ROCKY MOUNTAIN ARSENAL

Final
2010 Five-Year Review Report
for
Rocky Mountain Arsenal
Commerce City
Adams County, Colorado

Review Period: April 1, 2005–March 31, 2010

September 2011

Prepared by:

Tetra Tech EC, Inc

Prepared for:
Rocky Mountain Arsenal Remediation Venture Office
Department of the Army
Shell Oil Company
U S. Fish and Wildlife Service

This document is the property of Rocky Mountain Arsenal Remediation Venture Office and was prepared by Tetra Tech EC, Inc. It is provided on the condition that it will not be reproduced, copied, or issued to a third party; will be used solely for the intended purpose; and will be used solely for the execution or review of the engineering, remediation, and/or construction of the subject project.

Revision	Prepared By	Reviewed By	Approved By	Date	Pages Affected
0	Ellen Kaastrup	Scott Ache	John Edrich	09/23/11	All

ROCKY MOUNTAIN ARSENAL

Final
2010 Five-Year Review Report
for
Rocky Mountain Arsenal
Commerce City
Adams County, Colorado

Review Period: April 1, 2005–March 31, 2010

Volume I of III

Background, Remedy, and Conclusions

September 2011

Prepared by:

Tetra Tech EC, Inc.

Prepared for:
Rocky Mountain Arsenal Remediation Venture Office
Department of the Army
Shell Oil Company
U.S Fish and Wildlife Service

This document is the property of Rocky Mountain Arsenal Remediation Venture Office and was prepared by Tetra Tech EC, Inc. It is provided on the condition that it will not be reproduced, copied, or issued to a third party; will be used solely for the intended purpose; and will be used solely for the execution or review of the engineering, remediation, and/or construction of the subject project

Revision	Prepared By	Reviewed By	Approved By	Date	Pages Affected
0	Ellen Kaastrup EK	Scott Ache	John Edrich JE	09/23/11	All

TABLE OF CONTENTS

VOLUME I of III Background, Soil Remedy, and Conclusions

Section **Page**

TABLES

FIGURES

APPENDICES

TABLE OF CONTENTS

VOLUME II of III Five-Year Review Site Inspection and Interview Checklists

(Information for each tab listed below is provided on CD.)

TABLE OF CONTENTS

VOLUME III of III Responses to Regulatory Agency Comments

ACRONYMS

µg/L	Micrograms per Liter
µg/m^3	Micrograms per Cubic Meter
ACM	Asbestos-Containing Material
ALR	Action Leakage Rate
AMA	Army-Maintained Area
ARAR	Applicable or Relevant and Appropriate Requirement
Army	U.S. Army
BANS	Basin A Neck System
BAS	Biological Advisory Subcommittee
BBM	Biota Barrier Material
bcy	Bank Cubic Yard
BMP	Biomonitoring Program
BRES	Bedrock Ridge Extraction System
CAB	Citizen Advisory Board
CAMU	Corrective Action Management Unit
CBSG	Colorado Basic Standard for Groundwater
CBSMSW	Colorado Basic Standards and Methodologies for Surface Water
CCD	CERCLA Compliance Document
CCR	Construction Completion Report
CDD	CAMU Designation Document
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CFS	Confined Flow System
cm/sec	Centimeter per Second
COC	Contaminant of Concern
CPMSO	4-Chlorophenylmethyl Sulfoxide
CPMSO2	4-Chlorophenylmethyl Sulfone
CQA	Construction Quality Assurance
CQAE	Construction Quality Assurance Engineer
CQAP	Chemical Quality Assurance Plan
CQC	Construction Quality Control
CSRG	Containment System Remediation Goal
CSV	Contingent Soil Volume
CWTF	CERCLA Wastewater Treatment Facility
CWQCC	Colorado Water Quality Control Commission
cy	Cubic Yard
DBCP	Dibromochloropropane
DCN	Design Change Notice

DCPD	Dicyclopentadiene
DDE	2,2-bis(p-chlorophenyl)-1,1-dichloroethene
DDD	2,2-bis(p-chlorophenyl)-1,1-dichloroethane
DDT	2,2-bis(p-chlorophenyl)-1,1,1-trichloroethane
DIMP	Diisopropylmethyl Phosphonate
DNAPL	Dense Non-Aqueous Phase Liquid
DREZ	Demolition Range Exclusion Zone
ELF	Enhanced Hazardous Waste Landfill
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Difference(s)
FCS	First Creek Pathway System
FFA	Federal Facility Agreement
FS	Feasibility Study
ft	Foot/Feet
FY	Fiscal Year
FYR	Five-Year Review
FYRR	Five-Year Review Report
FYSR	Five-Year Summary Report
gpm	Gallon Per Minute
HCCPD	Hexachlorocyclopentadiene
HESS	Hazard Evaluation and Summary Subcommittee
HHE	Human Health Exceedance
HHRC	Human Health Risk Characterization
HI	Hazard Index
HQ	Hazard Quotient
HWL	Hazardous Waste Landfill
IC	Institutional Control
ICP	Institutional Control Plan
ICS	Integrated Cover System
IMPA	Isopropyl Methylphosphonic Acid
IRA	Interim Response Action
kg	Kilogram
lbs	Pounds
LCS	Leachate Collection System
LDS	Leak Detection System
LNAPL	Light Non-aqueous Phase Liquid
LTCP	Long-Term Care Plan
LTMP	Long-Term Groundwater Monitoring Plan

LWTS	Landfill Wastewater Treatment System
MOA	Memorandum of Agreement
MCL	Maximum Contaminant Level
MCR	Monitoring Completion Report
MEC	Munitions and Explosives of Concern
mg/L	Milligrams Per Liter
mg/kg-day^{-1}	Milligrams Per Kilogram per Day
mm/year	Millimeters Per Year
MRL	Method Reporting Limit
NBCS	North Boundary Containment System
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NDMA	n-Nitrosodimethylamine
NIOSH	National Institute for Occupational Safety and Health
NODp	Notice of Partial Deletion
NOIDp	Notice of Intent for Partial Deletion
NPL	National Priorities List
NPS	Northern Pathway System
NWBCS	Northwest Boundary Containment System
O&F	Operational and Functional
O&M	Operations and Maintenance
OAR	Operational Assessment Report
OCP	Organochlorine Pesticide
OGITS	Off-Post Groundwater Intercept and Treatment System
OU	Operable Unit
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethylene
PM-10	Particulate Matter less than 10 Micrometers in Diameter
PMC	Program Management Contractor
PPE	Personal Protective Equipment
PPLV	Preliminary Pollutant Limit Value
ppm	Part Per Million
PQL	Practical Quantitation Limit
PUD	Planned Unit Development
PWT	Pacific Western Technologies, Inc.
RAB	Restoration Advisory Board
RAO	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RCWM	Recovered Chemical Warfare Materiel
RDIS	Remediation Design and Implementation Schedule
Refuge	Rocky Mountain Arsenal National Wildlife Refuge

Refuge Act	Rocky Mountain Arsenal National Wildlife Refuge Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RMA	Rocky Mountain Arsenal
RMAED	RMA Environmental Database
ROD	Record of Decision
RS/S	Remediation Scope and Schedule
RVO	Remediation Venture Office
RWMP	Remediation Waste Management Plan
RYCS	Railyard Containment System
SAP	Sampling and Analysis Plan
SAR	Study Area Report
SARA	Superfund Amendments and Reauthorization Act of 1986
SC&A	Sanford, Cohen & Associates
SEO	State Engineer's Office
Shell	Shell Oil Company
SOM	Supplemental Operational Monitoring
SQI	Submerged Quench Incinerator
SSAB	Site-Specific Advisory Board
SWAQMP	Site-Wide Air Quality Monitoring Program SWOMP Site-Wide Odor Monitoring Program
SWOMP	Site-Wide Odor Monitoring Program
TBC	To-Be-Considered Criterion
TCE	Trichloroethylene
TCHD	Tri-County Health Department
TCLP	Toxicity Characteristic Leaching Procedure
TSCA	Toxic Substances Control Act
TSP	Total Suspended Particulates
UFS	Unconfined Flow System
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UV	Ultraviolet
UXO	Unexploded Ordnance
VOC	Volatile Organic Compound
WY	Water Year

EXECUTIVE SUMMARY

Background

The U.S. Army (Army) established Rocky Mountain Arsenal (RMA) in 1942 to produce chemical warfare agents and incendiary munitions used in World War II. Following the war and through the early 1980s, the Army continued to use these facilities. Beginning in 1946, some RMA facilities were leased to private companies to manufacture industrial and agricultural chemicals. Shell Oil Company (Shell), the principal lessee, manufactured primarily pesticides at RMA from 1952 to 1982. Common industrial and waste disposal practices during those years resulted in significant levels of contamination. Approximately 70 chemicals were the focus of the Remedial Investigation (RI) for the On-Post Operable Unit (OU) (Ebasco 1989, 1992). Of these, the principal contaminants are organochlorine pesticides, heavy metals, agent-degradation products and manufacturing by-products, and chlorinated and aromatic solvents.

The RI and subsequent investigations identified chemicals at more than 180 sites contaminating soil, ditches, stream and lakebed sediments, natural depressions and manmade basins, sewers, groundwater, surface water, biota, and structures. Unexploded ordnance was identified at several locations on site. Contaminated areas identified in the RI included approximately 3,000 acres of soil, 15 groundwater plumes, and 798 structures. Sites that posed potential immediate risks to human health and the environment were addressed through Interim Response Actions, which were followed by the actions required by the On-Post Record of Decision (ROD) (FWENC 1996).

Groundwater contamination migrated off post prior to the implementation of groundwater pump-and-treat systems, resulting in the need for the Off-Post OU, which addresses groundwater contamination north and northwest of RMA. The risk assessment performed for the Off-Post OU indicated that only human exposure via contaminated groundwater needed to be addressed. As a result, an Off-Post ROD was prepared and approved on December 19, 1995 (HLA 1995).

Current and future land use for the On-Post OU has been restricted because the provisions in the Federal Facility Agreement (FFA) (EPA 1989) and the On-Post ROD restrict certain land uses. Surrounded by development, the On-Post OU also provides a refuge for an abundant diversity of flora and fauna. For this reason, the majority of the site was designated a future National Wildlife Refuge in the Rocky Mountain Arsenal National Wildlife Refuge Act (Refuge Act) of 1992 (Public Law 102-402 1992).

As components of the remedy have been completed, administrative jurisdiction has been transferred to the U.S. Fish and Wildlife Service (USFWS) or other parties purchasing the land, except for the property and facilities continuing to be used for response actions. The portions of the On-Post OU transferred to other parties will be subject to the FFA restrictions prohibiting residential development, use of groundwater on the site as a source of potable water, hunting and fishing for consumptive use, and agricultural use. Current and future land use of the Off-Post OU has not been restricted; however, institutional controls (ICs) identified in the Off-Post ROD have been implemented to reduce the potential for exposure to groundwater exceeding remediation goals. In addition, the ROD requires a deed restriction that prohibits drilling new alluvial wells and use of deeper groundwater underlying the Shell Property for potable purposes until such

groundwater no longer contains contamination in exceedance of groundwater remediation goals established in the ROD.

As of the publication of the 2010 Five-Year Review Report (FYRR) in July 2011, about 93 percent of RMA has been deleted from the National Priorities List (NPL) and almost 15,000 acres have been transferred to the USFWS since the Rocky Mountain Arsenal National Wildlife Refuge was established on April 21, 2004. Groundwater has also been deleted in the eastern and southern perimeter areas of the RMA. However, groundwater underlying the central and northwestern portions of the site has not met remediation goals and remains on the NPL.

EPA guidance requires FYRs to be conducted site-wide. For RMA, this includes the On-Post OU, the Off-Post OU, and all Interim Response Actions (IRAs) implemented prior to the signing of the RODs. The review of the IRAs, the On-Post OU, and the Off-Post OU is required by statute. As a side note, a discussion of the pre-ROD, EPA-identified and tracked OUs associated with the RMA site is provided in Appendix C. The schedule for conducting this Five-Year Review (FYR) is determined by the date the Off-Post ROD was signed, on December 19, 1995.

Protectiveness Statements

The protectiveness of the remedial actions in both the On-Post and Off-Post OUs in terms of human health and the environment is discussed below. All controls are in place to adequately minimize risks. Because the remedial actions in both the On-Post and Off-Post OUs are expected to be protective of human health and the environment upon completion, the remedy for the entire site is expected to be protective of both human health and the environment.

On-Post Operable Unit

The Army concludes that the remedy at the On-Post OU is expected to be protective of human health and the environment upon remedy completion, and in the interim, exposure pathways that could result in unacceptable risks are being controlled. Placement of contaminated soils and debris in the Hazardous Waste Landfill (HWL), Enhanced Hazardous Waste Landfill (ELF), and Basin A, which was central to the effective implementation of the remedy, has been completed with engineered cover systems in place. These sites have become part of the containment remedy with specific groundwater monitoring and ongoing cover operations and maintenance (O&M) programs that monitor remedy effectiveness. Fences and signs are maintained around these areas and ICs prohibiting intrusive activities are in place to prevent exposure. All implementation projects are on schedule to be completed in 2010 and are in compliance with all elements of the On-Post ROD. Air, water, and biota monitoring programs are comprehensive in their design and were effective in their implementation during this FYR period. The long-term and operational groundwater and surface water monitoring programs effectively monitor contaminant migration pathways on post and ensure effective operation of the treatment systems as well as track off-post contamination trends. The long-term groundwater and surface water monitoring programs were revised during this FYR period to ensure contaminant migration is being adequately controlled. Risks to human health and the environment are also being controlled by a comprehensive worker protection and access control program and ICs. Monitoring of ICs to ensure protectiveness was implemented during this FYR period. Groundwater contamination is being treated to remediation goals at the RMA boundary as well as on post at the Railyard

Containment System (RYCS) and at the Basin A Neck System (BANS) and operation and maintenance plans are in place to ensure long-term protection.

Off-Post Operable Unit

The Army concludes that the remedy at the Off-Post OU is expected to be protective upon completion or is protective of human health and the environment; in the interim, exposure pathways that could result in unacceptable risks are being controlled. Groundwater contamination is being treated to Off-Post ROD remediation goals at the RMA boundary as well as at the Off-Post Groundwater Intercept and Treatment System (OGITS). Groundwater monitoring plans and system operation and maintenance plans are in place to ensure long-term protection. The required IC, notifying well permit owners of potential groundwater contamination, has been effective in its implementation.

This page intentionally left blank.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Rocky Mountain Arsenal (RMA)		
EPA ID: CO5210020769		
Region: VIII	**State:** CO	**City/County:** Commerce City/Adams County
SITE STATUS		
NPL Status: ☒ **Final** ☐ **Deleted** ☒ **Other (specify)** Some RMA area deleted from NPL		
Remediation Status: ☒ **Under Construction** ☒ **Operating** ☒**Complete**		
Multiple OUs? ☒ **Yes** ☐ **No**	**Construction Completion Date:** May 18, 2015	
Has site been put into reuse? ☐**Yes** ☒**No (**Re-use is planned or occurring on approximately 13,000 acres of land deleted from the NPL)		
REVIEW STATUS		
Reviewing Agency: ☐**EPA** ☐**State** ☐**Tribe** ☒**Other Federal Agency:** Army		
Author Name: Bruce Huenefeld		
Author Title: RMA Committee Chairman	**Author Affiliation:** Army	
Review Period: April 1, 2005, to March 31, 2010		
Date(s) of Site Inspection: April 27 through 29, 2010		
Type of review: ☒**Statutory** ☐**Policy (Post-SARA)**		
Review Number: ☐**First** ☐**Second** ☒**Third** ☐**Other (specify)**_____		
Triggering Action: ☐**Actual RA Onsite Construction at OU** ☐**Actual RA Start at OU** ☐**Construction Completion** ☐**Previous Five-Year Review Report** ☒**Other (specify): Signing of Off-Post ROD**		
Triggering Action Date: December 19, 1995		
Due Date: December 19, 2010		

Five-Year Review Summary Form

Summary

No issues were identified that affect the ongoing protectiveness of the remedy. The following issues have been identified to ensure continued protectiveness.

Issues

Dense Non-Aqueous Phase Liquid

In August 2009, field monitoring of the Lime Basins dewatering wells indicated the potential presence of dense non-aqueous phase liquid (DNAPL). Subsequent sampling confirmed that DNAPL was present in two of the wells.

Land Use Controls Monitoring

Pursuant to an amendment to the On-Post ROD completed in October 2005 (TtEC 2005a), annual monitoring of land use controls is required to ensure they remain effective and are protective of human health and the environment. The ROD amendment also specifies that results of the monitoring will be provided in an annual monitoring report. Land use control monitoring reports were not issued for fiscal year (FY) 2006, FY07, or FY08. In January 2010, a monitoring report was issued for FY09. Subsequent discussions related to this first report resulted in a decision to modify the report to include discussion of land use controls for FY06–FY09. Revisions to this FY09 report are in progress.

As a result of monitoring activities, two issues related to land use controls were identified that required corrective action. Several markers installed during remedy activities along the abandoned sanitary sewer were damaged or missing. Also, review of the Commerce City Prairie Gateway Planned Unit Development (PUD) revealed a use-by-right included as "(p)ublic gardening and similar cultivation of land, nursery, and supplementary to the primary public use" for a parcel of the Prairie Gateway. This use appears inconsistent with the land use restrictions delineated in the Refuge Act, which prohibit non-remedy agricultural activities. In addition, the PUD process includes notification to adjacent landowners of proposed amendments to the PUD. However, the Army has not been included in the notification list.

Exposed Sanitary Sewer Pipe

During the land use control inspection of the sanitary sewer markers, an exposed section of pipe was observed in Section 35. Although the sanitary sewer remedy requires plugging only of manholes, the intent is to prevent access to the sewer. An evaluation of the exposed pipe was completed and the pipe was plugged and buried in September 2010.

Regulatory Agency Notification

Regulatory Agency notification was not made for events associated with HWL groundwater monitoring, ELF leak detection system monitoring, and surface water monitoring. These events were instances of noncomformance with site plans; however, notification requirements were not well defined and the Regulatory Agencies were not notified in a timely fashion.

Chlordane Practical Quantitation Limit (PQL)

Historically, analytical results for the OGITS system show that chlordane has not been present above the Containment System Remediation Goal (CSRG). Chlordane results are obtained by adding the alpha and gamma isomers together; there is no single analytical method that can be used to test environmental samples. The gamma-chlordane method reporting limit (MRL) changed to a higher value during this FYR, in 2008, when the method was recertified. Currently, the MRL for gamma-chlordane is above the CSRG, and gamma-chlordane was not included in the new PQL study. Because the reported values continued to be below the MRL, the impact of the higher MRL on compliance reporting was not discovered until this review.

Establishing Site-Specific PQLs

The 2005 FYRR identified the need to establish new site-specific PQLs for groundwater contaminants for which the CSRGs could not be measured with available analytical methods. The PQL studies for aldrin, dieldrin, and n-nitrosodimethylamine (NDMA) were initiated after new Colorado Department of Public Health and Environment (CDPHE) PQL guidance was issued in 2008. At the end of the FYR period, the PQL studies had not yet been competed, so this becomes a continuing issue for the 2010 FYR.

Potential Inclusion of 1,4-Dioxane in RMA Applicable or Relevant and Appropriate Requirement (ARARs)

The need to determine whether the 1,4-dioxane Colorado Basic Standard for Groundwater (CBSG) should be included in the RMA ARARs has been identified as a FYR issue. In recent years, regulators have become aware that 1,4-dioxane is likely to be present at sites where 1,1,1-trichloroethane (1,1,1-TCA, methyl chloroform) is a contaminant. Although 1,1,1-TCA has been detected occasionally in RMA groundwater, the detections have been very limited in extent and very low in concentration, as is the case at the present time. Accordingly, 1,4-dioxane levels are likely to be well below detection limits and therefore unlikely to be of any potential public health concern.

Seasonal Worker Residential Use

In 2009, the USFWS began using a trailer located in the administrative area of RMA as a bunkhouse for seasonal workers. Because occupational residential use on RMA was not specifically addressed in the FFA or the ROD, the USFWS requested a qualitative risk assessment from the RVO for this use in 2009, prior to allowing the seasonal workers to reside in the bunkhouse. This qualitative risk assessment, based in large part on results from the previous RMA baseline risk assessment (Ebasco 1994), identified no unacceptable potential health risks for the Biological Worker in the bunkhouse area (Klingensmith 2009). The 2009 qualitative risk assessment was an internal document within the RVO and was not provided for Regulatory Agency review. Occupational residential use was therefore approved by the RVO.

During the preparation of the 2010 Five-Year Review Report, the Regulatory Agencies have requested, and the RVO has agreed to perform, a quantitative risk assessment to provide additional information regarding the occupational residential exposure scenario before the 2012

field season. The quantitative risk assessment is identified in Section 9.0 as an issue for follow-up in the next Five-Year Review.

Overall there is no reason to conclude that contaminant intake has increased in any of the scenarios originally evaluated in the selection of the remedy.

Recommendations and Follow-up Actions

DNAPL

In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), a Remedial Investigation/Feasibility Study (RI/FS) is being conducted to assess the nature and extent of the DNAPL and to determine the necessary remedial actions for the site.

Land Use Controls Monitoring

The Army will ensure that land use controls are monitored annually and that annual reports are issued as required. The following three corrective actions identified based on the evaluation performed in FY09 are recommended:

- Repair or replace damaged and missing markers along the abandoned sanitary sewer line.
- Obtain clarification from the Commerce City Planning Division on the use-by-right included in the Prairie Gateway PUD.
- Request that the Army be included on the notification list for future changes to the PUD to improve notice of upcoming amendments.

Exposed Sanitary Sewer Pipe

The Army will evaluate potential actions to address the exposed sanitary sewer pipe located in Section 35.

Regulatory Agency Notification

Communication with the Regulatory Agencies could be improved by identifying well-defined parameters for notification and consultation in site plans. Plans completed during this FYR period have incorporated this concept by including specific notification triggers and consultation requirements based on potential events. Finalization of additional plans or revision to the existing plans will continue to include notification triggers to ensure that the Regulatory Agencies are informed of events related to RMA remediation.

Chlordane PQL

The gamma-chlordane MRL will be addressed as part of the laboratory recertification process in 2011. The new MRL is expected to be below the CSRG of 0.03 micrograms per liter (µg/L).

Establishing Site-Specific PQLs

The Army recommends that the PQL Study Report be completed and the PQL values for NDMA, aldrin, and dieldrin be approved and established in 2011.

Evaluation of 1,4-Dioxane as a Potential RMA ARAR

To confirm that 1,4-dioxane does not pose an unacceptable human health risk in RMA groundwater, existing and historical information, as well as additional groundwater samples, will be evaluated by the RVO and the Regulatory Agencies to determine whether the 1,4-dioxane CBSG should be added to the RMA list of ARARs. A technical memorandum will be prepared during the next five-year review period to document this evaluation and the resulting decision.

Seasonal Worker Residential Use

To provide additional information regarding occupational residential use by USFWS seasonal employees at RMA, a human health risk assessment will be performed prior to the 2012 field season.

Protectiveness Statements

The protection of human health and the environment by remedial actions in both the On-Post and Off-Post OUs is discussed below. All controls are in place to adequately minimize risks. Because the remedial actions in both the On-Post and Off-Post OUs are expected to be protective of human health and the environment upon completion, the remedy for the entire site is expected to be protective of both human health and the environment.

On-Post OU

The Army concludes that the remedy at the On-Post OU is expected to be protective of human health and the environment upon remedy completion; in the interim, exposure pathways that could result in unacceptable risks are being controlled. Placement of contaminated soils and debris in the HWL, ELF, and Basin A, which was central to the effective implementation of the remedy, has been completed with engineered covers in place. These sites have become part of the containment remedy with specific groundwater monitoring and ongoing cover O&M programs that monitor remedy effectiveness. Fences and signs are maintained around these areas and ICs prohibiting intrusive activities are in place to prevent exposure. All implementation projects are on schedule to be completed in 2010 and are in compliance with all elements of the On-Post ROD. Air, water, and biota monitoring programs are comprehensive in their design and were effective in their implementation during this FYR period. The long-term and operational groundwater and surface water monitoring programs effectively monitor contaminant migration pathways on post and ensure effective operation of the treatment systems as well as track off-post contamination trends. The long-term groundwater and surface water monitoring programs were revised during this FYR period to ensure contaminant migration is being adequately controlled. Risks to human health and the environment are also being controlled by a comprehensive worker protection and access control program and ICs. Monitoring of ICs to ensure protectiveness was implemented during this FYR period. Groundwater contamination is being treated to remediation goals at the RMA boundary as well as on post at the RYCS and at the BANS and operation and maintenance plans are in place to ensure long-term protection.

Off-Post OU

The Army concludes that the remedy at the Off-Post OU is expected to be protective upon completion or is protective of human health and the environment; in the interim, exposure pathways that could result in unacceptable risks are being controlled. Groundwater contamination is being treated to Off-Post ROD remediation goals at the RMA boundary systems as well as at OGITS. Groundwater monitoring plans and system operation and maintenance plans are in place to ensure long-term protection. The required IC, notifying well permit owners of potential groundwater contamination, has been effective in its implementation.

This page is intentionally left blank.

1.0 Introduction

Section 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), together with the implementing regulation in the National Oil and Hazardous Substance Pollution Contingency Plan (NCP), requires that remedial actions resulting in any hazardous substances, pollutants, or contamination remaining at a site above concentrations that allow for unlimited use and unrestricted exposure be reviewed every 5 years to ensure protection of human health and the environment. This requirement applies to the cleanup being conducted at Rocky Mountain Arsenal (RMA), shown on Figure 1.0-1. In 2010, the RMA Five-Year Review (FYR) was conducted by the U.S. Army (Army) in accordance with Section 36 of the Federal Facility Agreement (FFA) (EPA 1989) and CERCLA Section 121(c), and this Five-Year Review Report (FYRR) presents a summary of this review.

The 2000 FYR and 2005 FYR of CERCLA remedial actions at RMA covered the periods December 19, 1995, through March 31, 2000; and April 1, 2000, through March 31, 2005. This report documents the RMA 2010 FYR, which covers the period April 1, 2005, through March 31, 2010. Environmental monitoring and analytical data results from October 1, 2004, through September 30, 2009, were reviewed and evaluated in this FYR. Changes in laws, applicable or relevant and appropriate requirements (ARARs), and to-be-considered criteria (TBCs) between April 1, 2005, and March 31, 2010, are included in this FYR. Construction Completion Reports (CCRs) approved by the U.S. Environmental Protection Agency (EPA) between April 1, 2005, and March 31, 2010, are considered "completed projects" for this FYR. Specifically, all projects are organized based upon their status as of March 31, 2010.

This RMA FYR required extensive research over an extended period of time. Where data and information relevant to preparation of the FYRR, or necessary for responses to Regulatory Agency comments, became available after the deadlines noted above, it was evaluated for inclusion. Subsequent data and reports were included whenever the information was important to the assessment based on best professional judgment.

The purpose of the FYR is to determine whether the remedy for RMA selected in the On-Post and Off-Post Records of Decision (RODs) remains protective of human health and the environment. For elements of the remedy that are under construction, the purpose of the review is to confirm that immediate threats have been addressed. The FYRR provides a detailed discussion of the conclusions reached and recommendations made.

