLAG MARKER TO ID LOCATION. Evidence of Soil Erosion or Deposition	Evidence of Cracks, Rills, Gullies	Evidence of Sink Holes or Burrows	Evidence of Depression/ Subsidence	Sign, Fence, Phys. Control unsat?	Evidence of IC Violation*	Evidence of Bio Resource Problem
1								
2								
3								
4					✓			
5								
6								
7								

LIST FLAG ID# REFERENCE AND PROVIDE SHORT NARRATIVE BELOW. STATE WHETHER PHOTOS TAKEN.

1) twisted metal - partially buried - 20' NW of tree w/ broken limb (cottonwood?)
2) length of rebar - partially buried - 20 yards SW of gas pipeline
3) rebar - partially buried - 75 yards South of Central Ave. Line of site w/ dead tree, pine tree + pair of sapling cottonwoods (East/West)
4) depression/sink hole - 20' North of South access/Cactus Ave - line of site w/ small sapling cottonwoods
5) uncovered cable - 40' North of South access/Cactus Ave., almost due East of #4.
   rebar + concrete - 20' North of #5 (no flag)
6) nestle of rebar - just South of Central Ave, 50 yds West of revegitation/FC-4
7) uncovered cable - 75 yards due South of Well #37591

* Indicate the RFLMA IC# (1-7) for which violation is indicated.

Date 3/19/07

Inspection Area A

INSPECTION PERFORMED By: Scott Raynes

Flag ID#	GIS Location	CHECK ALL BOXES THAT APPLY. PLACE FLAG MARKER TO ID LOCATION.						
		Evidence of Soil Erosion or Deposition	Evidence of Cracks, Rills, Gullies	Evidence of Sink Holes or Burrows	Evidence of Depression/ Subsidence	Sign, Fence, Phys. Control unsat?	Evidence of IC Violation*	Evidence of Bio Resource Problem
1								

LIST FLAG ID# REFERENCE AND PROVIDE SHORT NARRATIVE BELOW. STATE WHETHER PHOTOS TAKEN.

1) Partially buried cable - due South of dwarf pines trees (pair) South of pine tree line (5) - approx. 100 yards
- due West of well # 40005 - 50 yards

* Indicate the RFLMA IC# (1-7) for which violation is indicated.

Date 3/19/07

Inspection Area D

INSPECTION PERFORMED By: Linda Kaiser & Scott Surovchak

Flag ID#	GIS Location	CHECK ALL BOXES THAT APPLY. PLACE FLAG MARKER TO ID LOCATION. Evidence of Soil Erosion or Deposition	Evidence of Cracks, Rills, Gullies	Evidence of Sink Holes or Burrows	Evidence of Depression/ Subsidence	Sign, Fence, Phys. Control unsat?	Evidence of IC Violation*	Evidence of Bio Resource Problem
LK-1		✓	✓					
LK-2			✓					
LK-3			✓					
LK-4								
LK-5								
LK-6								

LIST FLAG ID# REFERENCE AND PROVIDE SHORT NARRATIVE BELOW. STATE WHETHER PHOTOS TAKEN.

LK-1 rills east of perimeter ~~channel~~ channel 5 north of road

LK-2 rills in area around wells west of North treatment system and also between treatment system and well area

LK-3 hill east of North treatment system has rills

LK-4 trash and old barricade

K-5+6 old concrete for old wooden fence posts

also 3 pieces of rebar east of north tree in the line of 4 trees by east shed (rebar east of road)

* Indicate the RFLMA IC# (1-7) for which violation is indicated.

Date 3/19/07

Inspection Area C

INSPECTION PERFORMED By: Bob Darr

Flag ID#	GIS Location	CHECK ALL BOXES THAT APPLY. PLACE FLAG MARKER TO ID LOCATION. Evidence of Soil Erosion or Deposition	Evidence of Cracks, Rills, Gullies	Evidence of Sink Holes or Burrows	Evidence of Depression/ Subsidence	Sign, Fence, Phys. Control unsat?	Evidence of IC Violation*	Evidence of Bio Resource Problem
BD1								
BD2								
BD3								
BD4				Small Depression				

LIST FLAG ID# REFERENCE AND PROVIDE SHORT NARRATIVE BELOW. STATE WHETHER PHOTOS TAKEN.