EPA guidance requires FYRs to be conducted site-wide. For RMA, this includes the On-Post Operable Unit (OU), the Off-Post OU, and all Interim Response Actions (IRAs) implemented prior to the signing of the RODs. The review of the IRAs, the On-Post OU, and the Off-Post OU is required by statute. A discussion of the OUs associated with the RMA site is provided in Appendix C. The schedule for conducting this FYR is determined by the date the Off-Post ROD was signed, on December 19, 1995.

Given the size and complexity of the RMA site, and to keep this report as clear and readable as possible, other documents are routinely referenced as sources for more detailed information. In

addition, every effort has been made to cross-reference to other parts of the FYRR where the topic is addressed further. The 2010 FYRR consists of three volumes.

The general structure of this report was based on current EPA FYR guidance (EPA 2001). To enable the reader to better understand this report, the outline for Volume I is provided below.

Section 1, Introduction—Provides the legal basis and the objectives for the review as well as a description of the report structure.

Section 2, Site Chronology—Provides a chronology of significant ROD-related events.

Section 3, Background—Provides historical information on RMA, including a description of past operations, a list of contaminants of concern (COCs), and information on current and future land use.

Section 4, Remedial Actions—To streamline the presentation of information, this section is first organized to be consistent with the selected remedy in the On-Post and Off-Post RODs. This approach helps streamline the presentation of the Remedial Action Objectives (RAOs), the selected remedy, the ROD standards, and the ROD goals. To accomplish this, the implementation projects are first grouped in Section 4 into one of three ROD medium groups (groundwater, soil, structures) or "other" for miscellaneous remedy components.

Consistent with EPA FYR guidance, within the three medium groups or "other," the projects are further grouped into projects under construction, operational projects, and completed projects. This second structure facilitates organization of the assessments in Section 7.0.

Section 5, Progress since 2005 Five-Year Review—Includes the protectiveness statements and lists the status of recommendations and follow-up actions from the 2005 FYRR and whether they achieved the intended purpose.

Section 6, Five-Year Review Process—Provides a list of participants in the FYR process as well as the approach taken in performing this review. This section also presents data collected in the groundwater, surface water, biota, and air monitoring programs, and a section summarizing remedy costs.

Section 7, Assessment—Uses information provided in Section 6.0 as well as additional information gathered in the review process to answer three key questions. Consistent with EPA FYR guidance, the projects are regrouped in Section 7.0 into projects under construction, operational projects, and completed projects to facilitate the assessment process.

Sections 7.1 through 7.3—Answers the question, "Is the remedy functioning as intended by the decision documents?"

Section 7.4—Answers the question, "Are the assumptions used at the time of the remedy selection still valid?" This includes a review of risk assessment assumptions; an update to all ARARs, standards, and TBCs; and a discussion of the impact of these changes.

Section 7.5—Answers the question, "Has any other new information come to light that could call into question the protectiveness of the remedy?"

Section 7.6—Provides a Technical Assessment Summary.

Section 8, Issues—Provides a succinct statement of the issues.

Section 9, Recommendations and Follow-up Actions—Details follow-up actions necessary to address the issues identified in Section 8.0.

Section 10, Protectiveness Statements—Provides protectiveness statements under the current FYR for both the On-Post and Off-Post OUs.

Section 11, Next Five-Year Review—Details when the next FYR is scheduled to take place.

Section 12, References.

The summary of the community interviews is presented in Appendix A of this report.

The FYR site inspection and interview checklists are presented in Volume II and responses to Regulatory Agency comments are presented in Volume III.

This page intentionally left blank.

2.0 Site Chronology

Table 2.0-1 lists the chronology of significant ROD-related events. Additional sources of information regarding the schedules of specific remedial project start and completion dates and CCR dates include Table 2.0-2 (provided under Tables tab), the Remediation Design and Implementation Schedule (RDIS) (PMRMA 2009a), and the CCRs listed in the references.

Table 2.0-1. Chronology of ROD-Related Events

Date	Event
1942	Establishment of RMA.
Late 1950s	Off-Post groundwater contamination first suspected.
1974	Army establishes the RMA Contamination Control Program.
Apr. 1975	Colorado Department of Health issues a Cease and Desist Cleanup and Monitoring Order to RMA in connection with the alleged pollution of groundwater and surface water north of RMA.
1977	Army installs pilot groundwater containment system at the north boundary.
1978–1984	Army and Shell install three boundary groundwater containment systems.
1984	Site proposed for addition to the NPL.
1984	Army completes a Preliminary Assessment and Site Inspection that identifies 179 potentially contaminated sites.
1985	First interim response action completed.
Aug. 1987	RMA added to the NPL.
Feb. 1989	FFA signed.
Jan. 1992	RI completed.
Dec. 1992	Development and Screening of Alternatives completed.
Oct. 1995	Detailed Analysis of Alternatives completed.
Dec. 1995	Record of Decision signed for Off-Post OU.
Jun. 1996	Record of Decision signed for On-Post OU.
May 1999	Technical Justification Report for volume modification of Toxic Storage Yards Soil Remediation project.
Oct. 2000	RMA first FYRR issued.
Nov. 2000	ESD issued on Chemical Sewer Remediation—Section 35 and Section 26.
Nov. 2000	ESD issued on South Plants Balance of Areas and Central Processing Area Soil Remediation project.
Nov. 2001	ESD issued on change in endrin standard for treatment systems (NBCS, NWBCS, BANS, and OGITS).
Feb. 2002	ESD issued on Secondary Basins Soil Remediation project.
Jan. 2003	Deleted approximately 940 acres on the western side of RMA from the NPL.
Apr. 2003	On-Post ROD Amendment for Hex Pit Remediation.
Apr. 2003	ESD issued on Section 36 Balance of Areas Soil Remediation project.
Dec. 2003	Removed Chemical Weapons Convention Treaty monument.
Jan. 2004	Deleted approximately 5,053 acres mostly on the southern and eastern sides of RMA from the NPL.

Table 2.0-1. Chronology of ROD-Related Events (Concluded)

Date	Event
Apr. 2004	Rocky Mountain Arsenal National Wildlife Refuge officially established.
Jul. 2004	ESD issued on Burial Trenches Soil Remediation project.
Sep. 2004	ESD issued on North Plants Structure Demolition and Removal project.
May 2005	ESD issued on Existing (Sanitary) Landfills Soil Remediation project.
Oct. 2005	On-Post ROD Amendment for the Section 36 Lime Basins and Basin F Principal Threat Soil projects.
May 2006	ESD issued on Section 36 Bedrock Ridge Groundwater Plume Extraction System.
Mar. 2006	ESD issued on groundwater remediation and revegetation requirements.
June 2006	ESD issued on Shell Disposal Trenches project.
July 2006	Deleted approximately 7,396 acres from the NPL.
Nov. 2007	RMA second FYRR issued.
Apr. 2008	Minor change to On-Post ROD for soil covers.
June 2008	ESD issued on Miscellaneous Southern Tier Soil Remediation project and Section 35 Soil Remediation project (Sand Creek Lateral and Other Ditches Remediation).
Sept. 2008	ESD issued on Off-Site Waste Disposal and cost increases for On-Site Disposal Facility projects.
Nov. 2008	ESD issued on Munitions (Testing) Soil Remediation project.
Jan. 2009	ESD issued on North Plants Soil Remediation project.
Jan. 2009	ESD issued on Basin F/Basin F Exterior Remediation project, Part 2, and Chemical Sewer Remediation project.
Apr. 2009	ESD issued on Basin F Wastepile Remediation project.
Oct. 2009	ESD issued on Section 36 Balance of Areas Soil Remediation project.

2.1 Deletions from the National Priorities List

As of the end of the FYR period, four partial deletions have occurred and include the Western Tier Parcel, Selected Perimeter Area, Surface Deletion Area, and Internal Parcel. Combined, these four deletions have reduced the area remaining on the National Priorities List (NPL) On-Post OU to approximately 5.6 square miles.

2.1.1 Western Tier Parcel

The Rocky Mountain Arsenal National Wildlife Refuge Act of 1992 (Refuge Act) stipulates that approximately 815 acres (subsequently more accurately defined as 917 acres) referred to as the Western Tier Parcel will be transferred to Commerce City for fair market value. The first step in the process was the partial deletion of the Western Tier Parcel from the NPL. In October 1998, a Notice of Intent for Partial Deletion (NOIDp) was published by EPA in the Federal Register to delete surface media and groundwater. The deletion was subsequently postponed to allow for additional soil sampling. During the soil sampling, a site reconnaissance was performed that identified eight areas requiring subsurface investigation. The investigation resulted in excavation of one of the eight areas. Concurrently, site-wide evaluation of potential unexploded ordnance (UXO) and recovered chemical warfare materiel (RCWM) was being conducted in response to

the discovery of chemical warfare agent-filled bomblets elsewhere at the site. This evaluation is discussed further in Section 4.4.1.3. These additional efforts resulted in the publication of a second NOIDp in September 2002. After public comment, the Notice of Partial Deletion (NODp) was published in January 2003. The ultimate sale of the property to Commerce City occurred in June 2004.

2.1.2 Selected Perimeter Area and Surface Deletion Area

The Refuge Act also requires that upon certification by EPA that all response actions at RMA have been completed (i.e., NPL deletions have been made) the Army will transfer administrative jurisdiction over the property to the U.S. Fish and Wildlife Service (USFWS). The Army first proposed deletion of the perimeter area in 1999, but the effort was suspended because bomblets were discovered as discussed above. Once the site-wide evaluation of UXO and RCWM had been completed, perimeter deletion efforts resumed, resulting in two NOIDps (Selected Perimeter Area and Surface Deletion Area) being published in the Federal Register in July 2003 for a total of approximately 5,000 acres. The Selected Perimeter Area included surface media and groundwater while the Surface Deletion Area included surface media only. The corresponding NODps were published in the Federal Register in January 2004. The Selected Perimeter Area and Surface Deletion Area were transferred to the USFWS on March 2, 2004, and the USFWS officially established the Rocky Mountain Arsenal National Wildlife Refuge (Refuge) in April 2004.

The Refuge Act also specifies that 100-foot (ft)-wide strips inside the RMA boundary on the northwestern, northern, and southern sides be transferred to local governments, at no cost, to allow improvement of public roads. The approximately 11 miles of 100-ft-wide strips amount to approximately 126 acres. This property was included in the Selected Perimeter Area deletion described above. Following that deletion, the property was transferred to the units of local government in September 2004.

2.1.3 Internal Parcel

The NOIDp for the Internal Parcel at RMA was published in April 2006. Following public comment, the NODp for approximately 7,400 acres (11.5 square miles) was published in the Federal Register at the end of July 2006. The Internal Parcel deletion included surface media and groundwater in areas east of E Street (with the exception of a small area of contaminated groundwater located in the northwestern corner of Section 6) and surface media only for areas west of E Street. Most of the property was transferred to the USFWS in September 2006 to further expand the Refuge.

2.1.4 Central Area and Eastern Surface Area

Another deletion effort is underway for the Central Area and Eastern Surface Area. The proposed deletion will include approximately 2,500 acres (3.9 square miles) of surface media in the central and eastern areas of the RMA. A NOIDp is expected in June 2010 and the NODp should be completed before the end of the year. This property will be transferred to the USFWS after deletion is complete.

2.1.5 Off-Post OU Partial Deletion

A partial deletion effort is underway for the Off-Post OU surface media. The proposed deletion will include all surface area in the Off-Post OU, including the Shell Property; however, groundwater in the off-post area has not met remediation goals and remains on the NPL. A NOIDp was issued in June 2010, and the NODp was completed before the end of 2010. In September 2009, EPA completed a Ready for Reuse Determination for most of the Shell Property that demonstrated that the property is ready for use for any purpose allowed under local land use and zoning laws. The property remains subject to restrictions specified in the Off-Post ROD, which includes prohibition against construction of new alluvial wells and use of deeper groundwater underlying the Shell Property for potable purposes until such groundwater no longer contains contamination in exceedance of groundwater CSRGs established in the Off-Post ROD.

3.0 Background

The RMA site is comprised of two OUs. The On-Post OU originally consisted of all of RMA and occupied approximately 26.6 square miles in southern Adams County, approximately 10 miles northeast of downtown Denver. As of the end of the FYR period, four partial deletions have occurred that reduce the area remaining on the NPL to approximately 5.6 square miles. The Off-Post OU encompasses groundwater Containment System Remediation Goal (CSRG) exceedance areas that underlie approximately 2.4 square miles of rural, agricultural, commercial, residential, and industrial-zoned areas north and northwest of RMA as well as property where the Off-Post Groundwater Intercept and Treatment System (OGITS) is located. The Off-Post and On-Post OUs are depicted on Figure 3.0-1.

The Army established RMA in 1942 to produce chemical warfare agents and incendiary munitions used in World War II. Following the war and through the early 1980s, the Army continued to use these facilities. Beginning in 1946, some RMA facilities were leased to private companies to manufacture industrial and agricultural chemicals. Shell Oil Company (Shell), the principal lessee, manufactured primarily pesticides at RMA from 1952 to 1982. Common industrial and waste disposal practices during these years resulted in the release of contamination. Approximately 70 chemicals have been the focus of the Remedial Investigation (RI) for the On-Post OU. Of these, the principal contaminants are organochlorine pesticides (OCPs), heavy metals, agent-degradation products and manufacturing by-products, and chlorinated and aromatic solvents. The specific COCs that were identified for on-post soil and off-post groundwater are listed in Table 3.0-1. The individual CCRs may be referenced for a list of COCs on a project-specific basis.

Table 3.0-1. Contaminants of Concern

On-Post OU Soil COCs (On-Post ROD, Table 6.1-1)	**Off-Post OU Soil COCs (Off-Post ROD, Table 6.4)**	**Off-Post OU Sediment COCs (Off-Post ROD, Table 6.3)**	**Off-Post OU Groundwater COCs (Off-Post ROD, Table 6.1)**	**Off-Post OU Surface Water COCs (Off-Post ROD, Table 6.2)**
Aldrin	Aldrin	Aldrin	Aldrin	Arsenic
Arsenic	Chlordane	DBCP	Arsenic	Chlordane
Benzene	Dieldrin	Dieldrin	Atrazine	Chloride
Cadmium	Endrin	Endrin	Benzene	DCPD
Carbon Tetrachloride	DDE	DDE	Carbon tetrachloride	DDE
Chlordane	DDT	DDT	Chlordane	DDT
Chloroacetic Acid			Chloride	Dieldrin
Chlorobenzene			Chlorobenzene	DIMP
Chloroform			Chloroform	Fluoride
Chromium			CPMSO	Sulfate
DBCP			$CPMSO_2$	
DCPD			DBCP	
DDE			1,2-Dichloroethane	

Table 3.0-1. Contaminants of Concern (Concluded)

On-Post OU Soil COCs (On-Post ROD, Table 6.1-1)	Off-Post OU Soil COCs (Off-Post ROD, Table 6.4)	Off-Post OU Sediment COCs (Off-Post ROD, Table 6.3)	Off-Post OU Groundwater COCs (Off-Post ROD, Table 6.1)	Off-Post OU Surface Water COCs (Off-Post ROD, Table 6.2)
DDT			DCPD	
1,2-Dichloroethane			DDE	
1,1-Dichloroethylene			DDT	
Dieldrin			Dichlorobenzene	
Endrin			DIMP	
HCCPD			Dieldrin	
Isodrin			Dithiane	
Lead			Endrin	
Mercury			Ethylbenzene	
Methylene Chloride			Fluoride	
1,1,2,2-Tetrachloroethane			HCCPD	
Tetrachloroethylene			Isodrin	
Toluene			Malathion	
Trichloroethylene			Manganese	
			Oxathiane	
			Sulfate	
			Tetrachloroethylene	
			Toluene	
			Trichloroethylene	
			Xylene	

Risk assessments were conducted for soil and off-post groundwater for which COCs were identified. The baseline risk assessment, however, did not evaluate exposure pathways related to on-post groundwater and surface water, fish and game consumption, or agricultural uses due to existing FFA restrictions, so COC concentrations in those media were not developed. During the investigation leading up to the ROD, groundwater monitoring was conducted for the analyte lists identified through the Comprehensive Monitoring Program and Groundwater Monitoring Program. Modifications to these programs were made during the course of the investigation in response to requests from all parties. The CSRG lists that apply to effluents for the different on-post containment/treatment systems were derived from the Groundwater Monitoring Program analyte list, but it should be noted that these are different for the different systems as reflected in the CSRG analyte tables presented in Section 4.1.

The RI and subsequent investigations have identified more than 180 sites with contaminated soil, ditches, stream and lakebed sediments, sewers, groundwater, surface water, and structures. These contaminated areas included approximately 3,000 acres of soil, 15 groundwater plumes, and

798 structures. Sites that posed potential immediate risks to human health and the environment were addressed through IRAs.

Groundwater contamination migrated off post prior to the implementation of groundwater pump-and-treatment systems, resulting in the necessity for establishing and investigating the Off-Post OU. Specifically, the Off-Post OU addressed groundwater contamination north and northwest of RMA. The risk assessment performed for the Off-Post OU indicated that the only exposure pathway of concern was human exposure to contaminated groundwater.

IRAs were determined to be necessary to mitigate the impact of contamination at several sites prior to selection of a final remedy. These interim actions are described in the IRA Summary Reports discussed in the 2000 FYRR (PMRMA 2000). Most of these actions were completed before the RODs were issued, although some are ongoing (e.g., groundwater treatment systems) and have been incorporated into the RODs. All interim actions necessary to mitigate immediate risks have been implemented, and those that are ongoing have been incorporated into ROD-mandated projects and are evaluated in that context.

Because the area is ecologically unique, current and future land use for the On-Post OU has been restricted pursuant to land use restrictions established by the FFA (EPA 1989). Surrounded by development, the RMA provides a refuge for an abundant diversity of flora and fauna. For this reason, the majority of the site was designated as a future National Wildlife Refuge by the Refuge Act of 1992. As components of the remedy have been completed and the land deleted from the NPL, administrative jurisdiction has been transferred to the USFWS or other parties purchasing the land, except for the property and facilities continuing to be used for response actions (e.g., landfills and groundwater treatment systems).

Refuge property must be managed in accordance with the FFA, On-Post ROD, and Refuge Act. The land transferred or sold to other non-USFWS parties continues to be subject to restrictions prohibiting residential and industrial use, use of water on the site as a source of potable water, hunting and fishing for consumptive use, and agricultural use in accordance with the On-Post ROD, the Refuge Act, and the FFA. Current and future land use of the Off-Post OU has not been restricted; however, institutional controls (ICs) identified in the Off-Post ROD have been implemented to reduce the potential for exposure to groundwater exceeding remediation goals. In addition, the ROD requires a deed restriction that prohibits drilling new alluvial wells and use of deeper groundwater underlying the Shell Property for potable purposes until such groundwater no longer contains contamination in exceedance of groundwater remediation goals established in the ROD.

This page intentionally left blank.

4.0 Remedial Actions

This section describes the remedy selected in the ROD, administrative changes that have been made to the ROD, and the status of each component of the ROD. The On-Post ROD specified that the remedy address four essential parts: groundwater, structures, soil, and "other," which are described below. The four parts and their components were reconfigured into a design/construction-oriented approach as detailed in the RDIS.

Table 2.0-2 provides a detailed list of the On-Post and Off-Post ROD projects/topics and IRAs and references the sections of this FYRR where each project/topic is discussed. The number in parentheses at the end of each section heading (e.g., #17) corresponds to the number used to identify the projects in Table 2.0-2.

The projects/topics listed in Table 2.0-2 are keyed to the list of projects provided in the table of contents to Appendix B of the RDIS. The table indicates the status of each project/topic as of March 31, 2010, and projected start and CCR completion dates for each project. More detailed information on the schedule of each project, as well as a more comprehensive description, can be found in the RDIS for On-Post ROD projects (PMRMA 2009a), Off-Post Remediation Scope and Schedule (RS/S) for Off-Post ROD projects (HLA 1996a), and the IRA Summary Reports.

Consistent with EPA FYR guidance, the status of each project is defined by one of the following:

- **Not yet begun**—Defined as "in the planning stages and prior to completion of the 100 Percent Design as of March 31, 2010."
- **Under construction**—Defined as "having an approved 100 Percent Design prior to or on March 31, 2010, but not yet having an approved CCR prior to or on March 31, 2010."
- **Operating**—Defined as "a fully operational project."
- **Completed**—Defined as "having an approved final CCR or IRA Summary Report prior to or on March 31, 2010."
- **Incorporated into Final IRA**—Applicable to IRAs, defined as "a project closed out with elements incorporated into a specific, related ROD-identified project."
- *For projects that include installation of a dewatering system, operating is defined for the project when the dewatering system is installed and functioning. However, dewatering goals are not expected to be achieved until cover construction is complete, which includes establishment of cover vegetation and approval of final CCRs.*

Sections 4.1 and 4.2 identify events that occurred during the FYR period as well as remedy-related FYR issues, which are further discussed in the Issues and Recommendations sections, i.e., Sections 8.0 and 9.0, of this document. Events include one-time events that would require Regulatory Agency notification and potential FYR issues that were resolved during the FYR period. These are not considered issues as they did not prevent the response action from being protective at the end of the FYR period.

4.1 Groundwater Remedy Selection and Implementation

The On-Post ROD specified the following RAOs for groundwater:

> *Ensure that the boundary containment and treatment systems protect groundwater quality off-post by treating groundwater flowing off RMA to the specific remediation goals identified for each of the boundary systems.*
>
> *Develop on-post groundwater extraction /treatment alternatives that establish hydrologic conditions consistent with the preferred soil alternatives and also provide long-term improvement in the performance of the boundary control systems.*

The selected remedy for on-post groundwater includes:

- *Continued operation of the three RMA boundary groundwater containment and treatment systems, the North Boundary Containment System (NBCS), the Northwest Boundary Containment System (NWBCS), and Irondale Containment System (ICS), which treat groundwater to attain ARARs and health-based remediation goals. These systems and the on-post groundwater IRA systems (Basin A Neck, North of Basin F, Motor Pool, and Rail Yard) will continue to operate until shut-off criteria specified in Section 9.1 of the On-Post ROD are met. ARARs for chloride and sulfate at the NBCS will be achieved through natural attenuation as described in "Development of Chloride and Sulfate Remediation Goals for the North Boundary Containment System at the Rocky Mountain Arsenal" (MKE 1996). Assessment of the chloride and sulfate concentrations will occur during the 5-year site reviews.*
- *Installation of a new extraction system to intercept and contain a contaminated groundwater plume in the northeast corner of Section 36 that will be treated at the Basin A Neck IRA system.*
- *Water levels in Lake Ladora, Lake Mary, and Lower Derby Lake will be maintained to support aquatic ecosystems. The biological health of the ecosystems will continue to be monitored.*
- *Lake-level maintenance or other means of hydraulic containment or plume control will be used to prevent South Plants plumes from migrating into the lakes at concentrations exceeding Colorado Basic Standards for Groundwater (CBSGs) in groundwater at the point of discharge. Groundwater monitoring Groundwater monitoring will be used to demonstrate compliance.*
- *Monitoring and assessment of n-nitrosodimethylamine contamination in support of potential design refinement/design characterization to achieve remediation goals specified for boundary groundwater treatment systems.*

Other specific components of the selected remedy for on-post groundwater are provided below in the context of the project discussions.

The Off-Post ROD (HLA 1995) identified the following remedial components for off-post groundwater:

- *Operation (and improvement if necessary) of the OGITS*
- *Continued operation (and improvement, if necessary) of the NBCS and NWBCS*
- *Long term groundwater and surface water monitoring*
- *Provision of alternative water supplies and implementation of institutional controls intended to prevent future use of contaminated groundwater.*

The on-post and off-post groundwater remedies for RMA are summarized as discussed in Sections 4.1.1.1 through 4.1.1.3. The site-wide groundwater and surface water monitoring programs associated with the RMA remedy are addressed in Sections 6.3.1 and 6.3.2 as part of the data review. Detailed presentations and evaluations of all the groundwater remedies and monitoring programs for the fiscal year 2005 (FY05) through FY09 FYR period are presented in the Five-Year Summary Report (FYSR) for Groundwater and Surface Water (TtEC and URS 2010a). The FYSR also includes detailed information on the status of follow-up actions for water-related issues identified in the 2005 FYRR (RVO 2007a), and identifies events associated with the groundwater remedy that required Regulatory Agency notification during this FYR period.

4.1.1 Operating Groundwater Remedies

The data used for this FYR were collected pursuant to the 1999 Long-Term Monitoring Plan (LTMP) for Groundwater (FWENC 1999a), the Sampling and Analysis Plans (SAPs) issued as part of the Operations and Maintenance (O&M) Manuals for the respective extraction and treatment systems, and the project-specific monitoring plans developed in accordance with Resource Conservation and Recovery Act (RCRA) requirements.

The long-term groundwater monitoring program described in the 1999 LTMP satisfies the requirements of the On-Post and Off-Post RODs (FWENC 1996; HLA 1995). The main objectives, as stated in the RODs, are to evaluate the effectiveness of the remedies; to verify the effectiveness of existing on-post and off-post groundwater extraction, containment, and treatment systems; to satisfy CERCLA requirements for waste left in place; and to provide data for FYRs. The main component of the remedy related to groundwater is continued operation of the groundwater extraction and treatment systems. It should be noted that to the extent possible, the performance and monitoring criteria developed for the 2010 version of the LTMP (TtEC and URS 2010c) were applied to the groundwater data evaluated in this report. The revised monitoring programs presented in the 2010 LTMP, however, will not be implemented until the next FYR period.

The RMA groundwater containment and treatment systems are identified in Figure 3.0-1. It should be noted that all these systems were evaluated in detail in the 2010 FYSR (TtEC and URS 2010a).

The following on-post and off-post groundwater extraction and treatment systems were evaluated against compliance requirements and performance criteria:

- Northwest Boundary Containment System (NWBCS)
- North Boundary Containment System (NBCS)

- Railyard Containment System (RYCS)
- Basin A Neck System (BANS)
- Bedrock Ridge Extraction System (BRES)
- Off-Post Groundwater Intercept and Treatment System (OGITS)

The 2010 LTMP (TtEC and URS 2010c) performance criteria for each of these systems are presented in their respective subsections in this report. The 2010 LTMP performance criteria are more rigorous than the criteria in the Off-Post RS/S and 1999 LTMP, which are also addressed by the 2010 LTMP criteria.

4.1.1.1 On-Post and Off-Post Extraction and Treatment System Evaluation

This section presents a summary evaluation of the extraction and treatment systems in the On-Post and Off-Post OUs. Detailed evaluations of these systems are presented in the 2010 FYSR (TtEC and URS 2010a) and the system locations are shown in Figure 3.0-1.

Northwest Boundary Containment System (#61)

The original NWBCS, located in the southeast quarter of Section 22, was installed to intercept and treat groundwater contaminant plumes migrating from the South Plants and the Basins A, C, and F areas to the RMA boundary. The NWBCS is a containment system designed to prevent the off-post migration of contaminated groundwater. In FY09, the NWBCS flow rate averaged 863 gallons per minute (gpm).

The ROD established CSRGs for the NWBCS effluent for eight contaminants potentially present in the groundwater that migrates toward the northwest boundary. These contaminants and their respective CSRGs/practical quantitation limits (PQLs) during the FYR period are listed in Table 4.1.1-1.

Table 4.1.1-1. Northwest Boundary Containment System (NWBCS) CSRG Analytes

Chemical Group	ROD CSRG Analyte	CSRG[1] (µg/L)	PQL[2] (µg/L)	CSRG Source
Volatile Halogenated Organics (VHOs)	Trichloroethylene (TCE)	3		ROD health-based value
	Chloroform	6		ROD CBSG[3]
Organophosphorous Compounds; Sarin (Isopropylmethyl Phosphonofluoridate [GB]) Agent Related	Diisopropylmethyl phosphonate (DIMP)	8		ROD CBSG
Organochlorine Pesticides (OCPs)	Dieldrin	0.002	0.05	ROD CBSG
	Endrin	2		CBSG (corrected in 2000 FYRR)
	Isodrin	0.06		ROD health-based value

Table 4.1.1-1. Northwest Boundary Containment System (NWBCS) CSRG Analytes (Concluded)

Chemical Group	ROD CSRG Analyte	CSRG[1] (µg/L)	PQL[2] (µg/L)	CSRG Source
Other Organic Compounds	n-Nitrosodimethylamine (NDMA)	0.007	0.033	EPA Integrated Risk Information System risk-based value
Arsenic	Arsenic	2.35		ROD health-based value

Notes:

[1] Containment System Remediation Goal

[2] Practical Quantitation Limit (PQL); subject to change pending outcome of 2010 PQL study.

[3] Colorado Basic Standard for Groundwater

The 2010 LTMP performance criteria for the NWBCS are as follows:

Primary Performance Criteria:

- Demonstrate containment through reverse hydraulic gradient by visual evaluation of potentiometric maps and visual comparison of paired well water levels. If visual inspection is unclear, statistical or other evaluation criteria will be considered.
- Demonstrate containment through plume-edge capture by visual evaluation of flow directions on potentiometric maps and evaluation of water quality data from performance and operational monitoring wells. If visual inspection is unclear, statistical or other evaluation criteria will be considered.

Secondary Performance Criterion:

- If unable to maintain reverse hydraulic gradient due to factors beyond Remediation Venture Office (RVO) control, the performance evaluation will be based on demonstrating that concentrations in downgradient water quality performance wells are at or below CSRGs/PQLs or show decreasing concentration trends, based on annual evaluations, over the previous period of at least 5 years. If visual inspection is unclear, statistical or other evaluation criteria will be considered.

The downgradient conformance wells from the 1999 LTMP and the downgradient performance wells in the 2010 LTMP serve similar purposes—to monitor downgradient concentration trends. Based on the 2010 LTMP criteria presented above and the criteria in the On-Post and Off-Post RODs, 1999 LTMP, and Off-Post RS/S, the NWBCS is functioning as intended in the decision documents. Concentrations during the FYR period were below CSRGs/PQLs in the treatment plant effluent, the reverse gradient and plume capture were maintained, and the contaminant concentrations were below CSRGs/PQLs in the downgradient conformance wells.

North Boundary Containment System (#62)

The NBCS is located immediately south of the RMA north boundary in Sections 23 and 24. The system treats water from the North Boundary Plume Group as the plumes approach the north boundary of RMA. The North Boundary Plume Group includes the Basins C and F Plume and the North Plants Plume. The sources of the Basins C and F Plume contamination are the two

basins that were used for disposal of a wide range of chemical wastes between the late 1950s and the early 1970s. In FY09, the NBCS flow rate averaged 193 gpm.

CSRGs for the NBCS effluent were established for 29 contaminants potentially present in the groundwater migrating toward the north boundary. Of these compounds, which are listed with their respective CSRGs in Table 4.1.1-2, chloride and sulfate levels were to be reduced to CSRGs through attenuation over time periods of 30 and 25 years (i.e., by 2026 and 2021), respectively.

Table 4.1.1-2. North Boundary Containment System (NBCS) CSRG Analytes

Chemical Group	ROD CSRG Analyte	CSRG[1] (µg/L)	PQL[2] (µg/L)	CSRG Source
Volatile Halogenated Organics (VHOs)	1,2-Dichloroethane	0.40		ROD CBSG[3]
	1,2-Dichloroethylene	70		ROD CBSG
	Carbon tetrachloride	0.30		ROD CBSG
	Chloroform	6		ROD CBSG
	Methylene chloride	5.0		ROD CBSG
	Tetrachloroethylene (PCE)	5		ROD CBSG/MCL[4]
	Trichloroethylene (TCE)	3		ROD health-based value
Volatile Hydrocarbon Compounds (VHCs)	Dicyclopentadiene (DCPD)	46		ROD health-based value
Volatile Aromatic Organics (VAOs)	Benzene	3		ROD health-based value
	Xylenes	1,000		ROD health-based value
	Toluene	1,000		ROD CBSG/MCL
Organosulfur Compounds; Mustard Agent Related (OSCMs)	1,4-Oxathiane	160		ROD health-based value
	Dithiane	18		ROD health-based value
Organosulfur Compounds; Herbicide Related (OSCHs)	Chlorophenylmethyl sulfide	30		ROD—EPA Region VIII Health Advisory Value
	Chlorophenylmethyl sulfone	36		ROD—EPA Region VIII Health Advisory Value
	Chlorophenylmethyl sulfoxide	36		ROD—EPA Region VIII Health Advisory Value
Organophosphorous Compounds; Sarin (Isopropylmethyl Phosphonofluoridate [GB]) Agent Related	Diisopropylmethyl phosphonate (DIMP)	8		ROD CBSG
Organophosphorous Compounds; Pesticide Related (OPHPs)	Atrazine	3		ROD CBSG/MCL
	Malathion	100		ROD health-based value

Table 4.1.1-2. North Boundary Containment System (NBCS) CSRG Analytes (Concluded)

Chemical Group	ROD CSRG Analyte	CSRG[1] (µg/L)	PQL[2] (µg/L)	CSRG Source
Organochlorine Pesticides (OCPs)	Aldrin	0.002	0.037	ROD CBSG
	Dieldrin	0.002	0.05	ROD CBSG
	Endrin	2		CBSG (corrected in 2000 FYRR)
	Isodrin	0.06		ROD health-based value
Other Organic Compounds	Dibromochloropropane (DBCP)	0.2		ROD CBSG/MCL
	n-Nitrosodimethylamine (NDMA)	0.007	0.033	ROD—EPA Integrated Risk Information System value
Arsenic	Arsenic	2.35		ROD health-based value
Anions	Fluoride	2 mg/L		ROD CBSG; Agricultural standard
	Chloride	250 mg/L		ROD CBSG
	Sulfate	540 mg/L		ROD background value

Notes:
[1] Containment System Remediation Goal; µg/L unless otherwise noted
[2] Practical Quantitation Limit (PQL); subject to change pending outcome of 2010 PQL study.
[3] Colorado Basic Standard for Groundwater
[4] Maximum Contaminant Level

The 2010 LTMP performance criteria for the NBCS are as follows:

Primary Performance Criteria:

- Demonstrate containment through reverse hydraulic gradient by visual evaluation of potentiometric maps and visual comparison of paired well water levels. If visual inspection is unclear, statistical or other evaluation criteria will be considered.
- Demonstrate containment through plume-edge capture by visual evaluation of flow directions on potentiometric maps, and evaluation of water quality data from performance water quality wells. If visual inspection is unclear, statistical or other evaluation criteria will be considered.

Secondary Performance Criterion:

- If unable to maintain reverse hydraulic gradient due to factors beyond RVO control, the performance evaluation will be based on demonstrating that concentrations in downgradient water quality performance wells are at or below CSRGs/PQLs or show decreasing concentration trends over the previous period of at least 5 years. If visual inspection is unclear, statistical or other evaluation criteria will be considered.

Based on criteria in the On-Post and Off-Post RODs, Off-Post RS/S, 1999 LTMP, and 2010 LTMP, the NBCS is functioning as intended in the decision documents. The NBCS treatment

plant effluent contaminant concentrations were below CSRGs/PQLs during the FYR period, including chloride and sulfate, which is well ahead of the ROD requirement to meet their respective CSRGs by 2026 and 2021, respectively.

The reverse gradient was maintained except for a short period in 2005 that was determined to not have an adverse effect on protectiveness. An evaluation was conducted by the RVO and the conclusions were that (1) the areas of forward gradient between the recharge trenches were relatively small (less than 200 feet (ft) between trenches); (2) the reverse gradient was maintained opposite the associated recharge trenches; (3) the magnitude of the forward gradients was small (the maximum head differential was 0.56 ft); (4) the slurry wall is 3 ft thick and keyed 10 to 20 ft into claystone bedrock, which would prevent migration of contaminants; (5) the amount of potential underflow was conservatively estimated to be 0.1 gpm or less; (6) the recharge trench flow on the north side of the slurry wall (trenches 10, 11, 12, and 13) was 50 gpm during 2005, and would dilute any contaminated underflow; (7) the reverse gradient may have been re-established before any underflow could have occurred; and (8) no further action was needed besides monitoring the reverse gradient more carefully. No further action was requested by the Regulatory Agencies, and the reverse gradient was maintained for the entire system for the remainder of the FYR period. The loss of reverse gradient did not affect system effectiveness; it was considered an event for the FYRR.

The contaminant concentrations either were decreasing or below CSRGs/PQLs in the downgradient conformance wells that are representative of system performance. Residual contamination in downgradient wells is still above CSRGs/PQLs in a few wells, but these wells are not representative of current system effectiveness. The NBCS conformance wells were selected in the Off-Post RS/S (HLA 1996a) and the network was modified in the1999 LTMP to address changes from widening 96th Avenue and moving the RMA boundary fence. The conformance wells were initially selected to be representative of system effectiveness. However, it became apparent during subsequent monitoring of the wells that some of the conformance wells were not representative of system performance. This finding was related to the Regulatory Agencies during Water Team Status Meetings and documented in the 2005 FYRR (RVO 2007a). The 2005 FYRR recommended that the NBCS well network was to be re-evaluated during the LTMP revision:

> *Concerns about the presence of elevated contaminant levels in downgradient conformance wells will be revisited when considering the performance monitoring well network in the revised LTMP*.

The revised LTMP (TtEC and URS 2010c) excluded the non-representative NBCS conformance wells in the downgradient performance well network. The 2010 FYSR re-examined the downgradient detections of contaminants in the NBCS conformance wells during the current FYR period and concluded that the concentration trends in the downgradient conformance wells observed during this FYR period are consistent with the evaluation in the 2005 FYRR, and no other explanations for the downgradient detections in the conformance wells (e.g., underflow or bypass) are feasible. Regardless, the concentrations are also decreasing in most of these wells. The concentration trends in the revised downgradient performance well network and the

representativeness of the selected wells will be evaluated in future annual assessment reports and the next FYSR in 2015.

Railyard Containment System and Motor Pool Area Treatment System (#58)

The Western, Motor Pool, and Railyard plumes are collectively defined as the Western Plume Group. The Irondale, Motor Pool, and Railyard systems were identified in the On-Post ROD (FWENC 1996) as integral to controlling the migration of these contaminant plumes.

The Irondale Containment System, which became operational in 1981, was located at the southern end of the RMA northwest boundary in Sections 33 and 28 and consisted of a hydraulic control system of extraction and recharge wells and a granular activated carbon treatment system. The system treated water from the Irondale, Railyard, and Motor Pool areas. The Irondale and Motor Pool extraction systems met shut-off criteria in 1997 and 1998, respectively. Approval of the CCR for the Motor Pool shutdown is anticipated in 2011.

When the Irondale and Motor Pool extraction systems were shut off, treatment of the remaining Railyard Plume was moved from the Irondale Containment System to the new RYCS in July 2001. Recharge of the treated water was also transferred from the Irondale Containment System to the RYCS.

The CSRGs established in the On-Post ROD for the Irondale Containment System for trichloroethylene (TCE) and dibromochloropropane (DBCP) apply to RYCS and are listed in Table 4.1.1-3.

Table 4.1.1-3. Railyard Containment System (RYCS) CSRG Analytes

Chemical Group	ROD CSRG Analyte	CSRG[1] (µg/L)	CSRG Source
Volatile Halogenated Organics (VHOs)	Trichloroethylene (TCE)	5	ROD CBSG[2]/MCL[3]
Other Organic Compounds	Dibromochloropropane (DBCP)	0.2	ROD CBSG/MCL

Notes:
[1] Containment System Remediation Goal
[2] Colorado Basic Standard for Groundwater
[3] Maximum Contaminant Level

The 2010 LTMP performance criteria are for the RYCS are presented below.

Performance Criteria:

- Demonstrate plume capture through visual evaluation of flow directions on potentiometric maps and evaluation of water quality data from performance and operational monitoring wells. If visual inspection is unclear, statistical and other evaluation criteria will be considered.
- Demonstrate decreasing concentration trends or that concentrations are at or below CSRGs in downgradient performance wells.

The RYCS treatment plant effluent contaminant concentrations were below CSRGs, plume capture was maintained, and the contaminant concentrations were below the CSRG in the downgradient wells monitored during the FYR period. The RYCS performance water quality well network in the 2010 LTMP includes upgradient, cross gradient, and downgradient wells.

Basin A Neck System (#59)

The BANS is a mass removal system that treats water migrating through the Basin A area as well as water extracted by the Complex Trenches dewatering system and the BRES. Four objectives for the BANS were identified in the IRA Decision Document (Army 1989) as follows:

- Minimize the spread of contaminated groundwater migrating through the Basin A Neck as soon as practicable.
- Improve the efficiency and efficacy of the boundary treatment system.
- Collect operational data on the interception, treatment, and recharge of contaminated groundwater from this area that may be useful in the selection and design of a Final Response Action.
- Accelerate groundwater remediation within RMA.

ROD CSRGs for the BANS effluent were established for 22 contaminants potentially present in the groundwater migrating toward the Basin A Neck and these contaminants and their respective CSRGs are listed in Table 4.1.1-4.

Table 4.1.1-4. Basin A Neck System (BANS) CSRG Analytes

Chemical Group	ROD CSRG Analyte	CSRG[1] (µg/L)	PQL[2] (µg/L)	CSRG Source
Volatile Halogenated Organics (VHOs)	1,2-Dichloroethane	0.40[3]		ROD CBSG[4]
	1,1,1-Trichloroethane	200		ROD CBSG/MCL[5]
	1,1-Dichloroethylene	7		ROD CBSG/MCL
	Carbon tetrachloride	0.30[3]		ROD CBSG
	Chlorobenzene	100		ROD CBSG/MCL
	Chloroform	6		ROD CBSG
	Tetrachloroethylene (PCE)	5		ROD CBSG/MCL
	Trichloroethylene (TCE)	5		ROD CBSG/MCL
Volatile Hydrocarbon Compounds (VHCs)	Dicyclopentadiene (DCPD)	46		Off-Post ROD health-based value
Volatile Aromatic Organics (VAOs)	Benzene	5		ROD CBSG/MCL
Organosulfur Compounds; Mustard Agent Related (OSCMs)	1,4-Oxathiane	160		Off-Post ROD health-based value
	Dithiane	18		Off-Post ROD health-based value

Table 4.1.1-4. Basin A Neck System (BANS) CSRG Analytes (Concluded)

Chemical Group	ROD CSRG Analyte	CSRG[1] (µg/L)	PQL[2] (µg/L)	CSRG Source
Organosulfur Compounds; Herbicide Related (OSCHs)	Chlorophenylmethyl sulfide	30		ROD—EPA Region VIII Health Advisory Value
	Chlorophenylmethyl sulfone	36		ROD—EPA Region VIII Health Advisory Value
	Chlorophenylmethyl sulfoxide	36		ROD—EPA Region VIII Health Advisory Value
Organophosphorous Compounds; Pesticide Related (OPHPs)	Atrazine	3		ROD CBSG/MCL
Semivolatile Halogenated Organics (SHOs)	Hexachlorocyclopentadiene	50		ROD CBSG
Organochlorine Pesticides (OCPs)	2,2-bis(p-chlorophenyl)-1,1,1-trichloroethane (DDT)	0.1		ROD CBSG
	Dieldrin	0.002	0.1	ROD CBSG
	Endrin	2		CBSG (corrected in 2000 FYRR)
Arsenic	Arsenic	50		ROD CBSG/MCL
Mercury	Mercury	2		ROD CBSG/MCL

Notes:
[1] Containment System Remediation Goal
[2] Practical Quantitation Limit (PQL); subject to change pending outcome of 2010 PQL study.
[3] CBSG achieved and replaced PQL during this FYR period
[4] Colorado Basic Standard for Groundwater
[5] Maximum Contaminant Level

The 2010 LTMP mass removal performance criteria for BANS are presented below.

Performance Criteria:

- Demonstrate effective mass removal through comparison of calculated mass removed by the system for each of the CSRG analytes and mass flux approaching the system estimated by standardized approach.
- Demonstrate that concentrations in downgradient performance wells are stable or decreasing.

BANS treatment plant effluent contaminant concentrations were below CSRGs/PQLs and the contaminant concentrations of most analytes were stable, decreasing, or below CSRGs/PQLs in the downgradient wells. The IRA and ROD goals for the BANS are to provide long-term improvement in the performance of the boundary control systems by reducing contaminant loading, which the BANS achieved by removing an average of 92 pounds (lbs) of contaminants per year. Some of the mass removal is for the Complex Trenches and Bedrock Ridge extraction systems, but the majority of the mass removal is from BANS extraction. There are no quantitative mass removal criteria for the BANS, but 75 percent mass removal has been set as the goal in the 2010 LTMP (TtEC and URS 2010c), pending further evaluation when 5 years additional data become available.

Bedrock Ridge Extraction System (#28)

The On-Post ROD identifies the following remedy for the Section 36 Bedrock Ridge Plume:

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

The BRES extraction wells were installed in 2000 in accordance with the On-Post ROD (FWENC 1996) to prevent further migration of the Section 36 Bedrock Ridge Plume northeast of the Basin A area toward the First Creek drainage. The ROD remedy was modified as documented in the Explanation of Significant Difference (ESD) for the Bedrock Ridge Groundwater Plume Extraction System (Washington Group International 2006a). The extracted water is treated and recharged to the groundwater at the BANS. Evaluation of the BRES, which originally consisted of three extraction wells, led to a decision to modify the system to improve plume capture. A fourth extraction well was installed and became operational in 2005. The BRES CCR was approved in September 2008 (Washington Group International 2008). The CSRGs for BANS, which are listed in Table 4.1.1-4, apply to the treated BRES effluent because this water is treated at BANS.

The 2010 LTMP performance criteria for the BRES are as follows:

Performance Criteria:

- Demonstrate plume capture through visual evaluation of flow directions on potentiometric maps and evaluation of water quality data from performance and operational monitoring wells. If visual inspection is unclear, statistical and other evaluation criteria will be considered.
- Demonstrate decreasing or stable concentration trends or that concentrations are at or below CSRGs in downgradient performance wells.

The BRES has maintained plume capture since the fourth quarter of FY05, and the contaminant concentrations have been decreasing in the downgradient wells.

Off-Post Groundwater Intercept and Treatment System (OGITS)(#94)

The OGITS is a mass removal system designed to treat contaminated alluvial groundwater off post. The mass removal objectives presented in the IRA Decision Document (HLA 1989) for OGITS are as follows:

- Mitigate migration of contaminants in alluvial groundwater as soon as practicable
- Treat contaminated alluvial groundwater to provide a beneficial impact on groundwater quality

The performance of the OGITS extraction and treatment systems was evaluated against its compliance requirements and performance criteria. The system consists of two separate extraction systems, the First Creek Pathway System (FCS) and the Northern Pathway System (NPS). The NPS underwent modifications during this FYR period because residential and commercial development in the area is pending. The modifications involved the addition of

extraction wells to replace the old system with the goal of meeting or exceeding past mass removal performance. The NPS Modifications have met or exceeded expectations. Contaminant concentrations for most compounds have decreased to below CSRGs downgradient of the new system. A Design Change Notice (DCN) (DCN-NPS-FCD-03) to the NPS Modifications design document (George Chadwick Consulting 2005) that was issued after the new system became operational indicated that two more wells may be required in the vicinity of NE-13 (well 37817) and NE-14 (well 37818) to allow for the shutdown of the old system. The final DCN for the project clarified that a new well was not required in the area of DW-13, and that downgradient extraction wells 37809 and 37810 would continue to operate to intercept flow that bypasses NE-14 (well 37818).

CSRGs for the OGITS effluent were established for 34 contaminants potentially present in the Off-Post OU; the contaminants and their respective CSRGs are listed in Table 4.1.1-5.

Table 4.1.1-5. Off-Post Groundwater Intercept and Treatment System (OGITS) CSRG Analytes

Chemical Group	ROD CSRG Analyte	CSRG[1] (µg/L)	PQL[2] (µg/L)	CSRG Source
Volatile Halogenated Organics (VHOs)	1,2-Dichloroethane	0.40		ROD CBSG[3]
	1,3-Dichlorobenzene	6.5		ROD health-based value
	Chlorobenzene	25		ROD CBSG/MCL[4]
	Carbon tetrachloride	0.30		ROD CBSG
	Chloroform	6		ROD CBSG
	Tetrachloroethylene (PCE)	5		ROD CBSG/MCL
	Trichloroethylene (TCE)	3		ROD health-based value
Volatile Aromatic Organics (VAOs)	Benzene	3		ROD health-based value
	Ethylbenzene	200		ROD health-based value
	Xylenes	1,000		ROD health-based value
	Toluene	1,000		ROD CBSG/MCL
Volatile Hydrocarbon Compounds (VHCs)	Dicyclopentadiene (DCPD)	46		ROD health-based value
Organosulfur Compounds; Mustard Agent Related (OSCMs)	Dithiane	18		ROD health-based value
	1,4-Oxathiane	160		ROD health-based value
Organosulfur Compounds; Herbicide Related (OSCHs)	Chlorophenylmethyl sulfide	30		ROD—EPA Region VIII Health Advisory Value

Table 4.1.1-5. Off-Post Groundwater Intercept and Treatment System (OGITS) CSRG Analytes (Concluded)

Chemical Group	ROD CSRG Analyte	CSRG[1] (µg/L)	PQL[2] (µg/L)	CSRG Source
Organosulfur Compounds; Herbicide Related (OSCHs) (Cont.)	Chlorophenylmethyl sulfone	36		ROD—EPA Region VIII Health Advisory Value
	Chlorophenylmethyl sulfoxide	36		ROD—EPA Region VIII Health Advisory Value
Organophosphorous Compounds; Sarin (Isopropylmethyl Phosphonofluoridate [GB]) Agent Related	Diisopropylmethyl phosphonate (DIMP)	8		ROD CBSG
Organophosphorous Compounds; Pesticide Related (OPHPs)	Atrazine	3		ROD CBSG/MCL
	Malathion	100		ROD health-based value
Semivolatile Halogenated Organics (SHOs)	Hexachlorocyclopentadiene	0.23		ROD CBSG
	Chlordane	0.03	0.039[5]	ROD CBSG
Organochlorine Pesticides (OCPs)	Aldrin	0.002	0.037	ROD CBSG
	Dieldrin	0.002	0.05	ROD CBSG
	Endrin	2		CBSG (corrected in 2000 FYRR)
	Isodrin	0.06		ROD health-based value
	2,2-bis(p-chlorophenyl)-1,1,1-trichloroethane (DDT)	0.1		ROD CBSG
	2,2-bis(p-chlorophenyl)-1,1-dichloroethene (DDE)	0.1		ROD CBSG
Other Organic Compounds	Dibromochloropropane (DBCP)	0.2		ROD CBSG/MCL
	n-Nitrosodimethylamine (NDMA)	0.007	0.033	ROD—EPA Integrated Risk Information System value
Arsenic	Arsenic	2.35		ROD health-based value
Anions	Fluoride	2 mg/L		ROD CBSG; Agricultural standard
	Chloride	250 mg/L		ROD CBSG
	Sulfate	540 mg/L		ROD background value

Notes:

[1] Containment System Remediation Goal; µg/L unless otherwise noted

[2] Practical Quantitation Limit (PQL); subject to change pending outcome of 2010 PQL study.

[3] Colorado Basic Standard for Groundwater

[4] Maximum Contaminant Level

[5] PQL for gamma-chlordane since 5/31/2008, prior to that date the CSRG was met

The 2010 LTMP performance criteria for the OGITS are as follows:

- Demonstrate effective mass removal through comparison of total calculated mass removed by the system for each of the CSRG analytes and mass flux approaching the system estimated by standardized approach.
- Demonstrate that concentrations in downgradient performance wells are stable or decreasing.

Chloride and sulfate concentrations exceeded CSRGs in the OGITS effluent, but these analytes are not treated by OGITS and will meet CSRGs in the effluent by attenuation by 2026 and 2021, respectively, consistent with the on-post remedy. Chloride and sulfate concentrations in the OGITS effluent have been relatively stable during the FYR period, averaging 304 milligrams per liter (mg/L) for chloride and 507 mg/L for sulfate. Chloride was consistently above the CSRG of 250 mg/L, but sulfate was above the CSRG of 540 mg/L only twice. At the NBCS, the CSRGs for both chloride and sulfate have consistently been met in the effluent since 2005, which is earlier than predicted in 1996 when the remediation goals for the NBCS were developed (MKE 1996) and when the On-Post ROD was signed. Since the OGITS is downgradient of the NBCS, flushing of the aquifer between the two systems will eventually cause the OGITS effluent to meet the CSRGs as well. It is anticipated that the chloride and sulfate concentrations also will meet the CSRGs in the OGITS effluent earlier than the timeframes in the ROD. Except for one diisopropylmethyl phosphonate (DIMP) CSRG exceedance in 2009, the other CSRG analyte concentrations were below CSRGs/PQLs in the treatment plant effluent.

There are no quantitative mass removal criteria for evaluating the performance of the OGITS, but 75 percent mass removal has been set as the goal in the 2010 LTMP, pending further evaluation after collecting additional data for 5 years. Data for the NPS are available for estimating mass removal during this review period, but these estimates are based on available data rather than the performance wells identified in the LTMP and are only provided for comparison with the criteria. Wells were added to the NPS upgradient performance well network in the 2010 LTMP to provide more data for estimating the mass removal for future compliance.

Similar mass removal estimates for the FCS cannot be made during this FYR period because the upgradient water quality data are more limited. Wells also were added to the FCS upgradient performance well network in the 2010 LTMP to address this data need.

Based on the available data, the NPS exceeded the 75 percent mass removal criterion established in the 2010 LTMP every year during the FYR period. Additional data collected under the 2010 LTMP will help refine the mass flux and extracted mass estimates for both the FCS and NPS; the 75 percent mass removal criterion will also be re-evaluated.

Except for chloride, sulfate, and arsenic, the contaminant concentrations either are decreasing or are below CSRGs/PQLs in the downgradient wells. Chloride and sulfate are expected to meet CSRGs in the OGITS effluent and in the downgradient wells by attenuation. Arsenic is sporadically detected above the CSRG in one well downgradient of the NPS. While the arsenic detected in downgradient well 37008 may be related to the upgradient plume, other explanations suggest that the arsenic plumes are separate and different sources of arsenic may exist downgradient of the NPS extraction wells.

Five-year shut-off monitoring associated with shutdown of NPS extraction wells in July 2004 was completed in September 2009 with no CSRG exceedances during the monitoring period. A CCR/Monitoring Completion Report (MCR) will be prepared to document completion of the shut-off monitoring requirement.