BD1 - 40 yds N. of W 88205 - Rebar sticking up -
BD2 - Rebar App 75 yds So of Rd, due east of Dead Cotton Wood
BD3 - Rebar App 100 ds So of Rd - 30 yds due west of small cottonwood - SE of Dead cottonwood
BD4 - Small Depression NE of W 88205 - photo - (So of old east access Rd -)
BD5 - Red painted Rebar 80 yds S. of RD SW of W 22996 - 50 yds photo
~~BD6 - Big Slab asphalt - 20 yds S of Central Ave - By big shrub~~

* Indicate the RFLMA IC# (1-7) for which violation is indicated.

Date 3/19/06

Inspection Area A

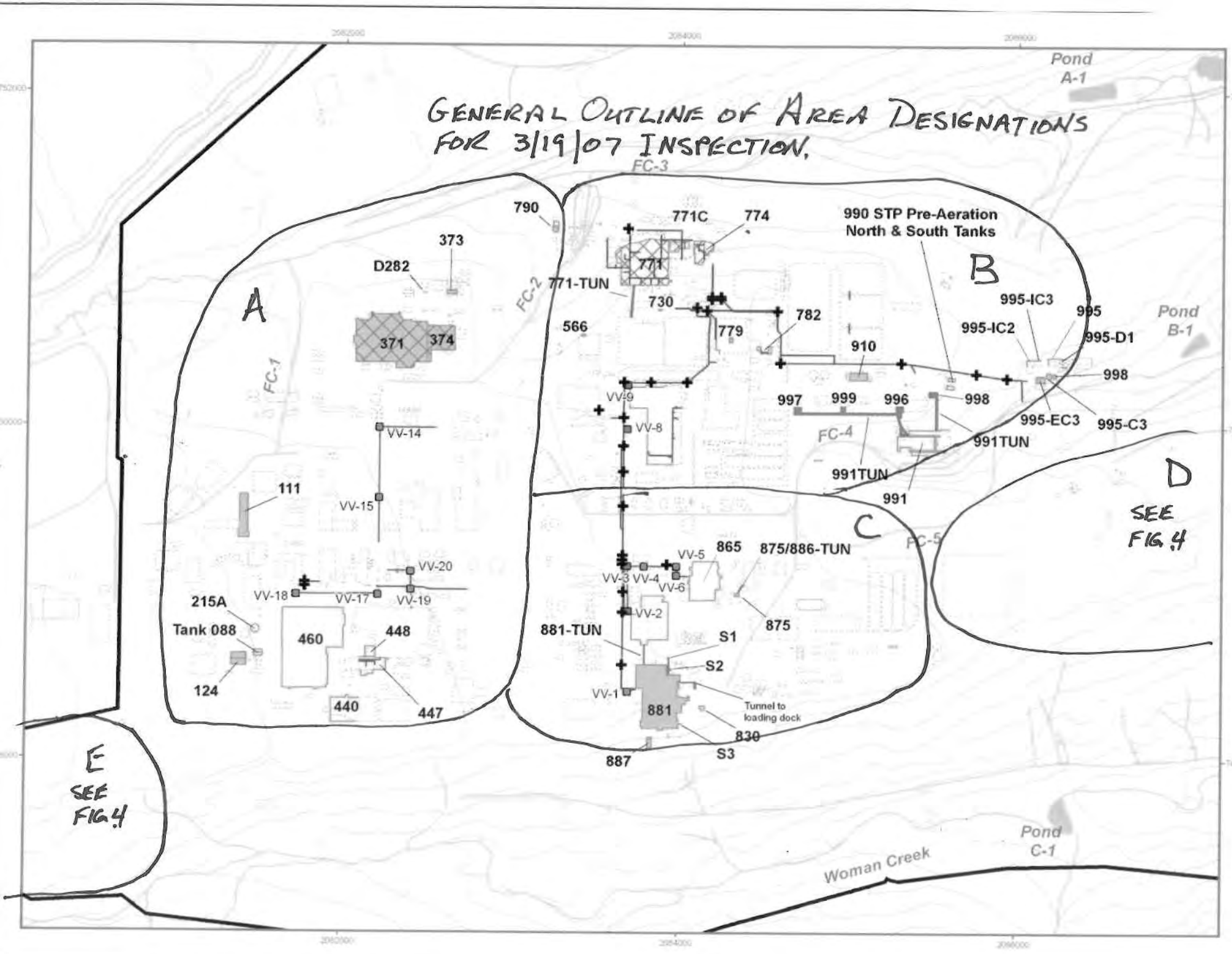
INSPECTION PERFORMED By: Bob Darr

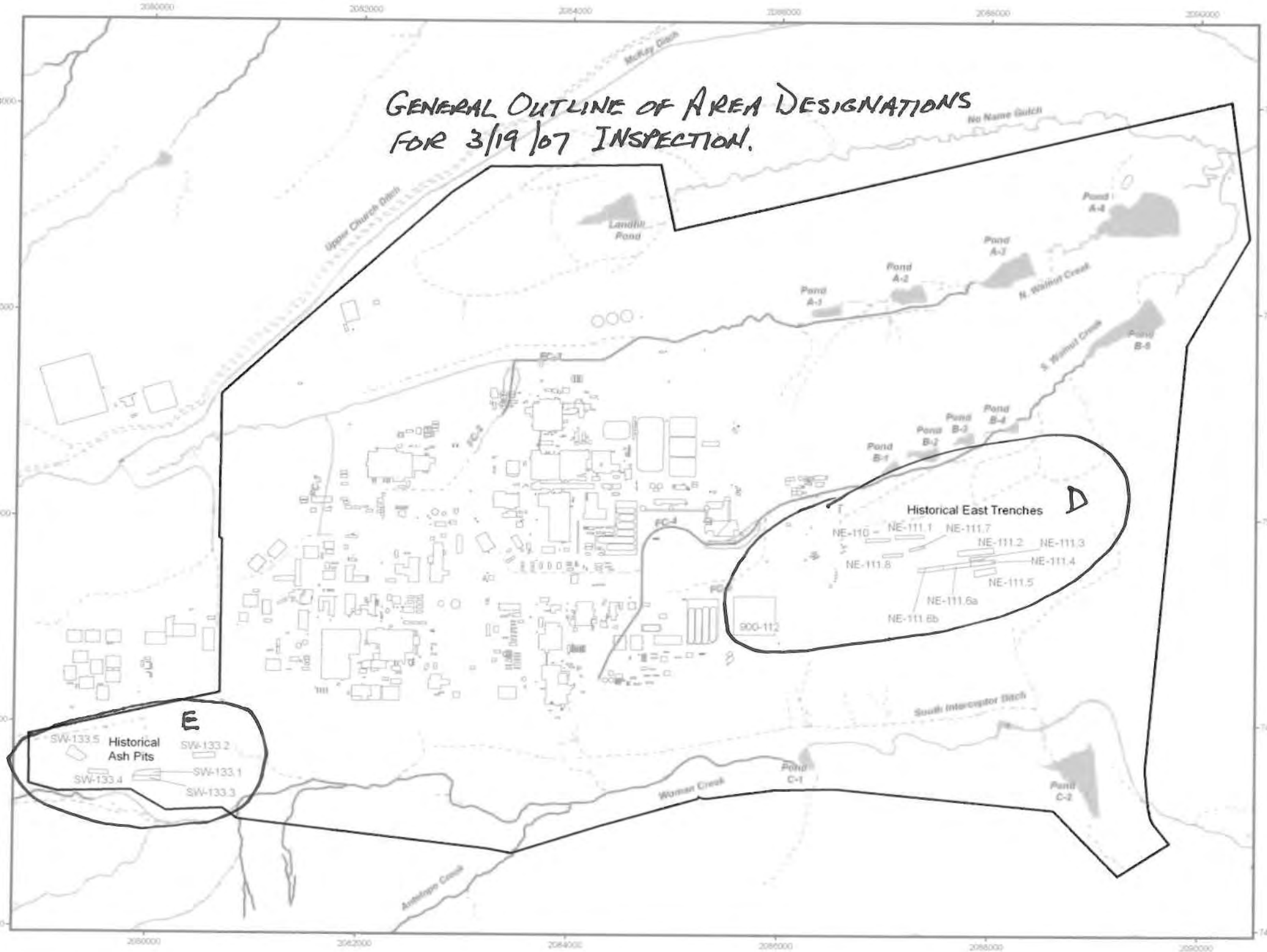
Flag ID#	GIS Location	CHECK ALL BOXES THAT APPLY. PLACE FLAG MARKER TO ID LOCATION. Evidence of Soil Erosion or Deposition	Evidence of Cracks, Rills, Gullies	Evidence of Sink Holes or Burrows	Evidence of Depression/ Subsidence	Sign, Fence, Phys. Control unsat?	Evidence of IC Violation*	Evidence of Bio Resource Problem
BD1								

LIST FLAG ID# REFERENCE AND PROVIDE SHORT NARRATIVE BELOW. STATE WHETHER PHOTOS TAKEN.