South Tank Farm and Lime Basins Mass Removal Project (#60a)

A Resolution Agreement was reached with the Regulatory Agencies in 2005 to implement short-term groundwater mass removal remedies within the South Tank Farm Plume and the former Lime Basins areas (Washington Group International 2005). These remedies entail the extraction of groundwater from the South Tank Farm Plume and the Lime Basins areas with treatment of the extracted groundwater to reduce the contaminant mass within the respective plumes.

The changes to the RMA On-Post ROD groundwater remedy resulting from the implementation of this project were documented in the *Explanation of Significant Differences for Groundwater Remediation and Revegetation Requirements* (TtEC 2006c).

Statement of Remedy Goals and Conditions for Terminating Remedy

Regulatory goals and conditions for termination of the Groundwater Mass Removal project were established in the Resolution Agreement and included as the project goals in the Design Analysis Report (Washington Group International 2005) and are provided below as follows:

1. *Extraction and treatment of contaminated groundwater will be performed at the South Tank Farm benzene plume source area(s) and in the vicinity of the Lime Basins. The goal of this action will be to remove as much contaminant mass as possible and enhance in-situ biodegradation. The system design will establish the amount of groundwater that can be extracted, and the contaminant mass removal that can be accomplished at the CERCLA Wastewater Treatment Facility (CWTF). The extraction flow rates from the South Tank Farm and Lime Basins will be designed to provide maximum utilization of CWTF treatment capacity. The design and operation will consider South Tank Farm as the primary mass removal system. The balance of production between the two systems may be adjusted during operation with concurrence of the Parties.*

2. *The South Tank Farm plume treatment system is subject to the RCRA exemption for the Underground Injection Control Program because the extracted groundwater will be treated to substantially reduce the concentrations of hazardous constituents prior to reinjection into the same plume area.*

3. *Mass reduction at the South Tank Farm site will be accomplished through "once through" treatment at the CWTF, addition of an in-situ biodegradation enhancing agent as appropriate, and reinjection of the treated water at the benzene plume site. The extraction/reinjection system will be designed as a re-circulation cell, thereby providing continuous enhancement of the in-situ biodegradation of benzene in the source area.*

4. *While the RCRA exemption and "once through" treatment approach also may be applied to the Lime Basins project site, the need to apply this exemption and the feasibility of achieving RMA Containment System Remediation Goals will be evaluated during design.*

5. *Conceptually, the design for both systems will consider existing CWTF capacity and treatment processes, aquifer characteristics, treatment interferences to the UV system, contaminant degradation stoichiometry, and potential fouling of the reinjection system, while maximizing contaminant mass removal and in-situ biodegradation. An assessment of the existing and new data requirements will be completed and used to define the areas of high contamination. Once the areas of high contamination have been defined, the groundwater extraction systems will be designed to maximize capture of the contaminants. System optimization will occur during the startup period.*

6. *Groundwater monitoring will be conducted during the South Tank Farm project for system operations, and to ensure that the plume does not migrate beyond current conditions. A groundwater monitoring plan to assess these objectives will be prepared concurrent with the design analysis.*

7. *The mass of contaminants removed by treatment of extracted groundwater from both the South Tank Farm and Lime Basins sites will be tracked on an incremental and cumulative basis during operation of CWTF. A status update containing this information will be provided at the Water Team meetings. Quarterly reports will be provided for the first year and annually thereafter subject to evaluation.*

8. *Both the STF Benzene and the Lime Basins groundwater mass removal projects will be added to the Remedial Design Implementation Schedule with a schedule for system startup within 54 weeks of the signing of this agreement. The Parties agree to the accelerated design/construction schedule provided by the RVO (attached) in order to meet this startup deadline. The systems will operate until June 30, 2010, or until the CWTF is decommissioned, whichever is longer.*

9. *The changes to the RMA Record of Decision (ROD) Groundwater remedy will be documented by an Explanation of Significant Differences, separate from the ROD Amendment being prepared for the changes to the Lime Basins and Former Basin F projects.*

10. *A schedule for completing all items required by this agreement will be completed within 30 days of the signing of this agreement.*

The South Tank Farm and Lime Basins groundwater extraction/recharge and monitoring systems of the Groundwater Mass Removal project were installed and became operational in 2006. These were short-term mass removal projects and groundwater extracted from these respective systems was treated at the CWTF before it was decommissioned in 2010. The Groundwater Mass Removal project had required treated groundwater regulated under the Underground Injection Control Program to be reinjected under an exemption that allowed recharge of groundwater at concentrations that exceeded the CBSGs (Washington Group International 2005). Operation of the Lime Basins mass removal wells was interrupted during 2008 and 2009 due to cover construction in the Lime Basins area.

During operation of the South Tank Farm extraction system, free product that was confirmed to be exclusively benzene was discovered in three of the seven wells. Two of the wells exhibited sufficient accumulation to allow recovery of the free product. Free product removal pumps were installed in these wells and were operated periodically to remove the free product once sufficient quantities accumulated in the well. A total of 120.7 gallons (402.5 kilograms [kg]) of free product was removed during the FYR period. Although a large spill of benzene (approximately 100,000 gallons) in the South Tank Farm area was documented in the RI, and benzene was a small component of the light non-aqueous phase liquid (LNAPL) during the South Tank Farm soil vapor extraction treatability study conducted during the Feasibility Study (FS), the discovery of free-product benzene is an event as it is the first time benzene LNAPL has been confirmed in this area.

The total mass removed for the South Plants and Lime Basins Mass Removal projects are presented in Tables 4.1.1-6 and 4.1.1-7.

Table 4.1.1-6. South Tank Farm Mass Removal Treatment Summary

Water Year	Average Flow Rate (gpm)	Volume of Groundwater Treated (gal)	Free Product Removed	Total Mass of Contaminants Removed	Mass Removal Rate (kg removed/ 1,000 gal treated)	Major Contaminants Removed
2005	Not operational	0	0	0	0	
2006	0.6	142,900	4.9 gal 16.2 kg	177.7 kg 391.4 lbs	1.1	Benzene DCPD TCE Chloroform
2007	0.6	328,900	61.7 gal 205.9 kg	526.5 kg 1,159.7 lbs	1.0	Benzene DCPD TCE Chloroform
2008	1.1	507,000	1 gal 3.3 kg	520.7 kg 1,146.9 lbs	1.0	Benzene DCPD TCE Chloroform
2009	1.2	719,200	53.1 gal 177.1 kg	1,040 kg 2,290.7 lbs	1.2	Benzene DCPD TCE Chloroform
Total	0.9 (avg.)	1,698,000	120.7 gal 402.5 kg	2,264.9 kg 4,988.8 lbs	1.1	

Notes:
gal gallons
gpm gallons per minute
kg kilograms
lbs pounds

Table 4.1.1-7. Lime Basins Mass Removal Treatment Summary

Water Year	Average Flow Rate (gpm)	Volume of Groundwater Treated (gal)	Total Mass of Contaminants Removed	Mass Removal Rate (kg removed/ 1,000 gal treated)	Major Contaminants Removed
2005	Not operational	0	0	0	
2006	0.6	106,198	105.8 kg 233 lbs	1.0	Chloroform Arsenic 1,2-dichlorobenzene 1,4-dichlorobenzene Chlorobenzene
2007	0.8	361,399	313.5 kg 690.5 lbs	0.9	Chloroform Arsenic 1,2-dichlorobenzene 1,4-dichlorobenzene Chlorobenzene
2008	0.4	241,926	257.6 kg 567.4 lbs	1.1	Chloroform Arsenic 1,2-dichlorobenzene 1,4-dichlorobenzene Chlorobenzene
2009	0.4	262,800	215.9 kg 475.6 lbs	0.8	Chloroform Arsenic 1,2-dichlorobenzene 1,4-dichlorobenzene Chlorobenzene
Total	0.55 (avg.)	972,323	892.7 kg 1,966.3 lbs	0.9 (average)	

Notes:
gal gallons
gpm gallons per minute
kg kilogram
lbs pounds

Based on criteria in the Resolution Agreement, Design Document (Washington Group International 2006b), and ESD (TtEC 2006c), the Groundwater Mass Removal project is functioning as intended in the decision documents. The South Tank Farm system has been successful in achieving its remedy objective of maximizing mass removal for a predetermined duration as established by the Resolution Agreement and ESD. Additional removal of contaminant mass after the project ends in 2010 is unnecessary because of natural attenuation of the plume, and it would not benefit the performance of any boundary control system. The plume has been shown to be at steady state or receding, and is contained by biodegradation that has been confirmed and will continue to be verified through future monitoring.

The discovery of the benzene LNAPL does not change this conclusion because the LNAPL was found in the central portion of the plume where dissolved concentrations have exceeded

1,000,000 µg/L. The high-concentration portion of the plume (i.e., > 100,000 µg/L) has been extremely stable and has not moved appreciably toward the lakes since the 1990s or earlier, due to intrinsic aerobic biodegradation of the benzene plume. Biodegradation is most effective at the edges of the high-concentration plume where steep concentration gradients are consistently observed. This biodegradation mechanism was demonstrated during the RI/FS and South Tank Farm IRA and was key in selecting monitoring for the South Tank Farm Plume in the On-Post ROD. There is evidence that the high-concentration plume was receding prior to operation of the Groundwater Mass Removal project. The historical data also show that the leading edge of the detectable plume has receded away from the lakes. Since both the high-concentration portion and the downgradient extent of the detectable plume were stable or likely receding prior to startup of the Groundwater Mass Removal system, operation of the system is not required to protect the lakes. Additional mass removal by the Lime Basins Groundwater System of the Groundwater Mass Removal project after the project ends in 2010 also would not provide any increased benefit given containment of the Lime Basins contamination by the Lime Basins slurry wall and dewatering system and the contaminant plume's extraction and treatment at the BANS, which is located downgradient of the Lime Basins area.

4.1.1.2 Extraction and Treatment System Events

Over the review period events associated with extraction and treatment system operation included:

- A reverse hydraulic gradient was not maintained at a portion of the NBCS during one quarter in FY05. This was a concern because maintaining a reverse hydraulic gradient is a performance criterion for the system to ensure proper containment at the boundary. However, since the loss of gradient was of short duration, there was no impact on plume containment.
- The Lime Basins mass removal system was shut down during RCRA-equivalent cover construction in 2008 and 2009 (232 days in FY08 and 199 days in FY09), so during this duration no contaminated groundwater was removed or treated by the system. However, there was no adverse impact to the protectiveness of the remedy.
- A DIMP CSRG exceedance occurred in the OGITS effluent on January 5, 2009. This was a compliance concern at the time, but the problem was quickly addressed so there was no impact to protectiveness.

4.1.1.3 Other On-Post Groundwater Remedial Actions

Complex (Army) Disposal Trenches Slurry Walls (Dewatering) (#17)

The selected remedy presented in the On-Post ROD for the Complex Trenches slurry walls is as follows:

> *Installation of a slurry wall into competent bedrock around the disposal trenches. Dewatering within the slurry wall is assumed for purposes of conceptual design and will be re-evaluated during remedial design.*

The performance criteria established in the approved design document (RVO 1997) for the Complex Trenches are as follows:

- Demonstrate groundwater elevations in compliance monitoring wells 36216 and 36217 are below the target elevations of 5,226 and 5,227 ft mean sea level, respectively.
- Maintain positive gradient from the outside to the inside of the barrier wall (for as long as active dewatering is occurring).

To meet the ROD-derived requirement of ultimately lowering the water table to below the bottom of the Complex Trenches, water is extracted at a flow rate that typically ranges between 1 and 2 gpm and piped to the BANS for treatment. The lowering of the water table is also aided by the construction of a RCRA-equivalent cover over the trench area. During Water Year 2009 (WY09), the flow rate averaged 2 gpm. The CSRGs for the BANS, which are listed in Table 4.1.1-4, apply to the treated Complex Trenches effluent because this water is treated at BANS.

The Complex Disposal Trenches dewatering system had not attained the dewatering goal in one of the two compliance wells by the end of the FYR period (well 36217). It is not expected, however, that the goal will be achieved until construction of the RCRA-equivalent covers has been completed and the vegetation at the site reestablished, which is anticipated to occur by September 2014. As of the end of FY09, the dewatering system was performing as expected in the ROD and design document.

Shell Disposal Trenches Slurry Walls (Dewatering) (#17)

The selected remedy presented in the On-Post ROD for the Shell Disposal Trenches slurry walls is as follows:

> *Expansion of the existing slurry wall around the trenches. Dewatering within the slurry wall is assumed for purposes of conceptual design and will be re-evaluated during remedial design.*

The performance criterion established in the approved design document (RVO 1997) for the Shell Trenches is presented below.

- Demonstrate groundwater elevations are below the disposal trench bottom elevations within the slurry wall enclosure.

The Shell Trenches containment remedy includes a slurry wall encircling the disposal trenches in addition to the cover. Water levels are to be lowered below the trench bottom, but during the FYR period, the water elevation was about 1 ft above the trench bottom at one of the six boreholes where the trench-bottom elevations were determined. A rise in the water table above the trench bottom likely was caused by infiltration of precipitation before and during cover construction and irrigation after construction. It is not expected that the goal at this borehole location will be achieved until the construction of the RCRA-equivalent covers has been completed and the vegetation at the site has been reestablished, which is anticipated to occur by October 2012. The purposes of groundwater level monitoring are to measure water level differentials across the barrier wall to obtain information on the direction (i.e., inward or outward) of gradients across the barrier and to determine whether the water levels are below the bottoms of the disposal trenches. Monitoring is also conducted to obtain information on the water level differentials that could potentially affect barrier wall stability. An apparent rise in the

water table during this FYR period likely is related to infiltration of precipitation before and during cover construction and irrigation after construction.

Lime Basins Slurry Wall (Dewatering) (#47)

The Lime Basins soil remedy presented in the On-Post ROD was changed in 2005 to include an encircling slurry wall and dewatering well system to lower water levels below the Lime Basins waste and create an inward hydraulic gradient across the slurry wall. Lime Basins dewatering began in 2009 and groundwater extracted by the Lime Basins dewatering system has been treated at the CWTF and reinjected in the Lime Basins recharge trenches. Once the CWTF has been decommissioned (in 2010), Lime Basins groundwater will be treated at the BANS and reinjected in the BANS recharge trenches. The BANS is currently undergoing modifications, discussed in Section 4.4.2.1, to accommodate treatment of Lime Basins groundwater.

For the Lime Basins, the Amendment to the ROD for the On-Post OU, Rocky Mountain Arsenal Federal Facility Site, Section 36 Lime Basins Remediation, Basin F Principal Threat Soil Remediation (Amendment to the ROD for Section 36 Lime Basins and Former Basin F) (TtEC 2005a) provides standard and monitoring provisions:

- *Standard: Dewater as necessary to maintain a positive gradient from the outside to the inside of the barrier wall and maintain groundwater level below the level of the Lime Basins waste for as long as the surrounding local groundwater table is in the alluvium.*
- *Monitor to ensure that the dewatering standard is met. If the groundwater table drops below the level of the alluvium inside the wall, monitor annually thereafter to check that the groundwater table remains below the alluvium inside the wall.*

The performance criteria for the Lime Basins as presented in the Amendment to the ROD for Section 36 Lime Basins and Former Basin F are presented below:

- *Maintain a positive gradient from the outside to the inside of the barrier wall (for as long as the surrounding local groundwater table is in the alluvium).*
- *Maintain a groundwater level below the elevation of the Lime Basins waste (5,242 ft) inside the barrier wall (for as long as the surrounding local groundwater table is in the alluvium).*

Based on criteria in the design document (TtEC 2008l) and Amendment to the ROD for Section 36 Lime Basin and Former Basin F (TtEC 2005a), the Lime Basins dewatering project is functioning as intended in the decision documents. After only 4 months of operation, significant progress was made toward meeting the dewatering goals, which is expected to occur by September 2014. For example, the average water level was lowered 1.2 ft inside the slurry-wall enclosure, which is approximately one-fifth of the distance required to meet the goal of lowering the water level below the Lime Basins waste. Progress toward meeting the dewatering goals will be evaluated further during the next FYR period.

Dense non-aqueous phase liquid (DNAPL) was discovered in some of the dewatering wells in August 2009. To evaluate the DNAPL, the Lime Basins dewatering wells were shut down on August 6, 2009, and the Lime Basins mass removal project extraction wells were shut down on August 13, 2009. Preliminary assessment monitoring activities conducted during the FYR period

included interface probe measurements, visual confirmation of DNAPL presence with a bailer, chemical analysis of the DNAPL, and sampling of selected Lime Basins extraction and dewatering wells. The DNAPL consists of a mixture of chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, and dicyclopentadiene (DCPD). The presence of DNAPL was not a known site condition during preparation of the Lime Basins design documents and represents a new source material for the Section 36 area. This is identified as an issue in Section 8.0 of this FYRR. A RI/FS will be conducted during the next FYR period to determine whether there are any impacts on the Lime Basins remedy and whether any follow-up actions are needed.

North Plants Fuel Release

The LNAPL associated with groundwater was first identified beneath the North Plants manufacturing area in 1993. Delineation of the LNAPL was initially conducted in July 2001 as part of the *North Plants Structures Demolition and Removal Project, 100 Percent Design Package* (FWENC 2001b). In 2001, attempts were made to recover the LNAPL (approximately 18 gallons were recovered) until demolition activities in the area required abandonment of the well and cessation of recovery in February 2002. Continuation of LNAPL recovery was planned to follow completion of North Plants surface remedial actions. The *North Plants Soil Remediation Project, Release Evaluation Report* (TtFW 2004a) concluded that LNAPL was present in association with groundwater beneath the former North Plants Production Area. During the FYR period, water levels and LNAPL thickness were monitored and LNAPL and groundwater sampling were conducted to characterize the LNAPL accumulation, assess potential groundwater impacts, and design a pilot LNAPL removal system. The results were reported in the *North Plants Soil Remediation Project Interim Free Product and Groundwater Characterization Data Summary Report* (TtEC 2007g). A pilot study on removal of LNAPL was initiated in 2009 (URS Washington Division and TtEC 2008). The wells were installed in February 2009, and monitoring began in March 2009. As of the end of FY09, sufficient LNAPL has not been present in the wells to commence recovery operations. The Colorado Petroleum Storage Tank guidance documents are being used for this project.

4.2 On-Post Soil Remedy Selection and Implementation

The On-Post ROD specified the following RAOs for the On-Post soil remedy:

Human Health

> *Prevent ingestion of, inhalation of, or dermal contact with soil or sediments containing COCs at concentrations that generate risks in excess of 1 x 10^{-4}(carcinogenic) or an HI greater than 1.0 (noncarcinogenic) based on the lowest calculated reasonable maximum exposure (5^{th} percentile) Preliminary Pollutant Limit Values (PPLV) (which generally represent the on-site biological worker population).*
>
> *Prevent inhalation of COC vapors emanating from soil or sediments in excess of acceptable levels, as established in the Human Health Risk Characterization (HHRC).*

Prevent migration of COCs from soil or sediment that may result in off-post groundwater, surface water, or windblown particulate contamination in excess of off-post remediation goals.

Prevent contact with physical hazards such as UXO.

Prevent ingestion of, inhalation of, or dermal contact with acute chemical agent hazards.

Ecological Protection

Ensure that biota are not exposed to COCs in surface water, due to migration from soil or sediment, at concentrations capable of causing acute or chronic toxicity via direct exposure or bioaccumulation.

Ensure that biota are not exposed to COCs in soil and sediments at toxic concentrations via direct exposure or bioaccumulation.

The selected remedy, ROD standards, and ROD goals are presented below in the context of the Implementation Projects.

4.2.1 On-Post Soil Remedies under Construction

4.2.1.1 Hazardous Waste Landfill Cap Construction (#8)

The selected remedy in the On-Post ROD for construction of the Hazardous Waste Landfill (HWL) requires:

Construction of a RCRA- and TSCA-compliant hazardous waste landfill on post.

The ROD remediation standards that apply to the landfill cap elements of the project include:

Design landfill to meet state 1,000 year siting criteria

Minimize infiltration by limiting the hydraulic conductivity of the clay/synthetic composite barrier layer (1 x 10^{-7} cm/sec or less for clay layer)

Meet or exceed all RCRA, TSCA, and state requirements

Construction of the HWL final cap was carried out during spring 2007 until the early summer 2009.

All modifications to the approved design package drawings and specifications (TtEC 2005f) were documented in the project files through approved DCNs.

The HWL Final Cap Construction project included installation of the following:

- Gravel capping layer
- Geosynthetic clay liner cushion geotextile
- Geosynthetic clay liner

- High-density polyethylene geomembrane
- Geomembrane cushion geotextile
- Cap anchor trench
- Soil cushion layer
- Biota barrier material (BBM) layer and adjacent gravel drainage layer
- Cover fill layer
- Water storage layer
- Rock-amended vegetative soil layer
- Surface water control and drainage features
- Revegetation

The HWL landfill was designed to meet state 1,000-year siting criteria. Design elements include a landfill-cell bottom located a minimum of 20 ft above the groundwater, a water storage layer designed with increased thickness to account for erosional soil loss during the 1,000-year period, a rock-amended vegetative soil layer designed to withstand 1,000-year storm event, and surface water controls and drainage features designed for the 1,000-year storm event. The Final Construction Quality Assurance Report (Golder 2009) documents that the HWL final cap construction was completed in accordance with the design. Performance of the final cap will be assessed in accordance with the HWL Post-Closure Plan (TtEC 2009k).

Personal health and safety sampling and analysis for silica, total dust, and respirable dust levels exposure was performed in accordance with the National Institute for Occupational Safety and Health (NIOSH) Manual of Analytical Methods. The results indicated that there were two action levels exceeded requiring personal protective equipment (PPE) upgrade during the HWL Final Cap Construction project.

Within the Army-Maintained Area (AMA), revegetation means and methods were distinct depending on the area. Revegetation of the cap included broadcast seeding and hydromulching only. Revegetation off the cap (but within the AMA) included soil amendment placement and incorporation, seedbed preparation, broadcast seeding, and mulching and crimping. Both areas required a prairie seed mix. Within the adjacent perimeter channels and east drainage swale, however, erosion control blankets were installed instead of hay mulch. The seed mix was also different and favored more hydrophilic plant species. Revegetation efforts outside of the perimeter fence consisted of soil amendment placement and incorporation, seedbed preparation, broadcast seeding, and mulching and crimping.

The USFWS is responsible for permanent revegetation in areas outside the AMA that were not permanently revegetated as part of this project. The USFWS has certified that the requirements of the ESD for Groundwater Remediation and Revegetation Requirements (TtEC 2006c) have been met and the areas outside the AMA will be restored to achieve the statutory purposes of the Refuge to the satisfaction of the USFWS.

Long-term maintenance will be conducted in accordance with the approved Post-Closure Plan (TtEC 2009k). Long-term groundwater monitoring is required because waste was left in place and will be performed in accordance with the Hazardous Waste Landfill Post-Closure Groundwater Monitoring Plan (TtEC 2009j) and the 2010 LTMP (TtEC and URS 2010c). Long-term O&M for the cap area will be conducted after completion of the final inspection by the Regulatory Agencies.

A CCR will be prepared for the HWL Final Cap Construction project and approval is expected in 2010. The CCR is expected to document that remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs.

4.2.1.2 Enhanced Hazardous Waste Landfill Cap Construction (#13)

The selected remedy in the On-Post ROD for construction of the Enhanced Hazardous Waste Landfill (ELF) requires:

> *Construction of a RCRA- and TSCA-compliant hazardous waste landfill on post. Basin F Wastepile …containment in dedicated triple-lined landfill cells.*

The ROD remediation standards that apply to the landfill cap elements of the project include:

> *Design landfill to meet state 1,000 year siting criteria*
>
> *Minimize infiltration by limiting the hydraulic conductivity of the clay/synthetic composite barrier layer (1 x 10^{-7} cm/sec or less for clay layer)*
>
> *Meet or exceed all RCRA, TSCA, and state requirements*

Construction of the ELF final cap was carried out during fall 2008 until early spring 2010.

All modifications to the approved design package drawings and specifications (TtEC 2007a) were documented in the project files through approved DCNs.

The ELF Final Cap Construction project included installation of the following:

- Geocomposite gas vent layer
- Geosynthetic clay liner
- High-density polyethylene geomembrane
- Geomembrane cushion geotextile
- Soil cushion layer
- BBM layer and adjacent gravel drainage layer
- Cover fill layer
- Water storage layer

- Rock-amended vegetative soil layer
- Surface water control and drainage features
- Revegetation

The ELF landfill was designed to meet state 1,000-year siting criteria. Design elements include a landfill-cell bottom located a minimum of 20 ft above the groundwater, a water storage layer designed with increased thickness to account for erosional soil loss during the 1,000-year period, a rock-amended vegetative soil layer designed to withstand 1,000-year storm event, and surface water controls and drainage features designed for the 1,000-year storm event. The Final Construction Quality Assurance Report (Golder 2010) documents that the ELF Final Cap Construction project was completed in accordance with the design. Performance of the final cap will be assessed in accordance with the ELF Post-Closure Plan (TtEC 2010e).

In 2009, the Colorado Front Range, including RMA, experienced the second highest precipitation totals for June in 120 years and the combined precipitation for June and July was the highest ever recorded historically. Water accumulated in the leak detection system (LDS) sumps and the soil cushion layer became saturated. At that time, construction of the cap geosynthetic barrier system was complete, construction of the soil cushion layer and the BBM layer was in progress, and construction of the internal cap drainage system had not begun.

After reviewing all potential sources of water in the LDS, it was concluded that the source was most likely water collecting in and migrating through the primary liner anchor trench to the secondary and tertiary anchor trenches and subsequently to the LDS sumps. Long-term slope stability for the ELF cap, considering the soil cushion layer excess moisture, was evaluated and determined to be acceptable. However, to facilitate construction, temporary drainage trenches were constructed in low areas of the perimeter berm where wet soils had been observed in order to drain the percolated surface water from the primary liner anchor trench, thus decreasing water accumulation in the sumps and allowing the soil cushion layer to drain, providing stable subgrade for overlying component construction. These trenches were later removed and a permanent drainage system was installed, in accordance with DCN-ELFCOV-039, which added trench drains along the southern, western, and northwestern portion of the ELF cap to the design.

Personal health and safety sampling and analysis for silica, total dust, and respirable dust levels exposure was performed in accordance with the NIOSH Manual of Analytical Methods. The results indicated that there were no action levels exceeded requiring PPE upgrade during the ELF Final Cap Construction project.

Within the AMA, revegetation means and methods were distinct depending on the area. Revegetation of the cap only included broadcast seeding and hydromulching. Revegetation off the cap (but within the AMA) included soil amendment placement and incorporation, seedbed preparation, broadcast seeding, and mulching and crimping. Both areas required a prairie seed mix. Within the adjacent perimeter channels, however, Flexterra FGM Hydromulch was installed instead of hay mulch in lieu of erosion control blankets. Similar to the AMA off the cap, revegetation efforts outside the perimeter fence consisted of soil amendment placement and incorporation, seedbed preparation, broadcast seeding, and mulching and crimping.

The USFWS is responsible for permanent revegetation in areas outside the AMA that were not permanently revegetated as part of this project. The USFWS has certified that the requirements of the ESD for Groundwater Remediation and Revegetation Requirements (TtEC 2006c) have been met and the areas outside the AMA will be restored to achieve the statutory purposes of the Refuge to the satisfaction of the USFWS.