BD1 - Big Slab of Asphalt - 20 yds SO old Central Ave Road - SE of Big shrub East of Road that went N/S West median Rd 122 - photo

* Indicate the RFLMA IC# (1-7) for which violation is indicated.


GENERAL OUTLINE OF AREA DESIGNATIONS FOR 3/19/07 INSPECTION.
A
B
C
D
E
SEE FIG 4
SEE FIG 4
Pond A-1
Pond B-1
Pond C-1
Woman Creek
FC-1
FC-2
FC-3
FC-4
FC-5
790
373
D282
371
374
566
771C
774
771
771-TUN
730
779
782
990 STP Pre-Aeration North & South Tanks
910
995-IC3
995
995-IC2
995-D1
998
997
999
996
998
995-EC3
995-C3
991TUN
991TUN
991
VV-9
VV-8
VV-14
VV-15
111
VV-20
VV-18
VV-17
VV-19
215A
Tank 088
460
448
124
440
447
VV-5
865
875/886-TUN
VV-3
VV-4
VV-6
VV-2
875
881-TUN
S1
S2
VV-1
881
Tunnel to loading dock
830
S3
887


GENERAL OUTLINE OF AREA DESIGNATIONS
FOR 3/19/07 INSPECTION.
McKay Ditch
No Name Gulch
Upper Church Ditch
Landfill Pond
Pond A-1
Pond A-2
Pond A-3
Pond A-4
N. Walnut Creek
S. Walnut Creek
Pond B-1
Pond B-2
Pond B-3
Pond B-4
Pond B-5
FC-1
FC-2
FC-3
FC-4
FC-5
FC-6
FC-7
FC-8
D
Historical East Trenches
NE-110
NE-111.1
NE-111.7
NE-111.2
NE-111.3
NE-111.4
NE-111.5
NE-111.8
NE-111.6a
NE-111.6b
900-112
South Interceptor Ditch
Woman Creek
Pond C-1
Pond C-2
Antelope Creek
E
Historical Ash Pits
SW-133.5
SW-133.2
SW-133.4
SW-133.1
SW-133.3

Photograph B1. Erosion on north side of former gravel road, above Woman Creek, west of Original Landfill, looking east. Typical of minor erosion along edge of former gravel road in this area.

Photograph B2. Truck tire damage to surface soil near but south of area where Photograph B1 was taken.

Photograph B3. Approximately 25 to 30 feet of deteriorated erosion control wattles along south side of former road, near where Photograph B1 was taken.

Photograph B4. Deep tire depressions along an approximately 100-foot stretch of former road, with some deposition.

Photograph B5. Gullies forming on steep slope, looking north, west of Original Landfill west perimeter channel; soil depositing on shallower slope.

Photograph B6. Small slumping area on hillside just west of SW018. Vegetation suggests this is fairly old and is stable.

Photograph B7. Small depression northeast of well 88205 (south of old East Access Road).

Photograph B8. Red-painted rebar approximately 80 yards south of road southwest of well 22996.

OPERATION AND MAINTENANCE INSPECTION
Conducted by Colorado Department of Public Health & Environment
April 19, 2007

Rocky Flats Site
EPA I.D. No. CO7890010526

Background
The purpose of this inspection was to observe the methods and procedures for monitoring and sampling RCRA wells at the Rocky Flats Site. Inspections are conducted on a triennial schedule as required by RCRA inspection national core program requirements for Land Disposal Facilities, which the Colorado Department of Public Health and Environment has agreed to implement in a CDPHE/EPA RCRA Hazardous Waste Program Memorandum of Agreement (September 11, 2000). Groundwater sampling is conducted at Rocky Flats according to the general monitoring requirements and sampling criteria in the Attachment 2 of the *Rocky Flats Legacy Management Agreement* and to the specific requirements in the *Present Landfill Monitoring and Maintenance Plan and Post-Closure Plan*.