Long-term inspection, monitoring, and maintenance will be conducted in accordance with the approved Post-Closure Plan (TtEC 2010e), including the trench drain system that will be inspected to evaluate the presence of flow, erosion, seepage/moisture, or bare/sparse vegetation. Data generated as part of this inspection will be available for evaluation of LDS flows. Long-term groundwater monitoring is required because waste was left in place and will be performed in accordance with the ELF Post-Closure Plan Groundwater Monitoring Plan (TtEC 2010d) and the 2010 LTMP (TtEC and URS 2010c). Long-term O&M for the cap area will be conducted after completion of the final inspection by the Regulatory Agencies.

A CCR will be prepared for the ELF Final Cap Construction project and approval is expected in 2010. The CCR is expected to document that remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs.

4.2.1.3 Integrated Cover System Part 1: Basin A Consolidation and Remediation Area (#15), South Plants Balance of Areas and Central Processing Area (#34), Complex (Army) Disposal Trenches Remediation Cover (#38), Shell Disposal Trenches 2-foot Soil Covers (#39), and Section 36 Lime Basins Cover (#47)

The Integrated Cover System (ICS) project is not specifically described in the On-Post ROD. The ICS project was created to manage cover construction common to several contiguous Implementation Projects that are described in the On-Post ROD and influence each other in both design and construction sequence. The ICS project included construction of ROD-required covers at Basin A, Complex Trenches, Lime Basins, Shell Disposal Trenches, and South Plants Balance of Areas and Central Processing Area project areas.

The selected remedy in the On-Post ROD for the Section 36 Lime Basins component of the soil remedy required:

> *Excavation and containment of principal threat and human health exceedance soil in [the ELF]…The excavated area is backfilled the [pre-existing] soil cover is repaired*

The amendment to the ROD for Section 36 Lime Basins and Former Basin F (TtEC 2005a) documented a change to the ROD remedy for the Lime Basins to "containment in place" including construction of a vertical groundwater barrier surrounding the Lime Basins and a RCRA-equivalent cover, including biota barrier, over the entire Lime Basins area.

The applicable portion of the selected remedy in the On-Post ROD for South Plants Central Processing Area required:

> *. . .placement of a soil cover consisting of a 1-foot-thick biota barrier and a 4-foot-thick soil/vegetation layer over the entire site . . .*

The selected remedy in the On-Post ROD for the South Plants Balance of Areas component of the soil remedy required:

> *The former human health exceedance area is covered with a 3-ft-thick soil cover and the former potential risk to biota area is covered with a 1-ft-thick soil cover. Prior to placing this cover, two composite samples per acre will be collected to verify that the soil under the 1-ft-thick soil cover does not exceed human health or principal threat criteria. If the residual soil is found to exceed these levels, the 3-ft-thick cover will be extended over these areas or the exceedance soil will be excavated and landfilled. The top 1 ft of the entire soil cover area will be constructed using soil from the on-post borrow areas.*

The ESD for the South Plants Balance of Areas and Central Processing Area Soil Remediation project (FWENC 2000a) contained three significant changes to the South Plants area.

- The 4-ft soil cover identified in the On-Post ROD for the South Plants Central Processing Area was changed to incorporate design and construction methods consistent with the RCRA-Equivalent Cover Demonstration project.
- The1-ft-thick soil cover in part of the South Plants Balance of Areas was eliminated and replaced with 1 ft of clean backfill.
- Excavation of biota risk soil in the 3-ft-thick soil cover area was eliminated, because it will be protected by the 3-ft cover, which is acceptable under the ROD.

The applicable portion of the selected remedy in the On-Post ROD for Complex (Army) Trenches required:

> *Construction of a RCRA-equivalent cap, including a 6-inch-thick layer of concrete, over the entire site.*

The applicable portion of the selected remedy in the On-Post ROD for Basin A required:

> *Construction of a soil cover consisting of a 6-inch-thick layer of concrete and a 4-ft-thick soil/vegetation layer over [the entire site].*

The ESD for Shell Disposal Trenches Remediation project (TtEC 2006d) states that approval was granted to transfer a portion of the area within the Section 36 Balance of Areas project to the Shell Disposal Trenches project. This area, which surrounds the Shell Disposal Trenches site, has received a 2-ft-thick soil cover on the eastern, western, and northern sides of the Shell Disposal Trenches site, and a RCRA-equivalent cover has been constructed over the former drum storage area to the south.

Other changes to the ROD cover requirements for the Implementation Projects listed were documented in the Minor Change to the On-Post ROD for Soil Covers, Fact Sheet (TtEC 2008f) and summarized in Table 4.2.1-1.

Table 4.2.1-1. Summary of Changes to Soil Cover Projects

Project	Changes from ROD
Basin A	Change 4-ft-thick soil cover to RCRA-equivalent soil cover Change 6-inch-thick concrete layer to 16-inch-thick crushed concrete layer
South Plants Central Processing Area	Change 4-ft-thick soil cover to RCRA-equivalent soil cover Change 12-inch-thick crushed concrete layer to 16-inch-thick crushed concrete layer Extend cover over former chemical sewer area in Section 36
South Plants Balance of Areas	Eliminate 1-ft backfill requirement for areas sampled and demonstrated to have no unacceptable risk to human health or wildlife
Complex Army Trenches	Change 6-inch-thick concrete layer to 16-inch-thick crushed concrete layer
Section 36 Lime Basins[1]	Change 18-inch-thick crushed concrete layer to 16-inch-thick crushed concrete layer Eliminate chokestone layer
Common Elements	Add lysimeters for percolation compliance monitoring Include 50-ft extension of concrete barrier around each cover Include a gravel layer above the wildlife barrier to provide a capillary barrier (contrasting pore size material to enhance the performance of the capillary barrier)

Note:
[1] Changes listed are from Amendment to the ROD for Section 36 Lime Basins and Former Basin F (TtEC 2005a).

These changes created a large contiguous area containing several adjacent project areas (Basin A, Complex Trenches, Lime Basins, Shell Disposal Trenches, and South Plants project areas), where construction of RCRA-equivalent covers was the final remedy. The ICS RCRA-equivalent covers, including the 50-ft BBM extension, cover approximately 330 acres. The 2-ft and 3-ft covers and the 1-ft backfill area comprise approximately 400 acres, for a total of approximately 730 acres, in the ICS project.

The ROD remediation standards that apply to the ICS RCRA-equivalent 2- and 3-ft covers:

RCRA-Equivalent Covers

Allow no greater infiltration through the cap than the range of infiltration that would pass through an EPA-approved RCRA cap

Demonstrate cap performance equivalent to a RCRA landfill cap according to an EPA- and CDPHE-approved demonstration that will include comparative analysis and field demonstration (Drainage channels built to Subtitle C standards do not require demonstration)

Maintain cover percolation less than or equal to the percolation of the underlying native soil

Prevent contact between hazardous. materials and humans/Biota by using Biota barriers and maintaining institutional controls

Two- and Three-Foot Covers

Maintain minimum cover thicknesses specified in the ROD (2 or 3 Foot)

Maintain cover percolation less than or equal to the percolation of the underlying native soil

Prevent humans from accessing underlying contaminated soil by maintaining institutional controls

Other

Identify, transport off-post, neutralize and destroy explosives/explosive residue

Meet air quality and odor standards that are Applicable or Relevant and Appropriate Requirements (ARARs).

The ROD goals that apply to the project include the following:

Serve as effective long-term barriers

Maximize runoff and minimize ponding

Minimize erosion by wind and water

Prevent damage to integrity of cap by humans (RCRA-Equivalent covers only) and biota

Maintain cover of locally adapted perennial vegetation

Control emissions, as necessary, during remediation

Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors

RCRA-equivalent covers (including biota barrier, capillary barrier layers, and lysimeters for compliance monitoring) and ancillary components (e.g., lined channels, lysimeters, erosion/settlement monuments, etc.) were constructed in Basin A, Complex Trenches, Lime Basins, and the South Plants Central Processing Area as part of the ICS project. RMA RCRA-equivalent covers are evapotranspiration covers with a capillary barrier, which were demonstrated to allow no greater range of infiltration through the cap than the range of infiltration that would pass through an EPA-approved RCRA cap. The ICS project also included construction of a 3-ft cover in a portion of the South Plants Balance of Areas project area and a 2-ft cover constructed in a portion of the Shell Disposal Trenches project area. The 3-ft cover and the 2-ft cover are soil covers that were designed to maintain cover percolation less than or equal to the percolation of the underlying native soil.

The Shell Disposal Trenches RCRA-equivalent cover (refer to Section 4.2.1.4) is contiguous with the ICS project but remains a separate project and was completed prior to the ICS project.

The ICS project also included grading in non-cover areas, construction of subgrade in the Lime Basins and South Plants areas, placement of 1 ft of backfill in portions of the South Plants Balance of Areas, construction of engineering controls, and construction of a long-term maintenance stockpile of RCRA-equivalent cover soil. South Plants Balance of Areas 1-ft backfill construction is documented in the South Plants Balance of Areas and Central Processing Area Soil Remediation—Phase 2, Part 1 and Part 2 CCR (TtEC 2009v). This work included the 2007 sampling conducted in accordance with the Biological Advisory Subcommittee (BAS) SAP for Residual Ecological Risk (TtFW 2004b), excavation of biota risk soil and any resulting confirmatory soil sampling and Contingent Soil Volume (CSV) excavation, backfill of excavations, consolidation of excavated biota risk soil, placement of 1 ft of clean backfill where required, and permanent revegetation of the 1-ft backfill area. This work also included excavation and consolidation of biota risk soil excavated as a result of Regulatory Agency-directed confirmatory soil sampling in the 1-ft backfill area that was based on a 2006 EPA evaluation of ditch banks.

Execution of the ICS project was carried out starting in summer 2007 and finishing in spring 2010.

All modifications to the approved design package drawings and specifications (TtEC 2007e) were documented in the project files through approved DCNs.

The AMA that includes all of the ICS RCRA-equivalent covers (and the Shell Disposal Trenches RCRA-equivalent cover) and Shell Disposal Trenches 2-ft cover and South Plants 3-ft cover encompasses approximately 661 acres and has been permanently revegetated and irrigated. Revegetation was performed within the AMA using a permanent seed mixture to allow sufficient evapotranspiration performance and redevelopment of native prairie grasslands.

The USFWS is responsible for permanent revegetation in areas outside the AMA that were not permanently revegetated as part of this project. The USFWS has certified that the requirements of the ESD for Groundwater Remediation and Revegetation Requirements (TtEC 2006c) have been met and the areas outside the AMA will be restored to achieve the statutory purposes of the Refuge to the satisfaction of the USFWS. The USFWS will perform permanent seeding of approximately 862 acres of non-cover areas outside the AMA including Borrow Areas 3, 4, and 10. Long-term O&M requirements of the ICS cover and non-cover areas located within the AMA are contained in the Long-Term Care Plan, Revision 1 (LTCP) (TtEC 2008i). Areas located outside the AMA do not require long-term O&M. Long-term groundwater monitoring is required because waste was left in place and will be performed in accordance with the LTMP (TtEC and URS 2010c). In accordance with the LTCP, interim O&M of cover areas begins following irrigation and continues until the entire cover system is determined to be Operational and Functional (O&F), expected to be 5 years after the final area is irrigated. Long-term O&M will be conducted after the O&F determination. The LTCP identifies the following compliance standards:

- Percolation (RCRA-equivalent covers only): less than or equal to 1.3 millimeters per year (mm/year) of water measured in the lysimeters over a rolling 12-month evaluation.
- Cover thickness (all covers): a minimum of 42-inch-thick soil cover layer above the capillary barrier material for RCRA-equivalent covers, a minimum of 36 inches of soil for 3-ft covers, and a minimum of 24 inches of soil for 2-ft covers
- A vegetation standard (RCRA-equivalent covers only) for maintaining cover vegetation.

A CCR has been prepared for the ICS project and approval is expected in 2010. The CCR is expected to document that remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment when it is determined to be O&F, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs.

A CCR—Part 2 will be prepared to document that the ICS soil covers are O&F once that determination has been made by the EPA in coordination with the Colorado Department of Public Health and Environment (CDPHE), Tri-County Health Department (TCHD), and the RVO. The O&F determination will be based on sufficient field inspection and monitoring data to show conformance with the cover performance standards.

4.2.1.4 Shell Disposal Trenches RCRA-Equivalent Cover Construction (#39)

The applicable portion of the selected remedy in the On-Post ROD for the Shell Disposal Trenches requires:

> *Modify existing cover to be a RCRA-equivalent cap and modify existing slurry wall around trenches.*

The ROD remediation standards that apply to the Shell Disposal Trenches cover elements of the project include:

RCRA-Equivalent Cover

> *Allow no greater infiltration through the cap than the range of infiltration that would pass through an EPA-approved RCRA cap*
>
> *Demonstrate cap performance equivalent to a RCRA landfill cap according to an EPA- and CDPHE-approved demonstration that will include comparative analysis and field demonstration (Drainage channels built to Subtitle C standards do not require demonstration)*
>
> *Maintain cover percolation less than or equal to the percolation of the underlying native soil*
>
> *Prevent contact between hazardous materials and humans/Biota by using Biota barriers and maintaining institutional controls*

Other

Meet air quality and odor standards that are Applicable or Relevant and Appropriate Requirements (ARARs).

The ROD goals that apply to the project include the following:

Serve as effective long-term barriers

Maximize runoff and minimize ponding

Minimize erosion by wind and water

Prevent damage to integrity of cap by biota and humans

Maintain cover of locally adapted perennial vegetation

Control emissions, as necessary, during remediation.

Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.

The Shell Disposal Trenches Remediation project is comprised of the Shell Disposal Trenches (Study Area Report [SAR] site CSA-1a) and the Former Drum Storage Area (a small portion of SAR site CSA-1b).

Contaminated soil is present in the Shell Disposal Trenches remediation area and will remain in place. The purpose of the Shell Disposal Trenches Remediation project was to build a RCRA-equivalent cover over the remaining waste. Excavation and disposal of contaminated soil was not required during any stage of the project, nor were unexpected contaminated materials encountered during execution of the work, though odorous soils were encountered. However, ROD-identified contaminated soil was previously present in some of the area of the Section 36 borrow source used for the Shell Disposal Trenches subgrade. All of this ROD-identified contaminated soil was removed as part of the Section 36 Balance of Areas Soil Remediation project prior to use as borrow soil for construction of the Shell Disposal Trenches RCRA-equivalent cover subgrade. Soil that was excavated, stockpiled, and used to construct the RCRA-equivalent cover was obtained from Borrow Areas 10 and 9C, where there was no ROD-identified contaminated soil.

The RCRA-equivalent cover soil stockpiling effort was performed to generate a source of pre-approved cover soil for use in the Shell Disposal Trenches RCRA-equivalent cover. The scope included excavation of soil intended for use in the Shell Disposal Trenches RCRA-equivalent cover, segregation of material that is unacceptable for use in covers, cover soil stockpiling, and extensive testing of the stockpiles to determine the gradation and agronomic properties of the soil.

The Shell Disposal Trenches Remediation project included construction of a RCRA-equivalent cover, as required by the ROD. The RCRA-equivalent cover constructed over the Shell Disposal Trenches is an evapotranspiration cover with a capillary barrier, which was demonstrated to allow no greater range of infiltration through the cap than the range of infiltration that would pass through an EPA-approved RCRA cap. The RCRA-equivalent cover was designed to minimize the infiltration of surface water into the underlying waste, prevent human and biota contact with the underlying waste, and serve as an effective long-term barrier. The RCRA-equivalent cover includes ancillary components (e.g., lysimeters and erosion/settlement monuments) to facilitate the monitoring of infiltration, mass erosion, and settlement, which could be deleterious to the long-term effectiveness of the cover.

Execution of the Shell Disposal Trenches Remediation project was carried out from April 12, 2005, to fall 2007.

Confirmatory samples were not collected, and CSV was not identified or excavated during the completion of this project.

Permanent revegetation was performed on the Shell Disposal Trenches RCRA-equivalent cover using a permanent seed mixture to allow sufficient evapotranspiration performance and redevelopment of native prairie grasslands.

Permanent revegetation of the Section 36 gradefill borrow sources is documented in the Section 36 Balance of Areas Soil Remediation—Part 2 CCR (TtEC 2009t).

The USFWS is responsible for permanent revegetation in areas outside the AMA that were not permanently revegetated as part of this project. The USFWS has certified that the requirements of the ESD for Groundwater Remediation and Revegetation Requirements (TtEC 2006c) have been met and the areas outside the AMA will be restored to achieve the statutory purposes of the Refuge to the satisfaction of the USFWS.

The ROD remedy for the Shell Disposal Trenches area also includes installation of a groundwater barrier wall and construction of a 2-ft soil cover, which abuts the northern, eastern, and western sides of the RCRA-equivalent cover. The groundwater barrier wall (Project #17) was installed between 1998 and 2001, and is documented in the Shell Section 36 Trenches Groundwater Barrier project CCR (FWENC 2001c). Discussion for the barrier wall construction project (#17) is presented in Section 4.1.1.3. The 2-ft soil cover subgrade was constructed in 2005 during the Section 36 Balance of Areas Remediation—Part 2, and is documented in the Section 36 Balance of Areas Remediation—Part 2 CCR. The 2-ft soil cover is currently under construction as part of the ICS project.

As documented in the Shell Disposal Trenches CCR (TtEC 2009u), remedial actions under this project have been completed, and will meet the intent of the ROD to be protective of human health and the environment when it is O&F. Long-term O&M is required for that part of the project within the AMA that includes the Shell Disposal Trenches Cover and will be conducted after the O&F determination. Interim O&M is currently being conducted in accordance with the approved LTCP (TtEC 2008i). The property involved in this project and the waste left in place

will be subject to evaluation in future FYRs. The EPA approved the CCR on January 5, 2009. The LTCP identifies the following compliance standards:

- Percolation (RCRA-equivalent covers only): less than or equal to 1.3 mm/year of water measured in the lysimeters over a rolling 12-month evaluation.
- Cover thickness (all covers): a minimum of 42-inch-thick soil cover layer above the capillary barrier material for RCRA-equivalent covers, a minimum of 36 inches of soil for 3-ft covers, and a minimum of 24 inches of soil for 2-ft covers.
- A vegetation standard (RCRA-equivalent covers only) for maintaining cover vegetation.

Long-term O&M requirements of the Shell Disposal Trenches RCRA-equivalent cover also include operation of the Soil Cover Moisture Monitoring System in accordance with the Soil Cover Moisture Monitoring System O&M Plan (TtEC 2006g). Operation of the Soil Cover Moisture Monitoring System began in July 2007 and cover maintenance activities began after the removal of irrigation components in September 2007.

A CCR—Part 2 will be prepared to document that the Shell Disposal Trenches soil cover is O&F once that determination has been made by the EPA in coordination with CDPHE, TCHD, and the RVO. The O&F determination will be based on sufficient field inspection and monitoring data to show conformance with the cover performance standards.

4.2.1.5 Basin F/Basin F Exterior RCRA-Equivalent Cover Construction (Basin F Cover) (#46)

The applicable portion of the selected remedy in the On-Post ROD for Basin F cover requires:

> *The entire site is capped (including the Basin F Wastepile footprint) with a RCRA-equivalent cap that includes a biota barrier.*

The ROD remediation standards that apply to the Basin F cover elements of the project include:

RCRA-Equivalent Cover

> *Allow no greater infiltration through the cap than the range of infiltration that would pass through an EPA-approved RCRA cap*
>
> *Demonstrate cap performance equivalent to a RCRA landfill cap according to an EPA- and CDPHE-approved demonstration that will include comparative analysis and field demonstration (Drainage channels built to Subtitle C standards do not require demonstration)*
>
> *Maintain cover percolation less than or equal to the percolation of the underlying native soil*
>
> *Prevent contact between hazardous materials and humans/Biota by using Biota barriers and maintaining institutional controls*

Other

Identify, transport off-post, neutralize and destroy explosives/explosive residue

Meet air quality and odor standards that are Applicable or Relevant and Appropriate Requirements (ARARs).

The ROD goals that apply to the project include the following:

Serve as effective long-term barriers

Maximize runoff and minimize ponding

Minimize erosion by wind and water

Prevent damage to integrity of cap by biota and humans

Maintain cover of locally adapted perennial vegetation

Control emissions, as necessary, during remediation

Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors

The Basin F Cover project involved the following:

- Completion of the subgrade with gradefill from areas outside the cover area, including soil from beneath former human health exceedance (HHE) areas in the southeast Basin F perimeter area.
- Excavation of HHE soil from a "deep acute" sample location, outside the cover area, that was exposed to within 10 ft of the ground surface by gradefill excavation.
- Sampling (utilizing the BAS method for sampling and analyses of potential ecological risk soil) of the final graded surface outside the cover area where HHE soil had been remediated and additional excavation or grading had been performed.
- Excavation of Residual Ecological Risk soil, from outside the cover area, that was exposed by gradefill excavation and backfill of these excavations.
- Construction of a RCRA-equivalent cover system and ancillary components (e.g., lined channels, lysimeters, erosion/settlement monuments, etc.) over Basin F and a chemical sewer extension that was discovered during gradefill excavation. RMA RCRA-equivalent covers are evapotranspiration covers with a capillary barrier, which were demonstrated to allow no greater range of infiltration through the cap than the range of infiltration that would pass through an EPA-approved RCRA cap.
- Revegetation and irrigation of the cover area and non-cover area inside the perimeter access road that delineates the AMA.

- Regrading of areas outside the perimeter access road and in Borrow Area 4 and placement/incorporation of topsoil or soil amendment prior to revegetation to be completed by the USFWS.
- Construction of engineering controls, including the erosion/settlement monitoring monuments, perimeter fence, cover perimeter survey monuments, obelisks, and perimeter warning signs.
- Excavation of biota risk soil and debris that was left at approximately 30 monitoring wells and piezometers within Site NCSA-4b (which existed in both Sections 23 and 26).

Changes to the ROD cover requirements for the Basin F cover were documented in the Minor Change to the On-Post ROD for Soil Covers, Fact Sheet (TtEC 2008f). The ROD change included changing from a 12-inch-thick crushed concrete layer to a 16-inch-thick crushed concrete layer for the biota barrier.

Remediation performed as part of the Basin F Cover project involved excavation of HHE, biota risk exceedance and Residual Ecological Risk soils, and backfilling and/or regrading and surface revegetation. All HHE and biota risk soil and debris were transported to and disposed at a permitted facility with CERCLA off-site rule approval. All Residual Ecological Risk soil was disposed in the on-site Basin A Consolidation Area.

Execution of the Basin F Cover project was initiated in summer 2008 and was completed in March 2010.

All modifications to the approved design package drawings and specifications (TtEC 2008a) were documented in the project files through approved DCNs.

Confirmatory soil samples were collected after remediation waste removal. No CSV was identified for removal.

The AMA that includes all of the Basin F RCRA-equivalent cover encompasses approximately 116.2 acres and has been permanently revegetated and irrigated. Permanent revegetation was performed within the AMA using a permanent seed mixture to allow sufficient evapotranspiration performance and redevelopment of native prairie grasslands.

The USFWS is responsible for permanent revegetation in areas outside the AMA that were not permanently revegetated as part of this project. The USFWS has certified in a letter to the EPA that the requirements of the ESD for Groundwater Remediation and Revegetation Requirements (TtEC 2006c) have been met and the areas outside the AMA will be restored to achieve the statutory purposes of the Refuge to the satisfaction of the USFWS. The USFWS will perform permanent seeding of approximately 327 acres of area in the northern half and southwestern quarter of Section 26, including the areas surrounding the Basin F AMA in Section 26. They will also perform permanent seeding of at least 298 acres of area in the south half of Section 23, including the disturbed portions of Borrow Area 4.

Long-term O&M requirements of the Basin F cover and non-cover areas located within the AMA are contained in the LTCP (TtEC 2008i). Areas located outside the AMA do not require

long-term O&M. Long-term groundwater monitoring is required because waste was left in place and will be performed in accordance with the Basin F Closure and Post-Closure Groundwater Monitoring Plan (TtEC 2006a) and the 2010 LTMP (TtEC and URS 2010c). In accordance with the LTCP (TtEC 2008i), interim O&M of cover areas begins following irrigation and continues until the entire cover system is determined to be O&F, expected to be 5 years after the final area is irrigated. Long-term O&M for the cover areas will be conducted after the O&F determination. The LTCP identifies the following compliance standards:

- Percolation (RCRA-equivalent covers only): less than or equal to 1.3 mm/year of water measured in the lysimeters over a rolling 12-month evaluation.
- Cover thickness (all covers): a minimum of 42-inch-thick soil cover layer above the capillary barrier material for RCRA-equivalent covers, a minimum of 36 inches of soil for 3-ft covers, and a minimum of 24 inches of soil for 2-ft covers.
- A vegetation standard (RCRA-equivalent covers only) for maintaining cover vegetation.

A CCR has been prepared for the Basin F Cover project and approval is expected in 2010. The CCR is expected to document that remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment when it is determined to be O&F, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs.

A CCR—Part 2 will be prepared to document that the Basin F soil cover is O&F once that determination has been made by the EPA in coordination with CDPHE, TCHD, and the RVO. The O&F determination will be based on sufficient field inspection and monitoring data to show conformance with the cover performance standards.

4.2.1.6 Section 36 Lime Basins Soil Remediation Slurry/Barrier Wall (#47)

The selected remedy in the On-Post ROD for the Section 36 Lime Basins component of the soil remedy required:

> *Excavation and containment of principal threat and human health exceedance soil in [the ELF]…The excavated area is backfilled with clean borrow and the [pre-existing] soil cover is repaired.*

The Amendment to the ROD for Section 36 Lime Basins and Former Basin F (TtEC 2005a) documented a change to the ROD remedy for the Lime Basins to "containment in place" including construction of a vertical groundwater barrier surrounding the Lime Basins and a RCRA-equivalent cover, including biota barrier, over the entire Lime Basins area.

The ROD remediation standards that apply to the project include:

> *Certify 3X decontamination or caustic wash of soil and structural debris to achieve 3X decontamination.*
>
> *Ensure disposal of 3X-decontaminated soil and structural debris in the on-post RCRA landfill.*

Meet air quality and odor standards that are applicable or relevant and appropriate requirements (ARARs).

Dewater as necessary to maintain a positive gradient from the outside to the inside of the barrier wall and maintain groundwater level below the level of the LB waste for as long as the surrounding local groundwater table is in the alluvium. Capture and treat contaminated groundwater to meet Containment System Remediation Goals as specified in the ROD.

Identify, transport off-post, neutralize, and destroy explosives/explosive residue.

Landfill Principal Threat and HHE volumes and agent-contaminated material.

Interrupt exposure pathway by permanently plugging all chemical sewer lines and manholes not excavated.

The ROD goals that apply to the project include the following:

Control air emissions, as necessary, during remediation.

Control air emissions as necessary to attain criteria that will be developed via the air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.

Minimize groundwater flow across the barrier wall with a design goal of 1 x 10^{-7} cm/sec hydraulic conductivity.

Construct barrier wall with sufficient thickness to withstand maximum hydraulic gradient.

Construct barrier wall with materials that are compatible with the surrounding groundwater chemistry.

Minimize migration by keying the barrier wall into competent bedrock.

Remediation at the Lime Basins site involved construction of a vertical groundwater barrier wall to fully encompass the three historic Lime Basins, closure of 23 existing groundwater monitoring wells at the site and installation of 11 new ones, installation of 6 new dewatering wells and the associated piping/pumping system on the interior of the groundwater barrier wall to extract groundwater, and construction of a RCRA-equivalent soil cover over the entire Lime Basins project area. All stabilized slurry material from construction of the barrier wall was placed within the confines of the barrier wall beneath the RCRA-equivalent soil cover.

The initial operation of the Lime Basins slurry wall dewatering system involves the discharge of the extracted groundwater to the CWTF for joint treatment of this groundwater with that extracted from the Groundwater Mass Removal project. During this phase of dewatering, the treatment objective is to remove contaminant mass to the maximum extent possible for re-injection of the treated water into the recharge trenches of the Groundwater Mass Removal

project. Following the decommissioning of the CWTF and shut down of the Groundwater Mass Removal project, the groundwater extracted from dewatering of the slurry wall will be directed to the BANS that will have been modified to accommodate this additional wastestream. These modifications will allow for the groundwater treated at this facility to meet its respective CSRGs that will also include ARARs for any new contaminants that are introduced through the groundwater extracted from the slurry wall dewatering system.

The groundwater barrier wall construction was carried out during fall 2007 and winter 2008. Closure and installation of groundwater monitoring wells and installation of new dewatering wells within this area were performed from summer 2007 through the end of 2008. Installation of the dewatering well piping and pumping system was performed and the dewatering wells were online by March 31, 2009.

All modifications to the approved design package drawings and specifications (TtEC 2008l) were documented in the project files through approved DCNs.

Segments of the former chemical sewer lines that penetrated the slurry/barrier wall were removed and disposed in the ELF. Note that segments of the chemical sewer lines that were located entirely within the confines of the slurry/barrier wall were left in place, since they were isolated from the surrounding groundwater and will be contained beneath the RCRA-equivalent cover.

Disposal of contaminated PPE and miscellaneous debris was documented using a waste tracking system as specified in the Program Management Contractor (PMC) Site-Wide Remediation Waste Management Plan (RWMP) (TtEC 2006i). Four truckloads of contaminated material were disposed in the ELF during the course of this project.

Chemical agent materiel monitoring for Mustard and Lewisite was performed during all intrusive activities at the site. In the course of monitoring, during the shallow trench excavation, a positive detection for Lewisite occurred. This caused a temporary shutdown of all excavation activities at the site while the agent detection was investigated. The site investigation resulted in no credible source for the agent materiel, and excavation of the shallow trench was allowed to proceed with enhanced monitoring. The results of this investigation are included in the Lime Materials Investigation Chronology and Results report (TtEC 2007f).

After the slurry/barrier wall was installed and cover soil placed over excavated lime material, the Lime Basins work area was covered with gradefill soil as a part of the ICS project. No interim vegetation was necessary. The Lime Basins site was overlaid with a RCRA-equivalent cover and permanent vegetation has been completed for the cover within the ICS AMA.

Long-term O&M associated with the slurry/barrier wall will include monitoring of the groundwater levels within the wells adjacent to the slurry/barrier wall to verify that the dewatering wells are keeping the groundwater level within the barrier wall to an elevation of 5,242 ft mean sea level or lower, per the design criteria. The pumping system for these dewatering wells must undergo routine checking and maintenance to assure proper operation of

the dewatering system. The O&M Manual has been modified to address the dewatering system and will be available for information purposes under separate cover.

Revegetation of the project area was not required or performed as part of this project. Required revegetation was performed as part of the ICS project (see Section 4.2.1.3).

The Lime Basins RCRA-equivalent cover, constructed as a part of the ICS project, will be subject to long-term O&M requirements of the RCRA-equivalent cover are contained in the LTCP (TtEC 2008i).

A CCR has been prepared for the Section 36 Lime Basins Soil Remediation project slurry/barrier wall construction and approval is expected in 2010. The CCR is expected to document that remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs.

Following final inspection, DNAPL was discovered in the project dewatering wells. Inspection and sampling of the dewatering wells, within the Lime Basins slurry wall, confirmed the presence of DNAPL in wells DW-9 and DW-10. The presence of DNAPL was not a known site condition during preparation of the design documents and represents a new source material for the Section 36 area. This is identified as an issue in Section 8.0 of this FYRR.

4.2.2 Operating On-Post Soil Remedies

4.2.2.1 Operation of Hazardous Waste Landfill Wastewater Treatment System (#10)

Operation and monitoring of the Landfill Wastewater Treatment System (LWTS) is also performed under RCRA. The LWTS was designed and constructed to process wastewater associated with the operation of the HWL. Since it was put in operation in 1999, the LWTS has been engaged in the treatment of wastewater that is comprised of HWL leachate; HWL decontamination wastewater; HWL potentially contaminated stormwater, which is stormwater runoff from waste and covered areas inside the HWL waste containment cell, access ramp, and decontamination pad; ELF leachate; ELF-contaminated stormwater; Basin F Wastepile leachate; and Basin F Wastepile-contaminated stormwater.

The LWTS discharges to First Creek. First Creek is a tributary to the Upper South Platte River Segment 16c. As a tributary, the use classifications for First Creek are Aquatic Life Warm 2, Recreation E, and Agriculture. The LWTS effluent discharge limits are based on the state of Colorado's Basic Standards for organics, surface water quality standards and criteria for aquatic life and human health, effluent limitations, and groundwater standards stated in the On-Post ROD.

The discharge of treated water from the facility is monitored for compliance with the requirements of the *Landfill Wastewater Treatment System ARARs Compliance and Discharge Control Mechanism Document* [CERCLA Compliance Document (CCD)] (EPA 2006a), which is a discharge authority issued by the EPA. The CCD establishes the self-monitoring requirements of the treatment system including regulatory basis, discharge standards, monitoring

requirements, and reopener provisions. Quarterly Discharge Monitoring Reports are required to be submitted to the Regulatory Agencies to certify compliance with the CCD and/or report any noncompliance events. The treatment plant has been operated in full compliance with the administrative requirements of the CCD, including the timely submission of the Discharge Monitoring Reports.

Groundwater beneath the LWTS during the treatment plant's operational period was routinely monitored and reported pursuant to the Hazardous Waste Landfill Operations Manual, Operational Groundwater Monitoring Plan FWENC 2003c) and the Closure/Post-Closure Groundwater Monitoring Plan (TtEC 2007k). As of the 2010 FYR data cutoff date, groundwater beneath the LWTS is being monitored pursuant to Appendix A of the Final Landfill Wastewater Treatment System Closure Plan (URS Washington Division and TtEC 2010). These plans were designed to monitor wells upgradient and downgradient of the LWTS to assess potential releases of hazardous constituents from the LWTS to groundwater.

During the 2005 through 2010 FYR period, there were five incidents of effluent exceedances that required Regulatory Agency notification. These included the four one-time effluent exceedances and one operational issue summarized below:

- The total chromium concentration of 88.5 micrograms per liter (µg/L) exceeded the CCD 30-day average of 50 µg/L in May 2005.
- The total recoverable iron concentration of 1,460 µg/L exceeded the CCD 30-day average of 1,000 µg/L in December 2005.
- An ammonia concentration of 132 µg/L exceeded the CCD 30-day average of 100 µg/L in December 2005.
- There was one whole effluent toxicity exceedance. Acute toxicity was confirmed for *Ceriodaphnia dubia* and *Pimephales promelas* in December 2006.
- A spill of leachate occurred due to a pipe break in September 2008.

Corrective actions were taken in all cases and no continuing protectiveness issues resulted. Additional detail on the causes and corrective actions are provided in the FYSR (TtEC and URS 2010a).

Based on the information provided above, operation of LWTS has been in accordance with On-Post ROD requirements as specified in the LWTS Operations Plan (MKE 1999).

4.2.2.2 Borrow Area Operations (#47a)

The RMA remedy as described in the On-Post ROD requires approximately 12 million cubic yards (cy) of borrow materials to backfill excavations, build structural fills, establish cover grades, and construct liner and cover components. The RVO maintains a tracking plan (TtEC 2009e) that identifies those areas within the RMA boundary where borrow operations would be appropriate, estimates the material types available at the sources, estimates the sizes of areas impacted by borrow excavations, allocates and manages borrow area operations, provides operation alternatives, and identifies operational issues.

It should be noted that the BAS identified potential biota residual risk areas and classified them as containing either Priority 1 or Terrestrial Residual Ecological Risk soils (PMRMA 2003, 1997b). These soils are located within the upper 1 ft of the soil profile in these areas. Borrow area boundary selection was focused on inclusion of areas containing Priority 1 soils. Priority 1 borrow soils were not used as top soil or liner soil, nor were they placed within the upper 2 ft of backfilled excavations or cap/cover systems. Remediation of Priority 1 and Terrestrial Residual Ecological Risk soils is complete and is discussed in Section 4.2.3.21.

Several issues related to unexpected discovery of contamination have been identified during borrow area operations or remediation activities adjacent to borrow areas. High pH soil was also identified in Borrow Area 10 during borrow area characterization efforts. This high pH soil, with pH greater than 8.8, was deemed unsuitable for cover soil construction and was identified for removal and use as common backfill or gradefill. This soil was removed during the Complex (Army) Disposal Trenches subgrade construction and used as gradefill beneath the Complex (Army) Disposal Trenches RCRA-equivalent cover.

During subcontractor operations to remove Priority 1 soil from Borrow Area 9A (Parcel 4), munitions debris and munitions and explosives of concern (MEC) were recovered. Upon recovery of these military munitions-related items, UXO personnel were added to observe future intrusive operations in borrow areas contiguous to the historic M47 (incendiary bomb) static-test firing pad (near the intersection of 8th Ave and the North Plants Haul Road). This action led to the additional recovery of MEC, which subsequently led to a Department of Defense Explosives Safety Board-approved munitions response action for Borrow Area 9A (Parcel 2) and Site CSA-2c southwest/northwest. Given the nature of operations performed at the M47 test pad, the munitions response action for the site was added to the scope of the Phase III Munitions Testing Remediation project. This munitions response action addressed the potential to recover MEC during intrusive operations in Borrow Area 9A (Parcel 2) and (Parcel 3).

As of March 31, 2010, borrow activities at RMA have been completed with the exception of final grading and revegetation. The USFWS has certified in letter to the EPA that the requirements of the ESD for Groundwater Remediation and Revegetation Requirements (TtEC 2006c) have been met and that the areas will be restored to achieve the statutory purposes of the Refuge to the satisfaction of the USFWS. No caps, covers, or treatment facilities are required by the ROD for the borrow areas, so no long-term O&M is required. The property involved is subject to restrictions on land and water use, which will be evaluated in future FYRs. Completion of activities in each borrow area is documented in the project CCR for the last project to use the area.

4.2.3 Completed On-Post Soil Remedies

4.2.3.1 Section 26 Human Health Exceedance and Biota Exceedance Soils Removal (#5)

The selected remedy in the On-Post ROD for the Surficial Soil component of the soil remedy requires:

> *Excavation and landfill of human health exceedance soil and excavation and consolidation to Basin A or Former Basin F of soil posing a potential risk to biota from this medium group . . . The consolidated material is contained under the*

Basin A cover or Basin F cap and the human health exceedance area is backfilled.

The selected remedy in the On-Post ROD for revegetation is:

Remedy components for all sites include reconditioning the surface soil and revegetating areas disturbed during remediation with locally adapted perennial vegetation.

The ROD remediation standards that apply to the project include:

Excavate all contaminated soil identified in the ROD for treatment, landfilling, or consolidation that corresponds to the areal and vertical extent detailed by the soil volume calculations in the Administrative Record.

Meet air quality and odor standards that are ARARs.

The ROD remediation goals that apply to the project include:

Control emissions, as necessary, during remediation.

Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.

The Section 26 HHE and Biota Exceedance Soils Removal project was originally part of the Basin F Exterior Soils Remediation project. During the late summer months of 1999, the HWL was scheduled to receive a significantly greater amount of asbestos-containing material (ACM) than originally anticipated. To mitigate this problem, removal of the Section 26 HHE soil was accelerated to provide necessary cover soils to continue disposal of ACM in the HWL. This portion of the Basin F Exterior project was separated out to provide additional HHE soils to the HWL operation. The Section 26 Biota risk soils were also removed at that time.

Because the work was accelerated, the project did not go through traditional design phases. The project scope was based upon a drawing and excavation specification completed by the U.S. Army Corp of Engineers, supplemented with drawings and specifications from similar soil remediation projects that had been approved by the RVO and Regulatory Agencies. The final design went to the Regulatory Agencies for review concurrent with the procurement process. Regulatory Agency comments were reconciled before fieldwork began, and the final package was issued for construction.

Disposal of contaminated soils and miscellaneous debris was documented using a waste tracking system as specified in the RWMP (TtEC 2006i). A total of 13,718 bank cubic yards (bcy) of HHE soil and miscellaneous debris was disposed in the HWL during the extent of this project, and 4,032 bcy of biota risk soil and road base were disposed in Basin A.

To meet the requirements of the On-Post ROD, a confirmatory sampling program was developed for implementation projects to determine whether contingent soils will be excavated. Accordingly, following excavation of design volumes during the project, two confirmatory

samples were taken and no CSV soil was identified for excavation. All soils removed were verified by pre- and post-excavation surveys.

In 2002, the BAS identified a concern related to unknown risk potential for sites that had not been backfilled following excavation of HHE soil. The ROD remedy for HHE soil excavations includes backfill of the excavation area. The approved design for Section 26 HHE and Biota Soils Removal project, however, eliminated the backfill requirement where HHE excavations were shallow and backfill was not needed to achieve a final ground surface consistent with the future use of the site as a wildlife refuge. Although backfill was eliminated, confirmatory samples were collected in these sites following excavation to verify that no HHE soil remained at the site. It should be noted, however, the analytical method at the time was relevant only for determining additional HHE soil excavation and was not certified for detection of concentrations that might pose a risk to biota.

At the recommendation of the BAS, site NCSA-4b was resampled using an analytical method capable of detecting concentrations of COCs in the biota risk range. Sampling was performed consistent with the method developed by the BAS for the Terrestrial Residual Ecological Risk evaluation by collecting a five-point composite sample over each area representing a small bird exposure range. This additional sampling indicated that there was contamination remaining at the excavation surface in site NCSA-4b that posed excessive risk to biota. As a result, additional biota risk soil was excavated from this site. A total of 5,128 bcy of CSV soil was excavated and taken to Basin A. This effort was documented in an addendum to the CCR (RVO 2006b).

Health and safety sampling and analysis was performed in accordance with the NIOSH Manual of Analytical Methods. The results indicated that no action levels were met or exceeded for the contaminants tested during the Section 26 HHE and Biota Soils Removal project.

Air and odor monitoring were conducted in accordance with site-wide air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were neither met nor exceeded during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the project met ROD remediation goals for the control of air emissions.

Upon completion of remediation activities, sites were seeded with locally adapted perennial vegetation.

As documented in the CCR (FWENC 2000c), remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. No caps, covers, or treatment facilities are required by the ROD for this remediation project, and so no long-term O&M is required. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs. The EPA approved the CCR on October 17, 2000. An addendum to the CCR (RVO 2006b) was approved by the EPA on March 30, 2006, for additional CSV soil excavation.

4.2.3.2 Operation of Hazardous Waste Landfill Cells 1 and 2 (#7)

The HWL was designed to contain waste derived from Implementation Projects and other remedy support operations at RMA. These materials were designated in the On-Post ROD for disposal in the HWL and were required to meet waste acceptance criteria outlined by the RWMP (TtEC 2006i) and the HWL Operations Manual (FWENC 2003c). The design approach for the HWL was presented in the Corrective Action Management Unit (CAMU) Designation Document (CDD) (HLA 1996b), and the Final Design Analysis for the HWL (USACE 1998). The design of the HWL includes a liner system, placement of the waste, final cover system, leachate management system, surface-water management system, and other ancillary features. Operations at the HWL involved placement of waste material from remediation activities, waste tracking, placement of daily and temporary cover, decontamination of vehicles, general facility maintenance, intermediate cover construction, stormwater management, wastewater treatment/disposal, and surface revegetation.

The ROD remediation standards that apply to the operation of the HWL include:

> *Landfill principal threat and human health soil exceedance volumes, UXO debris, agent-contaminated material, and structural debris.*
>
> *Design landfill to meet state 1,000-year siting criteria.*
>
> *Ensure all material disposed in landfill passes EPA paint filter test.*
>
> *Meet air quality and odor standards that are ARARs*

The ROD goals that apply to the project include the following:

> *Control emissions, as necessary, during remediation.*
>
> *Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.*

Construction of the HWL was completed in fall 1998. The landfill was certified to accept waste in April 1999 and the first waste was received on May 11, 1999. Waste receipt into the HWL complied with On-Post ROD requirements that dictated the final disposal of waste material from remediation projects. Disposal of contaminated wastes was documented using a waste tracking system as specified in the RWMP (TtEC 2006i). A total of 1,799,826 compacted cy of contaminated waste and cover soils has been placed in the HWL over the course of this project.

Consistent with the CDD (HLA 1996b) the placement of waste was governed by Part 265, Subpart B, C, D, and E of 6 the Code of Colorado Regulations 1007-3, Standards for Owners and Operators of Interim Hazardous Waste Treatment, Storage and Disposal Facilities. The specific operating requirements to ensure compliance with these regulations are presented in the HWL Operations Manual (FWENC 2001a) as reviewed and approved by the Regulatory Agencies.

Operations involved placement of waste material from remediation activities, waste tracking, placement of daily cover, decontamination of vehicles, stormwater management, and wastewater treatment/disposal.

Waste placement activities included moisture conditioning, compaction, and debris management. Moisture conditioning (when required) consisted of adding sufficient moisture to dry soil to control dust, or drying soil containing excess moisture to facilitate placement and compaction. Lift preparation and compaction were performed to promote adhesion of the previous and new lifts, to mitigate preferential seepage pathways forming between adjacent lifts, and to consolidate waste material into a stable mass. Debris consisted primarily of building superstructure, concrete floor slabs, and building substructure, and was typically sized (broken down) at originating locations. After spreading and initial compaction of debris, soil-like material was spread over the debris, and worked into the voids of the debris to the extent practical. The objective of this mixing was to fill voids within the non-soil-like material; increase the density of the material placed; aid in the homogenizing of building rubble, demolition debris, and soils; and preserve/maximize landfill capacity.

Disposal of waste materials was documented using a waste tracking system. The purpose of the waste tracking system was to document the movement of remediation waste from generating projects to acceptance at the HWL. The system provided an identification mechanism for waste as it was transported from an area of origin to placement in the HWL and to ensure that all remediation waste generated during implementation of remediation projects was properly disposed.

Daily cover was placed over waste to minimize the exposed waste surface area, thereby reducing dust and minimizing the generation of contaminated stormwater.

On a daily basis, the waste surface in active HWL cells was maintained to control and detain contaminated and potentially contaminated runoff. Stormwater segregation berms were established around each active waste placement area to contain contaminated runoff that came in direct contact with waste and segregate potentially contaminated run-off that did not come in direct contact with waste but fell within the landfill. Potentially contaminated runoff catchment areas were established by grading the daily cover surface within the landfill such that surface water runoff was directed to a location to facilitate pumping to the LWTS. Permanent and temporary drainage channels consisted of a series of channels designed for conveying run-on and runoff away from the landfill. The drainage channels were used to prevent stormwater run-on and runoff from damaging the landfill's final cover system.

A wet decontamination facility was constructed for HWL operations. The pad consisted of three concrete wash bays equipped with pressure washers, trench drains, and sumps for the collection of wastewater. All vehicles that had been used on contaminated or potentially contaminated roads or in waste-placement areas underwent decontamination before they exited the HWL area.

The LWTS was used to store, treat, and dispose of wastewater generated by the operation of the HWL. The wastewater processed by the LWTS included leachate from the HWL, precipitation runoff collected within the landfill cells and decontamination facilities, and decontamination wastewater. The LWTS was designed to treat the wastewater streams described above to the extent necessary to comply with the discharge standards established in the CCD.

In 2001, DIMP was unexpectedly detected in the leak detection water of Cell #2 of the HWL. After confirmation over several sampling events, an investigation was undertaken to confirm that the primary liner of the HWL had not been compromised and to evaluate the source of the DIMP in order to avoid use of DIMP-contaminated materials during ELF construction. In response, ELF construction was modified to prohibit use of borrow materials along the old sanitary sewer line in Borrow Area 5, the most likely source. The issue did not put remedy protectiveness at risk and is discussed in detail in the 2005 FYRR.

Personal health and safety sampling and analysis was performed in accordance with the NIOSH Manual of Analytical Methods. There were no confirmed employee exposures to hazardous substances above the permissible exposure limit.

Air and odor monitoring were conducted in accordance with site-wide and project-specific air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not met or exceeded during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the project met ROD remediation goals for the control of air emissions.

As documented in the CCR (TtEC 2007d), landfill operations under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. This landfill operations phase of the project does not require any long-term O&M. However, long-term O&M is required for the cap. Cap construction (discussed in Section 4.2.1.1) will be documented in a future CCR. The property involved in this project and the waste left in place will be subject to evaluation in future FYRs. The EPA approved the CCR on April 8, 2008.

4.2.3.3 Landfill Wastewater Treatment Addition of Ion Exchange (#9)

The LWTS is one of the support facilities for the operation of the two landfills, HWL and ELF, at RMA. The treatment system treats and disposes of the wastewater generated by landfill operations including leachate from the HWL, leak detection water from the HWL and ELF, stormwater from the HWL and ELF, and decontamination wastewater from the Landfill Operations Facility. The LWTS was constructed in 1998 to support the HWL operations that began in 1999 and began treating and disposing of wastewater from the ELF in 2004. The LWTS was considered to be O&F in November 1999 after successful treatment of the first batch of wastewater by the facility to meet the discharge standards established for the facility.

A DCN was issued for the ELF Final Design Package for the addition of an ion exchange system to the LWTS as part of an overall strategy for the management of wastewater generated by operation of the ELF. Construction of the ion exchange system addition to the LWTS was completed during fall 2004. The Regulatory Agencies were provided construction updates for the project during the weekly HWL operations progress meetings and have toured and inspected the ion exchange system during subsequent visits to the LWTS.

As documented in the LWTS CCR Addendum 1 (Washington Group International 2007), this remedial action has been completed in accordance with the final design, as modified; has achieved the intent of the ROD to be protective of human health and the environment; and, having been inspected by the RVO and Regulatory Agencies, is functioning as intended. No further action is required on this Implementation Project. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs. The EPA approved the CCR on July 17, 2008.

4.2.3.4 Construct Enhanced Hazardous Waste Landfill (#11)

The selected remedy in the On-Post ROD for construction of the ELF Liner requires:

> *Construction of a RCRA- and TSCA-compliant hazardous waste landfill on post.*

The ROD remediation standards that apply to the landfill and liner element of the project include:

> *Landfill principal threat and human health soil exceedance volumes and agent-contaminated material.*
>
> *Design landfill to meet state 1,000-year siting criteria.*
>
> *Minimize percolation by limiting the hydraulic conductivity of the compacted clay layer to 1 x 10^{-7} cm/sec or less.*
>
> *Install two composite liners, each consisting of 3 ft of compacted clay and a synthetic liner, and one additional composite liner.*
>
> *Meet or exceed all RCRA and state requirements.*
>
> *Meet air quality and odor standards that are ARARs.*

The ROD goals that apply to the project include the following:

> *Control emissions, as necessary, during remediation.*
>
> *Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.*

The ELF Liner project included construction of the following:

- Subgrade excavation and perimeter berm construction
- The triple-composite-liner system for two waste cells
- Leachate collection system (LCS) and riser pipes
- Two LDS and riser pipes
- Two leachate riser control houses, connected to the LCS and LDS riser pipes, with internal piping, mechanical/electrical systems, instrumentation, and secondary containment foundations with sumps

- Leachate Storage and Loadout Facility with internal piping, mechanical/electrical systems, instrumentation, indoor polyethylene storage tanks, outdoor fractionation tanks, and secondary containment foundation with sumps
- Contingent Contaminated Stormwater Control System with bladder tanks, piping, mechanical/electrical systems, instrumentation, and secondary containment system
- Yard piping for the transfer of contaminated stormwater, potentially contaminated stormwater, leachate, and leak detection water
- Centerberm between the two cells
- Waste haul ramp and access ramps
- Temporary stormwater drainage channels and culverts
- Revegetation

Construction of the ELF liner started November 3, 2003, and the final inspection was held on November 16, 2005.

A Construction Quality Assurance/Construction Quality Control (CQA/CQC) program was implemented for this project. CQA consisted of planning, assessment, reporting, and quality improvement to provide adequate confidence that the ELF was constructed as specified in the design. CQA activities included confirmatory inspections, independent testing, audits, and evaluations of materials and workmanship to assess conformance to the design drawings and specifications. CQC consisted of monitoring, inspecting, testing, and reporting to determine whether the control of supplies, manufacturers, products, services, site conditions, and workmanship met the design requirements.

A certification report was prepared and issued upon completion of the Excavation and Berm Construction and Part 1 Liner Construction projects. The certification report for Liner Construction—Part 2, the remaining Excavation and Berm work effort, and Contingent Contaminated Stormwater Control System and Infrastructure Construction was approved by the Regulatory Agencies on March 7, 2006. The Certification Reports are compliant with Section 265.19(d) of 40 Code of Federal Regulations (CFR) to document that the ELF Liner Construction Project met the approved design.

Personal health and safety sampling and analysis for silica exposure was performed in accordance with the NIOSH Manual of Analytical Methods. The results indicated that, during excavation of the ELF footprint and Borrow Area 5 activities, respirators for silica protection were required for the dozer operators. No action levels were exceeded during all other activities that required PPE upgrade during ELF construction.

Air and odor monitoring were conducted in accordance with site-wide air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not met or exceeded during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the project met ROD remediation goals for the control of air emissions.

As documented in the CCR (TtEC 2006b), the ELF Liner Construction project has been completed, achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, is functioning as intended. No further action is required on the ELF Liner Construction project. This CCR documents only the construction effort, and the construction phase does not require any long-term O&M. However, long-term O&M is required for the cap. Cap construction (discussed in Section 4.2.1.2) will be documented in a future CCR. The property involved in this project, and the waste left in place, will be subject to evaluation in future FYRs. The EPA approved the CCR on January 29, 2007.

4.2.3.5 Operation of Enhanced Hazardous Waste Landfill (#12)

The ROD remediation standards that apply to the ELF operations include:

> *Ensure all material disposed in landfill passes EPA paint filter test.*
>
> *Landfill principal threat and human health soil exceedance volumes and agent-contaminated material.*

The ELF was designed to contain waste derived from Implementation Projects and other remedy support operations at RMA. These materials were designated in the RMA on-post ROD for disposal in the ELF and were required to meet waste acceptance criteria outlined by the RWMP (TtEC 2006i) and the ELF Operations Manual (TtEC 2007b). The technical and Regulatory Agency approach for the ELF was similar to that of the HWL, which was presented in the CDD (HLA 1996b), and the Final Design Analysis for the HWL (USACE 1998). The CDD contains the siting, design, operational, and closure/post-closure criteria for the ELF. These criteria are derived from regulatory requirements and guidance, standard practice guidelines, and the 1,000-year demonstration contained in the CDD. The ELF design includes requirements for a liner system, placement of the waste, final cover system, leachate management system, surface-water management system, and other ancillary features approved by the Regulatory Agencies in 2002, details of which are presented in the ELF 100 Percent Design Analysis (TtEC 2007a).