During this inspection, sampling and monitoring was observed at two RCRA wells, one upgradient and one downgradient, at the Present Landfill. Carl Spreng was the inspector for the Colorado Department of Public Health & Environment; John Boylan of S.M. Stoller was site representative; Nick Malczyk and Emile Bettez were the samplers. The weather was clear and sunny with a slight breeze; temperature was about 45° F.

Well No. 70393 (upgradient RCRA well)

- Monitoring/sampling began at 9:00 am using weighted tape and a peristaltic pump with dedicated tubing.
- Casing diameter = 2"
- Water level = 8.02'
- Well depth = 26.97'
- The following parameters were measured and recorded:
    - Total well volume (L)
    - Water level (feet)
    - Water temperature (°C)
    - Specific conductivity (µmhos/cm)
    - DO (mg/L)
    - pH (s.u.)
    - ORP (mV)
    - Turbidity (NTU)
- Pumped and purged up to 3 well volumes (or until parameters and well volume stabilized).
- Observed water samples being collected for laboratory analyses of metals and VOCs.

Well No. 73205 (southern downgradient RCRA well)

- Monitoring/sampling began at 10:38 am using weighted tape and a peristaltic pump with dedicated tubing.
- Casing diameter = 2"
- Water level = 17.12'
- Well depth = 32.05'
- All other procedures and parameters as above.

Summary of Findings

All procedures were conducted in accordance with approved monitoring requirements and sampling criteria in *Rocky Flats Legacy Management Agreement*, and with the quality assurance and quality control requirements in the *Legacy Management CERCLA Sites Quality Assurance Project Plan* and in current EPA guidance.

Carl Spreng

CDPHE Inspector [Carl Spreng]

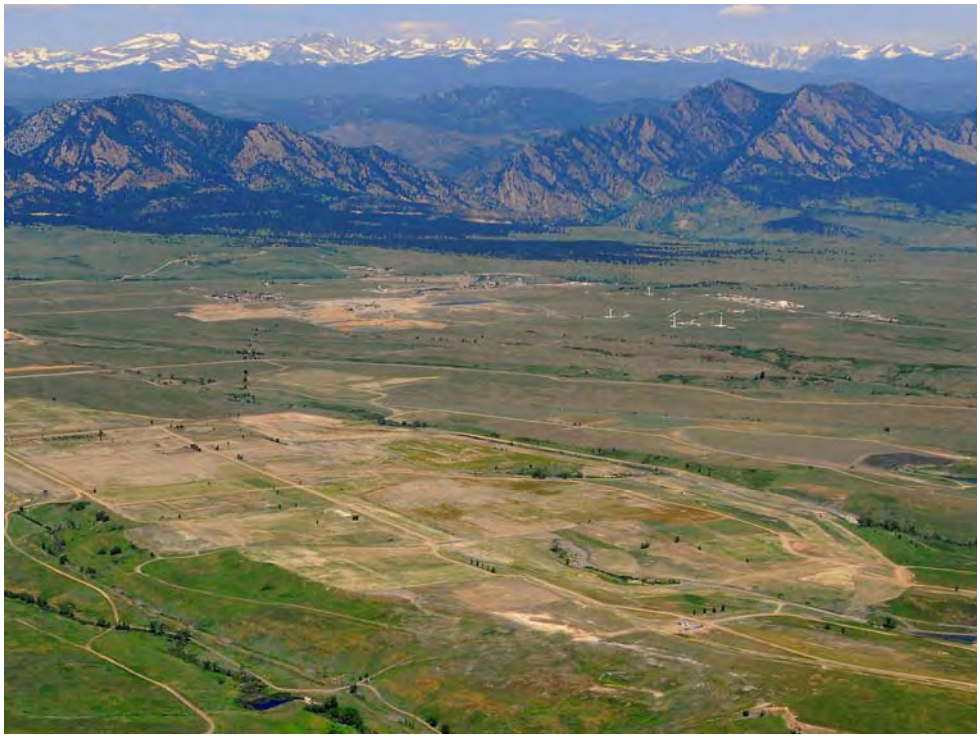
5/16/07

Date [May 16, 2007]