Operations at the ELF, which took place from April 3, 2006, until May 5, 2008, involved placement of waste material from remediation activities, waste tracking, placement of daily cover, odor control, decontamination of vehicles, general facility maintenance, construction of above-grade waste containment berms, intermediate cover construction, stormwater management, and wastewater treatment/disposal.

All modifications to the approved design package drawings and specifications were documented in the project files through approved DCNs.

Disposal of contaminated wastes was documented using a waste tracking system as specified in the RWMP (TtEC 2006i). A total of 940,712 compacted cy of contaminated waste was placed in the ELF over the course of this project.

The HWL was designated as the final repository for CSV material at the RMA, although timing and volume dictated that a portion of CSV be disposed in the ELF. The CSV quantities were

tracked by the individual projects and summaries of these data can be found in the CCRs for the individual projects.

Operations involved placement of waste material from remediation activities, waste tracking, placement of daily cover, odor control, decontamination of vehicles, stormwater management, and wastewater treatment/disposal.

Waste placement activities included moisture conditioning, compaction, and debris management. Moisture conditioning (when required) consisted of adding sufficient moisture to dry soil to control dust, or drying soil containing excess moisture to facilitate placement and compaction. Lift preparation and compaction were performed to promote adhesion of the previous and new lifts, to mitigate preferential seepage pathways forming between adjacent lifts, and to consolidate waste material into a stable mass. Debris consisted primarily of building superstructure, concrete floor slabs, and building substructure, and was typically sized (broken down) at originating locations. After spreading and initial compaction of debris, soil-like material was spread over the debris, and worked into the voids of the debris to the extent practical. The objective of this mixing was to fill voids within the non-soil-like material; increase the density of the material placed; aid in the homogenizing of building rubble, demolition debris, and soils, and preserve/maximize landfill capacity.

Disposal of waste materials was documented using a waste tracking system. The purpose of the waste tracking system was to document the movement of remediation waste from generating projects to acceptance at the ELF. The system provided an identification mechanism for waste as it was transported from an area of origin to placement in the ELF and to ensure that all remediation waste generated during implementation of remediation projects was properly disposed.

Daily cover was placed over waste to minimize the exposed waste surface area, thereby reducing dust and odors and minimizing the generation of contaminated stormwater.

On a daily basis, the waste surface in active ELF cells was maintained to control and detain contaminated and potentially contaminated runoff. Stormwater segregation berms were established around each active waste placement area to contain contaminated runoff that came in direct contact with waste and segregate potentially contaminated run-off that did not come in direct contact with waste but fell within the landfill. Potentially contaminated runoff catchment areas were established by grading the daily cover surface within the landfill such that surface water runoff was directed to a location to facilitate pumping to the LWTS. Permanent and temporary drainage channels consisted of a series of channels designed for conveying run-on and runoff away from the landfill. The drainage channels were used to prevent stormwater run-on and runoff from damaging the landfill's final cover system.

A wet decontamination facility was constructed for HWL operations and was maintained for use during ELF operations. The pad consisted of three concrete wash bays equipped with pressure washers, trench drains, and sumps for the collection of wastewater. All vehicles that had been used on contaminated or potentially contaminated roads or in waste-placement areas underwent decontamination before they exited the ELF area.

The ELF generated wastewater in the form of landfill leachate, leak detection liquid, decontamination wastewater, and stormwater collected inside the landfill cells. This wastewater, with the exception of leachate, was treated and disposed through the LWTS specifically designed and operated for this purpose. Leachate from the ELF is not treated by the LWTS due to treatment limitations; this wastewater is treated off site.

Air and odor monitoring were conducted in accordance with site-wide and project-specific air and odor monitoring plans as discussed in Section 6.3.4. Although project odor action levels at the RMA fenceline were exceeded three times in October 2007 due to odors attributed to ELF Operations, odor monitoring conducted after odor controls were implemented showed that the controls were effective in limiting additional impacts and no odor ARARs were exceeded. No off-site transport of fugitive dust was noted during project implementation. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria.

Permanent revegetation of the project area was not required or performed as part of this project. Required revegetation was performed as part of the ELF Cap Construction project (see Section 4.2.1.2).

As documented in the CCR (TtEC 2009g), landfill operations under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. This landfill operations phase of the project does not require any long-term O&M. Long-term O&M is required for the cap, however. Cap construction (discussed in Section 4.2.1.2) will be documented in a future CCR. The property involved in this project and the waste left in place will be subject to evaluation in future FYRs. The EPA approved the CCR on May 5, 2009.

4.2.3.6 Basin A Consolidation and Remediation Area Operations/Subgrade (#14)

The selected remedy in the On-Post ROD for the Basin A Consolidation Area component of the soil remedy requires:

> *Construction of a soil cover consisting of a 6-inch-thick layer of concrete and a 4-ft.-thick soil/vegetation layer over the principal threat and human health exceedance soil and soil posing potential risk to biota, and consolidation of debris and soil posing a potential risk to biota and structural debris from other sites. No RCRA-listed or RCRA characteristic waste from outside the AOC will be placed in Basin A. Any UXO encountered will be removed and transported off post for detonation (unless the UXO is unstable and must be detonated on post) or other demilitarization process.*

The ROD remediation standards that apply to the Basin A project include:

> *Consolidate biota exceedance volume and structural debris in Basin A.*
>
> *Maintain minimum cover thickness of 4 ft.*

Maintain cover percolation less than or equal to the percolation of the underlying native soil.

Prevent biota and humans from accessing underlying contaminated soil by using biota barriers and maintaining institutional controls.

Meet air quality and odor standards that are ARARs.

The ROD goals that apply to the project include the following:

Maximize runoff and minimize ponding.

Minimize erosion by wind and water.

Prevent damage to integrity of cover by biota and humans.

Maintain cover of locally adapted perennial vegetation.

Control emissions, as necessary, during remediation.

Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.

Work performed to prepare Basin A for operation included the construction of a foundation layer approximately 1 to 3 ft thick to prevent contact of waste hauling and placement equipment with potential UXO in the basin. This foundation layer consisted primarily of biota risk exceedance soil that originated from the areas of the CAMU. The CAMU Soil Remediation project (#2) is discussed in the 2000 and 2005 FYRRs.

The Basin A Consolidation Area was available for waste consolidation on January 19, 1998, and operations continued through June 2004. On July 1, 2004, Basin A entered an Interim Operational phase and waste consolidation activities were limited to a small area on the western boundary of the basin, referred to as the Basin A Notch. Interim operations continued until December 10, 2008. Consolidation of contaminated wastes was documented using a waste tracking system as specified in the RWMP (TtEC 2006i). Approximately 2.6 million cy of contaminated waste and gradefill material was consolidated in Basin A over the course of this project.

Following waste consolidation operations, clean gradefill was imported and placed to the lines and grades of the cover subgrade design. The Basin A subgrade was subdivided into three subsites: Basin A North, Basin A South, and Basin A Notch. Completion of the Basin A South and Basin A North subgrades occurred in fall 2006. The Basin A Notch subgrade was completed on February 23, 2009. Construction activities included other earthwork within the Basin A Consolidation and Remediation Project area as needed in support of RCRA-equivalent cover construction, such as berm removal and finish grading in channels. The final inspection was held on February 26, 2009.

Three confirmatory samples were collected in and around the haul road leading to the Basin A Notch (TtEC 2009f). No CSV was identified. Integrated personnel monitoring was performed

that complied with Occupational Safety and Health Administration 29 CFR 1926.65 and the requirements of the subcontract specifications, which included monitoring for silica, asbestos, metals, pesticides, and particulates not otherwise classified. There were no confirmed employee exposures to hazardous substances above the permissible exposure limit.

Air and odor monitoring were conducted in accordance with site-wide air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not met or exceeded during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the project met ROD remediation goals for the control of air emissions.

The ROD-prescribed remedy for Basin A also included construction of a 4-ft soil cover overlying a 6-inch concrete layer. In 2002, the RVO authored a Resolution Agreement with the Regulatory Agencies to upgrade the planned soil cover for Basin A to a RCRA-equivalent cover (RVO 2002). Later, the Minor Change to the On-Post ROD for Soil Covers, RMA Fact Sheet (TtEC 2008f) was prepared to document ROD changes for Basin A and other soil covers. The RCRA-equivalent cover was constructed as part of the ICS project and is discussed in Section 4.2.1.3.

As documented in the CCR (TtEC 2009b), remedial actions for this portion of the project have been completed in accordance with the ROD and comply with the final design package as modified. Together with construction of the RCRA-equivalent cover the Basin A project will achieve the intent of the ROD, as amended, to be protective of human health and the environment. This phase of the project does not require any long-term O&M; however, long-term O&M is required following cover construction. Long-term O&M requirements are provided in the LTCP (TtEC 2008i). The property involved in this project is also subject to restrictions on land and water use and will be included in the RMA-wide FYRs of remedial action. The EPA approved the CCR on September 3, 2009.

4.2.3.7 Existing (Sanitary) Landfills Remediation Section 1 (#20)

This project addressed remedial actions stated in the On-Post ROD for a distinct portion of the Existing (Sanitary) Landfills Remediation project. The selected remedy in the ROD for Sanitary Landfills requires the following:

> *Excavation and landfill of human health exceedance soil and excavation and consolidation to Basin A of landfill debris and soil posing a potential risk to biota. The consolidated material is contained under the Basin A cover. The excavated area is backfilled with on-post borrow material.*

The selected remedy in the On-Post ROD for revegetation is:

> *Remedy components for all sites include reconditioning the surface soil and revegetating areas disturbed during remediation with locally adapted perennial vegetation.*

Additionally, the ROD remediation standard that applies to the Sanitary Landfills is to accomplish the following:

> *Excavate all contaminated soil identified in the ROD for treatment, landfilling, or consolidation that corresponds to the aerial and vertical extent detailed by the soil volume calculations in the administrative record.*
>
> *Meet air quality and odor standards that are ARARs.*

The ROD remediation goals that apply to the project include:

> *Control emissions, as necessary, during remediation.*
>
> *Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.*

The original Existing (Sanitary) Landfills Section 1 Remediation project was completed during the first FYRR (PMRMA 2000). In 2002, however, the BAS identified a concern related to unknown risk potential for sites that had not been backfilled following excavation of HHE soil. The ROD remedy for HHE soil excavations includes backfill of the excavation area. Nonetheless, the approved design for Existing (Sanitary) Landfills Section 1 Remediation (SSA-4) eliminated the backfill requirement where HHE excavations were shallow and backfill was not needed to achieve a final ground surface consistent with the future use of the site as a wildlife refuge. Although backfill was eliminated, confirmatory samples were collected in these sites following excavation to verify that no HHE soil remained at the site. It should be noted, however, that the analytical method at the time was relevant only for determining additional HHE soil excavation and was not certified for detection of concentrations that might pose a risk to biota.

At the recommendation of the BAS, SSA-4 was resampled using an analytical method capable of detecting concentrations of COCs in the biota risk range. Sampling was performed consistent with the method developed by the BAS for the Terrestrial Residual Ecological Risk evaluation by collecting a five-point composite sample over each area representing a small bird exposure range. This additional sampling indicated that there was contamination remaining at the excavation surface in site SSA-4 that posed excessive risk to biota. As a result, additional biota risk soil was excavated from this site SSA-4. A total of 1,666 cy of CSV soil was excavated and taken to Basin A. One confirmatory sample was collected after excavation of the CSV soil. Backfill was placed at SSA-4 after CSV removal. Upon completion of backfill and grading, the site was permanently seeded by the USFWS.

Health and safety sampling and analysis was performed in accordance with the NIOSH Manual of Analytical Methods. The results indicated that action levels were not met or exceeded for the contaminants tested during the Existing (Sanitary) Landfills Section 1 Remediation project.

Air and odor monitoring were conducted in accordance with site-wide air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not met or exceeded during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring

conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the project met ROD remediation goals for the control of air emissions.

The ESD for the Existing (Sanitary) Landfills Section 1 Remediation project (TtEC 2005e) documents an increase in HHE and biota risk soil excavation volumes associated with the landfill sites due to over excavation of required volume to ensure complete removal. The ESD also documents a significant decrease in trash/debris volume. Trash/debris volume was identified in the ROD based on estimated trench depth and lateral extent. Remediation was performed to excavate all visible trash/debris from each identified trench. The reduced volume is based on the differences between ROD-assumed landfill trench depths and lateral extents and actual debris encountered during excavation.

As documented in the addendum (RVO 2004), remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment and, having been inspected by the RVO and Regulatory Agencies, are fully functional. This project does not require any long-term O&M. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs. The addendum to the CCR was approved by the EPA on March 30, 2006, for the additional CSV excavation.

4.2.3.8 Existing (Sanitary) Landfills Remediation Section 30 (#22)

The selected remedy in the On-Post ROD for the Existing (Sanitary) Landfills Section 30 Remediation component of the soil remedy requires:

> *Excavation and landfill of human health exceedance soil and excavation and consolidation to Basin A of landfill debris and soil posing a potential risk to biota. The consolidated material is contained under the Basin A cover. The excavated area is backfilled with on-post borrow material.*

The selected remedy in the On-Post ROD for revegetation is:

> *Remedy components for all sites include reconditioning the surface soil and revegetating areas disturbed during remediation with locally adapted perennial vegetation.*

The ROD remediation standards that apply to the Sanitary Landfills include:

> *Excavate all contaminated soil identified in the ROD for treatment, landfilling, or consolidation that corresponds to the areal and vertical extent detailed by the soil volume calculations in the administrative record.*
>
> *Meet air quality and odor standards that are ARARs.*

The ROD goals that apply to the project include the following:

> *Control emissions, as necessary, during remediation.*

Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.

The Existing (Sanitary) Landfills Section 30 Remediation project involved Site ESA-2b, located in Section 30. The project involved excavation and removal of both HHE soil and trash/debris; excavation and removal of ACM and associated soil; excavation and removal of suspect hazardous materials; backfilling, compacting, final grading, and ripping; perimeter fence removal and staging for reuse; soil amendment application, and surface revegetation. All HHE soil, ACM, and suspect hazardous materials were transported to the on-site HWL for disposal. All trash and debris were disposed in Basin A.

Although not anticipated in the ROD, further evaluation during design indicated the possibility of MEC. As a result, spotters were present during excavation and several munitions-related anomalies were addressed. Items that contained liquids (i.e., bottles) were taken to the Environmental Analytical Laboratory and analyzed; none contained agent. Solid anomalies were cleared following further characterization. Energetic items were determined unstable and detonated in place or at the on-site demolition range.

Disposal of trash and debris; munitions debris and associated soil; and HHE soils, ACM, and associated soil were documented using a waste tracking system as specified in the RWMP (TtEC 2006i). A total of 874 cy of HHE soil and 156 loads of ACM, munitions debris, and petroleum-contaminated material, polychlorinated biphenyl (PCB)-contaminated equipment, and PPE was disposed in the HWL during the course of the project. Approximately 143,515 cy of trash/debris and 100 loads of miscellaneous debris and PPE were disposed in Basin A.

Following excavation of design volumes during the Existing (Sanitary) Landfills Section 30 Remediation project, one confirmatory sample was taken. No CSV was identified for excavation.

Personal health and safety sampling and analysis was performed in accordance with the NIOSH Manual of Analytical Methods. The results indicated that there were no action levels exceeded requiring PPE upgrade during the Existing (Sanitary) Landfills Section 30 Remediation project.

Air and odor monitoring were conducted in accordance with site-wide air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not met or exceeded during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the project met ROD remediation goals for the control of air emissions.

All trenches were backfilled and the site was finish-graded to promote positive drainage and to blend into the surrounding grades.

Permanent revegetation of this project area was completed in spring 2005.

The approved ESD for Existing (Sanitary) Landfills Section 30 Remediation project (TtEC 2005e) documents an increase in HHE and biota risk soil excavation volumes associated with the landfill sites due to over excavation of required volume to ensure complete removal. The ESD also documents a significant decrease in trash/debris volume. Trash/debris volume was identified in the ROD based on estimated trench depth and lateral extent. Remediation was performed to excavate all visible trash/debris from each identified trench. The reduced volume is based on the differences between ROD-assumed landfill trench depths and lateral extents and actual debris encountered during excavation.

As documented in the CCR (TtEC 2005g), remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. No caps, covers, or treatment facilities are required by the ROD for this remediation project, so no long-term O&M is required. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs. The EPA approved the CCR on August 16, 2005.

4.2.3.9 Munitions (Testing) Soil Remediation Parts II–IV (#25)

The selected remedy in the On-Post ROD for the Munitions Testing component of the soil remedy requires:

> *UXO in these sites is located using a geophysical survey, excavated, and transported offpost for detonation (unless the UXO is unstable and must be detonated on-post) or other demilitarization process. Removal and landfill of munitions debris and nearby soil in excess of TCLP.*

The selected remedy in the On-Post ROD for revegetation is:

> *Remedy components for all sites include reconditioning the surface soil and revegetating areas disturbed during remediation with locally adapted perennial vegetation.*

The On-Post ROD remediation standards that apply to the Munitions Testing Soil Remediation project include the following:

- *Excavate all contaminated soil identified in the ROD for treatment, landfilling, or consolidation that corresponds to the areal and vertical extent detailed by the soil volume calculations in the administrative record.*
- *Identify, transport off-post, neutralize, and destroy explosives/explosive residue.*
- *Ensure excavation of all identified munitions-contaminated soil exceeding TCLP (Munitions Testing and Burial Trenches) and munitions debris and disposal in the on-post RCRA landfill.*
- *Meet air quality and odor standards that are ARARs.*

The On-Post ROD goals that apply to the project include the following:

- *Control emissions, as necessary, during remediation.*

- *Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.*

The Munitions Testing Soil Remediation project was implemented in four parts. Part I was completed in 2004 and is discussed in the 2005 FYRR. Parts II, III, and IV were implemented from summer 2002 through fall 2007 and are described below.

An ESD (TtEC 2008e) documenting significant changes in remediation volumes, MEC remediation areas, and implementation cost for the Munitions Testing project was issued for public review and comment from September 29, 2008, to October 29, 2008. No comments were received from the public and the ESD was approved by the EPA and CDPHE on November 18, 2008.

Changes in the remediation volumes were based on results of soil sampling and field investigation. During design, soil sampling and toxicity characteristic leaching procedure (TCLP) analysis were conducted to determine the volume of soil in excess of TCLP criteria. The results indicated that none of the soil in contact with the munitions debris exceeded the regulatory levels. As a result, soil excavation was eliminated in project areas where munitions debris could be cleared through geophysical anomaly location, characterization, and removal. Also during design, the lateral and vertical boundaries of munitions debris remediation areas were modified based on extensive field investigation of debris distribution. These boundary changes were applied to visually impacted burn areas and generally resulted in larger remediation areas and increased remediation volume. Together these changes led to an overall 61 percent decrease in project volume.

The project also experienced significant increases in scope of remediation. The On-Post ROD included approximately 55 acres for remediation of MEC. Expansion of the ESA-4a remediation area and the addition of several new MEC areas, including the Demolition Range Exclusion Zone (DREZ), resulted in an expanded MEC remediation area of 710 acres. Other scope additions included removal of ACM from CSA-2c and biota risk soil from ESA-4b. These scope changes lead to significant cost growth for the project compared to the On-Post ROD-estimated costs. Overall, project costs increased from a ROD-estimated $2.75 million to approximately $7.03 million, an approximate 155 percent cost increase over the ROD estimate.

Munitions Testing Part II

The Part II Munitions Testing Soil Remediation project is located in Sections 29, 30, 31, and 32 of the On-Post OU and consists of the following three sites:

- Site ESA-4a, Munitions Test Site
- Borrow Area 10, Surface Burn Site
- Burial Trenches BT32-10, Target Characterization and Recovery

Remediation of Sites ESA-4a, Borrow Area 10, and Burial Trenches BT32-10 involved some or all of the following activities: surface inspections for MEC, electromagnetic (EM- 61) geophysical survey, target characterization and recovery, and ripping and seedbed preparation

for future permanent revegetation. Remediation of the Part II Munitions Testing Soils was carried out from summer 2002 through winter 2005.

Although Site ESA-4a was originally considered complete under Part I, based on historical research performed by the Hazard Evaluation and Summary Subcommittee (HESS) regarding the flight path of the 4.2-inch high-explosive mortar on RMA, the original ROD surface area of Site ESA-4a was expanded (FWENC 2002b). During the RI, an evaluation of Site 30-1 noted the location of impact craters and a concrete bunker used to observe mortar impacts. The concrete bunker had observation windows facing northwest and northeast, suggesting that the main impact range was north of the bunker. A 42-acre parallelogram was used to bound the mortar impact area and the site was designated ESA-4a. As part of the remedial design, in 1998 a magnetic survey was performed by Sanford Cohen & Associates (SC&A) to identify locations of potential subsurface MEC. This led to the characterization of 326 targets, four of which were characterized as MEC.

As noted above, in late 2001 the HESS discovered a draftsman's sketch (circa 1945) indicating the mortar impact area may have extended beyond the previously investigated ROD site limits. In January 2002, the HESS recommended expanding the remediation area. Site ESA-4a was subsequently expanded (parallelogram was extended 3.3 acres to the southeast and 7 acres to the west). The PMC was tasked to clear an additional 35 targets from the 1998 SC&A survey area. While characterizing the previously mentioned targets, the PMC discovered 14 additional targets within the original ROD boundary that had not been investigated. One of these 14 targets resulted in the clearance of three 4.2-inch high-explosive mortars that were subsequently characterized as MEC. Given the concerns that additional MEC may exist in areas outside the 42-acre ROD site and the additional 10.3 acres, the boundary of ESA-4a was expanded to include most of Site 30-1 (approximately 212 acres).

Remediation waste under the Part II Munitions Testing Soil Remediation project was transported to the HWL and Basin A Consolidation Area. Disposal of munitions debris was documented using a waste tracking system as specified in the RWMP (TtEC 2006i). Approximately 52,000 lbs of munitions debris (13 truckloads) from ESA-4a; 2,260 lbs of munitions debris and miscellaneous debris from Burial Trenches 32-10 (two truckloads); and 20 bcy of charred soil and related debris from Borrow A 10 (one truckload) were disposed in the RMA HWL during the course of the Part II Munitions Testing Project. A total of nine loads of miscellaneous debris from ESA-4a were disposed in Basin A. All MEC recovered under the Part II Munitions Testing Soil Remediation project were disposed on site per RMA's Standard Operating Procedure for MEC Disposal by Detonation.

A CSV tracking form was used to identify, document, and track CSV inspections for the Part II Munitions Testing Soil Remediation project sites. Eight confirmatory soil samples were collected, but no CSV soil was identified for excavation. EPA collected a split sample at one of the confirmatory soil sample locations.

Air and odor monitoring were conducted in accordance with site-wide air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not met or exceeded during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring

conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the project met ROD remediation goals for the control of air emissions.

As documented in the CCR (TtEC 2008g), remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. No caps, covers, or treatment facilities are required by the ROD for this remediation project, so no long-term O&M is required. In addition, there are no specific ICs required for these sites based on the resolution statement for Site ESA-4a signed January 6, 2004 (RMA Council 2004a) and the subsequent amendment dated August 24, 2004 (RMA Council 2004b). The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs. The EPA approved the CCR on April 8, 2008.

Munitions Testing Part III

The Part III Munitions Testing Soil Remediation project is comprised of the following munitions response sites:

- Munitions Testing Site
- Borrow Area 9A (Parcel 2)
- CSA-2c SW/NW

Remediation of sites DREZ, Borrow Area 9A (Parcel 2), and CSA-2c SW/NW involved some or all of the following activities: initial surface sweep, electromagnetic geophysical survey, magnetometer (mag)/dig, and target characterization. Remediation waste under the Part III Munitions Testing Soil Remediation project was transported to the HWL.

Remediation under the Part III Munitions Testing Soil Remediation project was carried out from summer 2005 through fall 2006. During the DREZ munitions response efforts, 47,466 targets were characterized and 209 MEC recovered. During the Borrow Area 9A (Parcel 2) and CSA-2c SW/NW munitions response efforts, 1,612 targets were characterized, 22 grids addressed through mag and dig, and eight MEC recovered.

MEC recovered during the DREZ and Borrow Area 9A (Parcel 2)/CSA-2c SW/NW munitions response efforts was not considered safe for off-site transportation and was disposed on site per RMA protocol.

Disposal of munitions debris was documented using a waste tracking system as specified in the RWMP (TtEC 2006i). Approximately 31,500 lbs of munitions debris (5½ partial truckloads) was recovered from the DREZ and approximately 10,000 lbs of munitions debris (3½ partial truckloads) was recovered from Borrow Area 9A (Parcel 2)/CSA-2c SW/NW. The recovered munitions debris was disposed in the RMA HWL during the course of the Part III Munitions Testing Soil Remediation project.

A CSV tracking form was used to identify, document, and track CSV inspections for the Part III Munitions Testing Soil Remediation project. There were no CSV samples taken during the

Part III project. One health and safety sample was collected because a petroleum smell during excavation of a potential burn pit in the DREZ was reported. The sample results were nondetect and there was no additional soil removed.

Air and odor monitoring were conducted in accordance with site-wide air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not met or exceeded during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the project met ROD remediation goals for the control of air emissions.

There are no caps, covers, or treatment facilities required by the ROD for this remediation project, so no long-term O&M is required. Given the use of engineering controls, it is not anticipated that future explosives disposal operations on the RMA Demolition Range will impact the DREZ. There are no ICs required for sites DREZ, Borrow Area 9A (Parcel 2), and CSA-2c SW/NW; however, the property involved in this project is subject to restrictions on land and water use and will be included in the RMA FYRs of remedial action.

As documented in the CCR (TtEC 2008h), remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. No caps, covers, or treatment facilities are required by the ROD for this remediation project, so no long-term O&M is required. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs. The EPA approved the CCR on March 26, 2008.

Munitions Testing Part IV

The Part IV Munitions Testing Soil Remediation project consists solely of the RMA Demolition Range munitions response site. Remediation of the Demolition Range involved the following activities: initial surface sweep, electromagnetic geophysical survey, magnetometer/dig, target characterization, and removal of soil possessing elevated levels of mercury (identified as biota risk soil). Remediation waste under the Part IV Munitions Testing Soil Remediation project was transported to the ELF and the Basin A Consolidation Area. Remediation under the Part IV Munitions Testing Soil Remediation project was carried out from spring 2007 through fall 2007.

During munitions response efforts associated with the Demolition Range, 3,932 targets were characterized and 281 MEC recovered. MEC recovered during the Demolition Range munitions response effort was not considered safe for off-site transportation and was disposed on site per RMA protocol.

Disposal of remediation waste was documented using a waste tracking system as specified in the RWMP (TtEC 2006i). Approximately 7,000 lbs of munitions debris (3½ partial truckloads) was recovered. The recovered munitions debris was disposed in the RMA ELF during the course of the Part IV Munitions Testing Soil Remediation project. A total of 6,600 bcy of biota risk soil was removed during the performance of the 1-ft cut and disposed in the Basin A Consolidation

Area. A total of 175 bcy of potential hazardous waste/biota soil was removed during the clearance of the disposal pits. The excavated soil was disposed in the ELF.

A CSV tracking form was used to identify, document, and track CSV inspections for the Part IV Munitions Testing Soil Remediation project. Six CSV confirmatory samples were taken during the project. There were no additional soils excavated as a result of the six CSV confirmatory samples.