Appendix C

Select Photographs

Photograph C1. Aerial photograph of the Site (2001)



Photograph C2. Aerial photograph of the Site (June 2007)

Photograph C3. Rocky Flats Site No Trespassing sign

Photograph C4. Use Restrictions for the Central OU sign

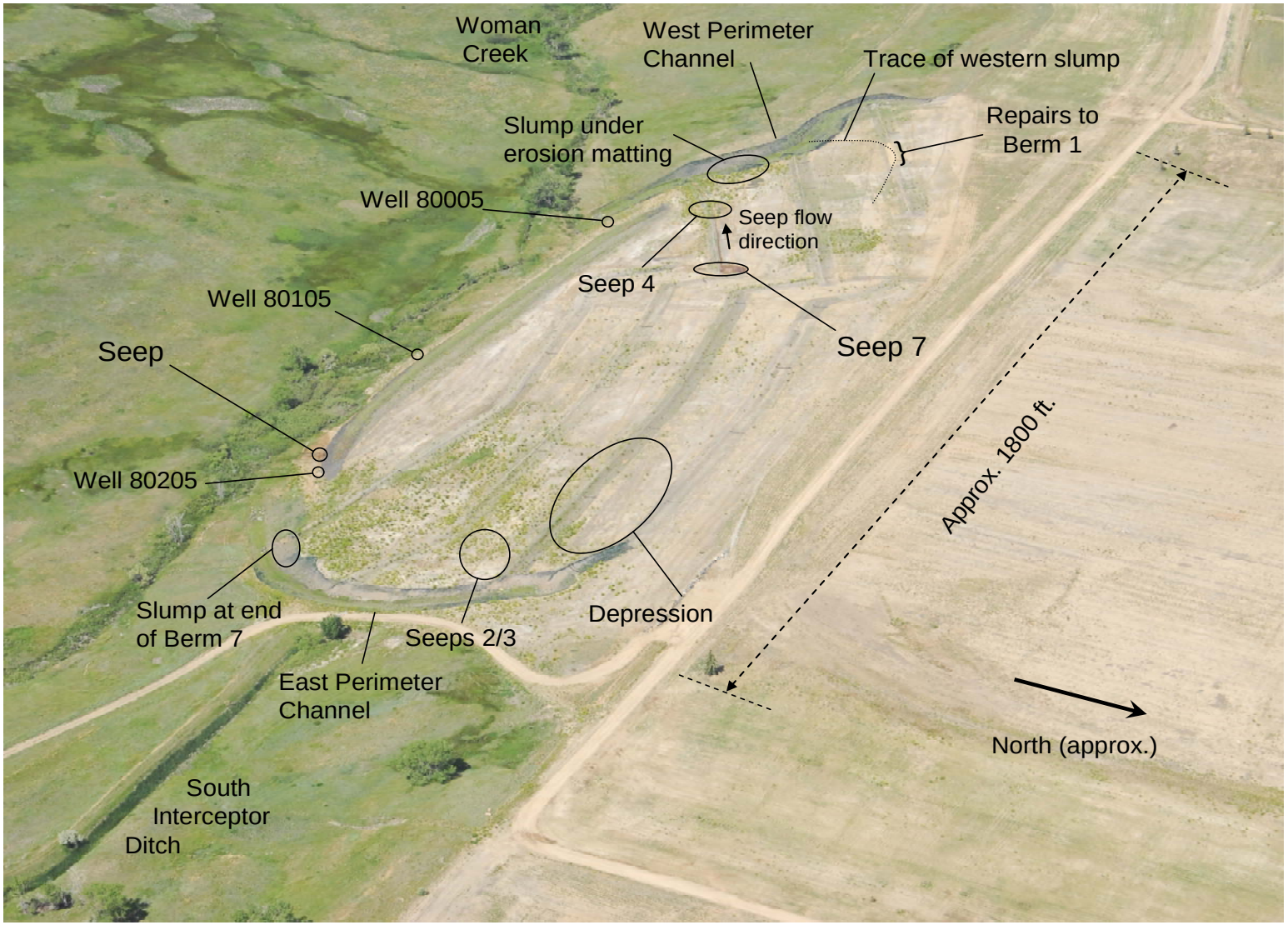


Figure C1. Aerial photo taken June 2007 of Original Landfill. Approximate locations of main slumps and seeps are noted.

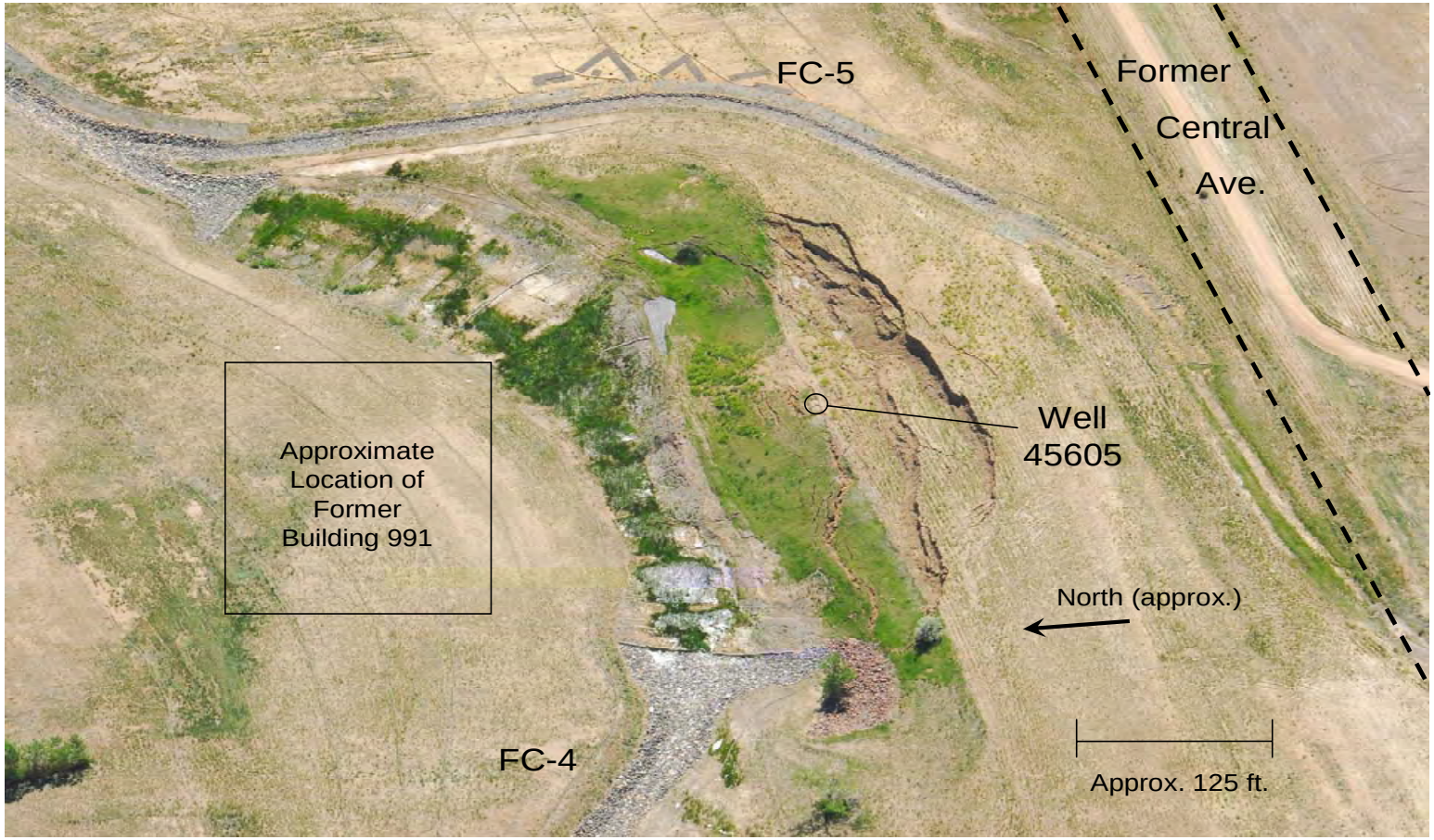


Figure C2. Aerial photo taken June 2007 of slump south of former Building 991. Movement is vertically downward and laterally to the north. Location of monitoring well 45605, which is installed within the slump block, is indicated.