Air and odor monitoring were conducted in accordance with site-wide air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not met or exceeded during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the project met ROD remediation goals for the control of air emissions.

As documented in the CCR (TtEC 2009o), remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. The Part IV Munitions Testing Soil Remediation project, together with Parts I, II, and III, completes the Munitions Testing Soils Remediation project as identified in the On-Post ROD. No caps, covers, or treatment facilities are required by the ROD for this remediation project, therefore no long-term O&M is required. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs. The EPA approved the CCR on May 14, 2009.

4.2.3.10 Miscellaneous Northern Tier Soil Remediation (#26)

The selected remedy in the On-Post ROD for the Surficial Soil component of the soil remedy requires:

> *Excavation and landfill of human health exceedance soil and excavation and consolidation to Basin A or Former Basin F of and soil posing a potential risk to biota from this medium group and excavation and landfill of soil from the pistol and rifle ranges. The consolidated material is contained under the Basin A cover or Basin F cap, and the human health exceedance area is backfilled.*

The selected remedy in the On-Post ROD for the Sand Creek Lateral medium group component of the Miscellaneous Northern Tier Soil Remediation requires:

> *Excavation and landfill of human health exceedance soil …. The excavated area is backfilled with on-post borrow material.*

The selected remedy in the On-Post ROD for revegetation is:

> *Remedy components for all sites include reconditioning the surface soil and revegetating areas disturbed during remediation with locally adapted perennial vegetation.*

The Miscellaneous Northern Tier Soil Remediation included demolition of structures. The RAOs and selected remedy in the On-Post ROD for the structures medium group are presented in Section 4.3.

The ROD remediation standard that applied to this project required:

> *Excavate all contaminated soil identified in the ROD for treatment, landfilling, or consolidation that corresponds to the areal and vertical extent detailed by the soil volume calculations in the administrative record.*
>
> *Meet air quality and odor standards that are ARARs.*

The ROD remediation goals that apply to the project include:

> *Control emissions, as necessary, during remediation.*
>
> *Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.*

The Miscellaneous Northern Tier Soil project is comprised of the following three sites: NCSA-8b, Sewage Treatment Plant; NPSA-4, Fuse and Detonator Magazine Ditch; and the Pistol Range. Remediation at the three sites involved excavation of both HHE and biota risk soils, demolition of several aboveground and underground structures, backfilling and/or regrading, and surface revegetation.

All HHE soil or debris was transported to the HWL and all biota risk soil and debris were disposed in Basin A. ACM was discovered at Site NCSA-8b and the Pistol Range House and properly disposed in the HWL. Disposal of contaminated soil and miscellaneous debris was documented using a waste tracking system as specified in the RWMP (TtEC 2006i). A total of 4,112 cy of contaminated soil was disposed in the HWL and 26,452 cy of biota risk soil was disposed in Basin A.

To meet requirements of the On-Post ROD, a confirmatory sampling program was developed for Implementation Projects to determine whether contingent soils will be excavated. Accordingly, following excavation of design volumes during the project, 27 confirmatory samples were taken and approximately 387 cy of CSV soil was excavated. All soils removed were verified by pre- and post-excavation surveys.

In 2002, the BAS identified a concern related to unknown risk potential for sites that had not been backfilled following excavation of HHE soil. The ROD remedy for HHE soil excavations includes backfill of the excavation area. Nonetheless, the approved design for Miscellaneous Northern Tier Soils (NCSA-8b) eliminated the backfill requirement where HHE excavations were shallow and backfill was not needed to achieve a final ground surface consistent with the future use of the site as a wildlife refuge. Although backfill was eliminated, confirmatory samples were collected in these sites following excavation to verify that no HHE soil remained at the site. It should be noted, however, the analytical method at the time was relevant only for

determining additional HHE soil excavation and was not certified for detection of concentrations that might pose a risk to biota.

At the recommendation of the BAS, NCSA-8b was resampled using an analytical method capable of detecting concentrations of COCs in the biota risk range. Sampling was performed consistent with the method developed by the BAS for the Terrestrial Residual Ecological Risk evaluation by collecting a five-point composite sample over each area representing a small bird exposure range. This additional sampling indicated that there was contamination remaining at the excavation surface at site NCSA-8b.

As a result, 11,133 bcy of CSV soil was excavated from NCSA-8b and taken to the HWL. Initially, 1,500 bcy of CSV was disposed in Basin A. Upon further review, the levels of contamination in this CSV soil were determined to require disposal in the HWL. As a result, 4,000 cy of soil was excavated out of Basin A to ensure that all 1,500 cy of CSV would be removed. The remaining volume of CSV was taken directly to the HWL. This effort was documented in an addendum to the CCR (RVO 2006a).

Sites NCSA-8b and the Pistol Range were revegetated with locally adapted perennial vegetation. NPSA-4 is within Borrow Area 6 and will be revegetated upon completion of North Plants Soils Remediation project.

Air and odor monitoring were conducted in accordance with site-wide air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not met or exceeded during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the project met ROD remediation goals for the control of air emissions.

As documented in the CCR (FWENC 2002a) and CCR addendum (RVO 2006a), remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. This project does not require any long-term O&M. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs. The EPA approved the CCR on April 20, 2000, and the addendum for additional CSV removal was approved March 30, 2006.

4.2.3.11 South Plants Balance of Areas and Central Processing Area Soil Remediation Phase 2, Parts 1 and 2 (#34)

The selected remedy in the On-Post ROD for the South Plants Central Processing Area component of the soil remedy requires:

> *Excavation and landfill of principal threat and human health exceedance exceedance soil to a depth of 5 ft and caustic washing and landfill of any agent-contaminated soil found during monitoring. Backfill excavation and placement of a soil cover consisting of a 1-ft-thick biota barrier and a 4-ft-thick soil/vegetation layer over the entire site to contain the remaining human health exceedance soil*

and soil posing a potential risk to biota. Soil posing a potential risk to biota from other portions of South Plants may be used as backfill and/or gradefill prior to placement of the soil cover.

The selected remedy in the On-Post ROD for the South Plants Balance of Areas component of the soil remedy requires:

Excavation (maximum depth of 10 ft) and landfill of principal threat and human health exceedance soil and caustic washing and landfill of any agent-contaminated soil found during monitoring. Any UXO encountered will be excavated and transported off-post for detonation (unless the UXO is unstable and must be detonated on post) or other demilitarization process. Excavation of soil posing a potential risk to biota and consolidation as backfill and/or gradefill under the South Plants Central Processing Area soil cover and/or for use as backfill for excavated areas within this medium group. The former human health exceedance area is covered with a 3-ft-thick soil cover and the former potential risk to biota area is covered with a 1-ft-thick soil cover. Prior to placing this cover, two composite samples per acre will be collected to verify that the soil under the 1-ft.-thicK cover does not exceed the human health or principal threat criteria. If the residual soil is found to exceed these levels, the 3-ft-thick cover will be extended over these areas or the exceedance soil will be excavated and landfilled. The top 1 ft of the entire soil cover area will be constructed using soil from on-post borrow areas.

The selected remedy in the ROD for the South Plant Ditches component of the soil remedy requires:

Excavation and landfill of principal threat and human health exceedance soil. Excavation of soil posing a potential risk to biota and consolidation under the South Plants Central Processing Area soil cover. Backfill excavated area with on-post borrow material. These sites are contained under the South Plants Balance of Areas soil cover.

The selected remedy in the On-Post ROD for the Chemical Sewers component of the soil remedy requires:

For sewers located within the South Plants Central Processing Area…the sewer void space is plugged with a concrete mixture to prohibit access to these lines and eliminate them as a potential migration pathway for contaminated groundwater. The plugged sewers are contained beneath the soil cover or cap in their respective sites. For sewers located outside the South Plants Central Processing Area…sewer lines and principal threat and human health exceedance soil are excavated and landfilled. Any agent-contaminated soil found during monitoring is caustic washed and landfilled. Prior to excavation of exceedance soil, overburden is removed and set aside. The excavated area is backfilled with on-post borrow material and the overburden replaced.

The selected remedy in the On-Post ROD for the Sanitary/Process Water Sewers component of the soil remedy requires:

> *Void space inside sewer manholes is plugged with a concrete mixture to prohibit access and eliminate the manholes as a potential migration pathway for contaminated groundwater. Aboveground warning signs are posted every 1,000 ft along the sewer lines to indicate their location underground.*

The selected remedy in the On-Post ROD for PCB-contaminated soil requires:

> *Soil identified with concentrations ranging from 50 to 250 ppm will be covered with at least3 ft of soil (five areas identified by the PCB IRA).*

In addition, the selected remedy in the On-Post ROD for structures located in South Plants requires:

> *The slabs and foundations of structures located in the South Plants Central Processing Area within principal threat or human health soil exceedance excavation areas are removed to a depth of 5 ft. In most cases, floor slabs and foundations of structures for the Other Contamination History and Significant Contamination History Groups are left behind after demolition (unless contaminated soil is to be excavated from beneath the slabs or foundations). Floor slabs are broken to prevent water ponding.*

The selected remedy for revegetation is:

> *Remedy components for all sites include reconditioning the surface soil and revegetating areas disturbed during remediation with locally adapted perennial vegetation.*

The On-Post ROD remediation standards that apply to the project include:

- *Identify, transport off-post, neutralize, and destroy explosives/explosive residue.*
- *Ensure excavation of all identified munitions-contaminated soil exceeding TCLP (Munitions Testing and Burial Trenches) and munitions debris and disposal in the on-post RCRA landfill.*
- *Excavate all contaminated soil identified in the ROD for treatment, landfilling, or consolidation that corresponds to the areal and vertical extent detailed by the soil volume calculations in the administrative record.*
- *Interrupt exposure pathway with a minimum of 3 ft of soil in the five areas identified as having PCB contamination <250 ppm.*
- *Interrupt exposure pathway by permanently plugging all Sanitary Sewer manholes.*
- *Interrupt exposure pathway by permanently plugging all chemical sewer lines and manholes not excavated.*
- *Certify 3X decontamination or caustic wash of soil and structural debris to achieve 3X decontamination.*

- *Ensure disposal of 3X-decontaminated soil and structural debris in the on-post RCRA landfill.*
- Meet air quality and odor standards that are ARARs.

The On-Post ROD goals that apply to the project include:

- *Control emissions, as necessary, during remediation.*
- *Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.*

The South Plants Balance of Areas and Central Processing Area Soil Remediation project was separated into two phases (Phase 1 and Phase 2) during the 95 percent design development. Phase 1 included excavation of contaminated soil and chemical sewers, ACM abatement, underground storage tank removal, foundation removal, backfilling/grading, and placement of interim revegetation and was identified as a completed project in the 2005 FYRR.

An ESD for South Plants Balance of Areas and Central Processing Area Soil Remediation project (FWENC 2000a) documents and provides rationale for changes to the ROD-identified remedy for this project.

The changes to the South Plants remedy documented in the ESD are as follows:

- Removal of the requirement for a 1-ft cover in the South Plants Balance of Areas and replace with 1 ft of backfill
- Enhancement of construction standards for the South Plants Central Processing Area cover
- Removal of the requirement to excavate biota risk soil from under the South Plants Balance of Areas 3-ft cover area

As described in the ESD, an enhanced sampling program was conducted that included collection of 200 samples in addition to the ROD-required two samples per acre for a total of more than 600 samples over 208 acres. The ESD also required removal of all identified HHE soil and removal of all biota risk soil in the 1-ft backfill area.

As noted above, the South Plants Balance of Areas and South Plants Central Processing Area Soil Remediation project was separated into two phases (Phase 1 and Phase 2) during the design development. This section discusses Part 1 and Part 2 of Phase 2.

Phase 2, Part 1 included remediation of HHE and biota risk soil as part of cover subgrade construction. In accordance with the ROD, HHE located in the South Plants Central Processing Area were excavated to a maximum depth of 5 ft below grade and removed. HHE located in the South Plants Balance of Areas was excavated to a maximum depth of 10 ft below grade and removed. Prior to the conclusion of Phase 2, Part 1 it was determined that final subgrade contours required recontouring, and as a result, final subgrade contours were not achieved during Phase 2, Part 1.

Phase 2, Part 2 was developed for the completion of recontour work to achieve final subgrade contours. During implementation of Phase 2, Part 2, interim subgrade boundaries and contours were approved to allow continued use of 7th Avenue for access to Building 312 and also to improve surface water drainage during the interim period between subgrade and cover construction.

South Plants Soils Phase 2 project is comprised of the following 25 ROD-identified sites: SPSA-1A, SPSA-1G, SPSA-2A, SPSA-2B, SPSA-2C, SPSA-2D, SPSA-2E, SPSA-3A, SPSA-3C, SPSA-3E, SPSA-4A, SPSA-4B, SPSA-5B, SPSA-6, SPSA-7A, SPSA-7B, SPSA-7C, SPSA-8A, SPSA-8B, SPSA-8C, SPSA-9A, SPSA-9B, SPSA-10, SPSA-11, and SPSA-12c.

Remediation at the 25 sites involved excavation of HHE soil, biota risk soil, munitions debris soil, agent screening, MEC clearance, excavation and/or grouting of chemical sewers, demolition of one structure and foundations, hazardous material abatement, removal of underground storage tanks and removal or grouting of underground storage tank-associated piping, placement of backfill and gradefill to soil cover subgrade elevations, monitoring well abandonment, monitoring well lowering and extension, and placement of temporary revegetation. Process water lines and sanitary sewers were excavated and grouted when encountered during excavation. The HHE soil was transported to the HWL for disposal. Biota risk soil was consolidated within the South Plants soil cover boundary.

Foundations remaining from structures demolition were addressed consistent with the On-Post ROD requirements and detail provided in the South Plants Phase 2 design. All foundations from the Agent History Group structures were removed and disposed in the HWL. Foundations located within the South Plants cover areas were cracked and left in place unless removal was required where contaminated soil was located beneath the foundations. All foundations located outside the cover areas were removed. Foundations from the Significant Contamination History Group structures were disposed in the HWL. Foundations from the Other Contamination History Group were removed and used as backfill/gradefill within the South Plants cover areas or were disposed in Basin A.

Disposal of contaminated soil and debris in the HWL was documented using a waste tracking system as specified in RWMP (TtEC 2006i). During Phase 2, Part 1, 155,727 bcy of contaminated soil was disposed in the HWL and approximately 344,533 bcy of biota risk soil was consolidated within the South Plants soil cover boundary.

To meet requirements of the On-Post ROD, a confirmatory sampling program was developed for implementation projects to determine whether contingent soils would be excavated. Accordingly, following excavation of design volumes during the project, 96 confirmatory soil samples were collected during Phase 2, Part 1, and approximately 31,332 bcy of CSV was excavated based on the sample results. One confirmatory sample was collected during Phase 2, Part 2 and no CSV was excavated. All soils removed were verified by pre- and post-excavation surveys.

Personal health and safety sampling and analysis was performed in accordance with the NIOSH Manual of Analytical Methods. The integrated sampling results indicated that there were no action levels exceeded requiring PPE upgrade during either phase. Real-time air monitoring,

however, conducted outside of the exclusion zone on April 11, 2002, did indicate an exceedance of the DBCP action level that required upgrading of the PPE in this area and incorporation of this area into the exclusion zone.

During Phase 2, Part 2 implementation, air and odor monitoring were conducted in accordance with site-wide air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not met or exceeded during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the Phase 2, Part 2 project met ROD remediation goals for the control of air emissions. The air quality remedy components of the Phase 2, Part 1 project implementation were discussed in the 2005 FYRR.

Temporary seeding was placed on all South Plants Balance of Areas and Central Processing Area—Phase 2, Part 1, sites in the interim period prior to subgrade recontouring. Permanent revegetation of the project area was not required or performed as part of this project. Required revegetation was performed as part of the ICS project (see Section 4.2.1.3).

As documented in the South Plants Balance of Areas and Central Processing Area Soil Remediation Phase 2, Part 1 and Part 2 CCR (TtEC 2009v), remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. This soil remediation phase of the project does not require any long-term O&M. Long-term O&M is required for the required covers, however. Cover construction will be documented in a future CCR. The property involved in this project and the waste left in place will be subject to evaluation in future FYRs. The EPA approved the CCR on January 19, 2010.

4.2.3.12 Sanitary Sewer Manhole Plugging Project Phase II (#35)

The selected remedy in the On-Post ROD for the Sanitary Sewers component of the soil remedy requires:

> *Sanitary/Process Water Sewers—Void space inside sewer manholes is plugged with a concrete mixture to prohibit access and eliminate the manholes as a potential migration pathway for contaminated groundwater. Aboveground warning signs are posted every 1,000 ft along the sewer lines to indicate their location underground.*

The ROD remediation standards that apply to the project include:

> *Interrupt exposure pathway by permanently plugging all sanitary sewer manholes.*
>
> *Meet air quality and odor standards that are ARARs.*

The ROD goals that apply to the project include the following:

> *Control emissions, as necessary, during remediation.*

> *Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.*

The Phase II Sanitary Sewer Manhole Plugging project is comprised of one SAR site and one non-SAR site as follows:

- Western Study Area-7A located in Sections 3, 4, and 34
- Non-SAR Site located in Section 35

Remediation at the two sites involved plugging the void space with concrete inside 50 sanitary sewer manholes and installation of five sanitary sewer pipeline markers. Plugged manholes and sanitary sewer pipeline markers each were installed with one engraved brass monument and one flexible warning marker. Remediation of the Phase II Sanitary Sewer Manhole Plugging project was carried out during summer 2008. The final construction inspection was held on August 12, 2008.

No waste was generated during the project that required disposal in the on-site disposal facilities. Sanitary sewer manhole covers were sent off site to a scrap metal recycler and concrete waste and washout material was recycled in accordance with the project design. No COCs were identified during the Phase II Sanitary Sewer Manhole Plugging project design (TtEC 2007j). No confirmatory samples were collected during the project and no CSV was identified for excavation.

Personal health and safety sampling and analysis was performed in accordance with the NIOSH Manual of Analytical Methods. The results indicated that there were no action levels exceeded requiring PPE upgrade during the Phase II Sanitary Sewer Manhole Plugging project.

Air and odor monitoring were conducted in accordance with site-wide air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not met or exceeded during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the project met ROD remediation goals for the control of air emissions.

No significant disturbance to vegetation occurred during remediation of the Phase II Sanitary Sewer Manhole Plugging II project. As a result, no revegetation activities were required during the project.

No caps, covers, or treatment facilities are required by the ROD for this remediation project, so no long-term O&M is required. Inspections of the plugged sanitary sewers, brass monuments, and warning system markers, however, will be performed as part of the CERCLA FYR process. Details of these inspections will be provided in the Long-Term Environmental Management System that is being developed for post-remediation activities.

As documented in the CCR (TtEC 2008k) remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the

environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. This project does not require any long-term O&M. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs. The EPA approved the CCR on February 17, 2009.

During fall 2009, an inspection was conducted to confirm the presence of aboveground markers along the abandoned sanitary sewer line as part of the FY09 land use control monitoring effort. The inspection included segments of sewer addressed during Phase 1 (discussed in the 2000 FYRR) and Phase 2 of the project. Observations recorded during the inspection included missing or broken markers at several locations, lack of markers along one segment of abandoned sewer, and an exposed sewer pipe in Section 35. This is identified as an issue in Section 8.0 of this report.

4.2.3.13 Section 36 Balance of Areas Soil Remediation Parts 1 and 2 (#36)

The selected remedy in the On-Post ROD for the Section 36 Balance of Areas component of the soil remedy requires:

> *Excavation and landfill of human health exceedance soil and UXO debris and excavation and consolidation to Basin A of soil posing a potential risk to biota. The consolidated material is contained under the Basin A cover and the human health excavation area is backfilled with on-post borrow material. Prior to excavation, a geophysical survey is conducted to locate potential UXO. Any UXO encountered will be excavated and transported off post for detonation (unless the UXO is unstable and must be detonated on post) or other demilitarization process. Caustic washing and landfill of any agent-contaminated soil found during monitoring. The former human health exceedance area is covered with a 2-ft-thick soil cover and the former potential risk to biota area is covered with a 1-ft-thick soil cover.*

The selected remedy in the On-Post ROD for the Chemical Sewers component of the soil remedy requires:

> *For sewers located outside the South Plants Central Processing Area and Complex Trenches areas, sewer lines and principal threat and human health exceedance soil are excavated and landfilled. Any agent-contaminated soil found during monitoring is caustic washed and landfilled. Prior to excavation of exceedance soil, overburden is removed and set aside. The excavated area is backfilled with on-post borrow material and the overburden replaced.*

The selected remedy in the On-Post ROD for the Ditches/Drainage Areas component of the soil remedy requires:

> *Excavation and consolidation to Basin A of soil posing a potential risk to biota. The consolidated material is contained under the Basin A cover. The excavated area is backfilled with on-post borrow material.*

The selected remedy in the On-Post ROD for the Surficial Soil component of the soil remedy requires:

> *Excavation and landfill of human health exceedance soil and excavation and consolidation to Basin A . . . of and soil posing a potential risk to biota from this medium group . . . The consolidated material is contained under the Basin A cover . . . and the human health exceedance area is backfilled.*

The selected remedy in the On-Post ROD for revegetation is:

> *Remedy components for all sites include reconditioning the surface soil and revegetating areas disturbed during remediation with locally adapted perennial vegetation.*

The Section 36 Balance of Areas Soil Remediation included demolition of structures. The RAOs and selected remedy in the On-Post ROD for the structures medium group are presented in Section 4.3.

The ROD remediation standards that apply to the project include:

- *Identify, transport off-post, neutralize, and destroy explosives/explosive residue.*
- *Ensure excavation of all identified . . . munitions debris and disposal in the on-post RCRA landfill.*
- *Excavate all contaminated soil identified in the ROD for treatment, landfilling, or consolidation that corresponds to the areal and vertical extent detailed by the soil volume calculations in the administrative record.*
- *Interrupt exposure pathway by permanently plugging all chemical sewer lines and manholes not excavated.*
- *Certify 3X decontamination or caustic wash of soil and structural debris to achieve 3X decontamination.*
- *Ensure disposal of 3X-decontaminated soil and structural debris in the on-post RCRA landfill.*
- *Meet air quality and odor standards that are ARARs.*

The ROD goals that apply to the project include the following:

- *Control emissions, as necessary, during remediation.*
- *Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.*

The sites included in the Section 36 Balance of Areas include CSA-1b, CSA-2a, CSA-4, NCSA-1g, CSA-3, NCSA-6b, NCSA-6a, CSA-2b, NCSA-1c, NCSA-1f, NCSA-1d, surficial soil exceedance sites, Priority 1 Soil Sites, a Priority 2 Soil Site, CSA-1d, and the Complex (Army) Disposal Trenches Priority 1 Soil Site.

During the design of this project, new information obtained from detailed review of project documents and additional soil sampling resulted in changes proposed by the Army to the chemical sewer excavation, specific cover requirements, and excavation volumes. The remedy

changes were detailed in an ESD (FWENC 2003b). The changes enhanced the effectiveness of the remedy, but did not alter the overall hazardous waste management approach that was selected in the On-Post ROD. The combined changes to the remedy were:

- Adding four chemical sewer lines not identified in the On-Post ROD to be excavated and disposed in the HWL.
- Reducing the extent of soil excavation associated with the chemical sewers removal since analysis of soil samples taken adjacent to existing and previously removed sewer lines did not indicate HHE soil remaining in place with the exception of portions of line 1. Verification sampling was conducted to ensure no HHE soil remained in place.
- Deleting the requirement for the ROD-identified 1-ft and 2-ft soil covers based on design soil sampling and a requirement to excavate all contaminated soil identified during design or post-excavation sampling. Portions of the ROD-identified 1-ft and 2-ft soil cover area were later identified for soil cover construction under the Shell Disposal Trenches and South Plants Central Processing Area projects.
- Documenting changes to project remediation boundaries and volumes.

As a result, remediation at these sites included:

- Removal of HHE soil, On-Post ROD designated potentially agent-contaminated soils, and munitions debris and associated soils and disposal in the HWL
- Removal of biota risk soil, Priority 1 soil, and debris piles and disposal in Basin A
- Plugging and/or removal of chemical sewer lines and designated HHE soil and disposal in the HWL
- Removal of a length of the freeze protection berm, underlying biota risk and Priority 1 soil, and utilities associated with the Complex (Army) Disposal Trenches groundwater extraction system with the disposal of the biota risk soil, Priority 1 soil, freeze protection berm, electrical line, and communication line in Basin A and disposal of the of the pipe used to convey the contaminated groundwater in the HWL
- Demolition of several above- and belowground structures and miscellaneous items and disposal in either the Basin A or the HWL
- Backfill of HHE and chemical sewer excavations, and structures demolition areas
- Ripping Priority 2 soil areas
- Revegetation in accordance with the ROD requirements

In addition, during implementation of the Section 36 Balance of Areas project, field observations of stained and odorous soils and post-excavation sampling results suggested that all contaminated soil could not be reliably located and removed as required by the ESD. A portion of the Section 36 Balance of Areas project area adjacent to the Shell Disposal Trenches, where stains and odors were observed, has therefore been transferred to the Shell Disposal Trenches project for remedy completion. This portion of the revised remedy, now a part of the Shell Disposal Trenches project, is documented in the ESD for the Shell Disposal Trenches Project. The ESD for Section 36 Balance of Areas Project Implementation (TtEC 2009h) summarized

modifications to the remedy for the Section 36 Balance of Areas Project that resulted from new information gathered during the remediation phase of the project. These remedy modifications included the removal of specific portions of the project for transfer to adjacent Implementation Projects and subsequent expansion of covers over those transferred areas.

Disposal of contaminated soil, munitions debris, and associated soil, On-Post ROD-designated potentially agent-contaminated soil, and miscellaneous debris was documented using a waste tracking system as specified in the RWMP (TtEC 2006i). Contaminated soil excavated and disposed under Parts 1 and 2 included 128,911 cy of HHE soil; 2,318 cy of CSV; 264,047 cy of biota risk soil; 101,596 cy of Priority 1 soil; 14,575 cy Terrestrial Residual Ecological Risk soil; 61,679 cy of munitions debris soil; 145 cy of miscellaneous soils; and 871 cy of Demolition Debris.

During project implementation, in an effort to ensure protectiveness, evaluation of isolated detections of contaminants located at greater depths was performed. This effort identified soils exceeding acute site evaluation criteria that, in the absence of additional ICs, warranted remediation. As a result, excavation of this soil and disposal in the HWL was incorporated into this project.

Personal health and safety sampling and analysis was performed in accordance with the NIOSH Manual of Analytical Methods. In two instances during the implementation of this project permissible exposure limits were exceeded, once for respirable dust and once for respirable quartz. In each instance engineering controls and respiratory PPE were reviewed and where appropriate, modified.

Air and odor monitoring were conducted in accordance with site-wide air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not met or exceeded during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the project met ROD remediation goals for the control of air emissions.

Permanent revegetation within the AMA was performed using a permanent seed mixture of native prairie grasslands.

The USFWS is responsible for permanent revegetation in areas outside the AMA that were not permanently revegetated as part of this project. Part of the project area (disturbed areas east of E St.) was permanently revegetated in 2007. The USFWS has certified in two letters to the EPA that the requirements of the ESD for Groundwater Remediation and Revegetation Requirements (TtEC 2006c) have been met and the areas outside the AMA will be restored to achieve the statutory purposes of the Refuge to the satisfaction of the USFWS. All areas referenced in these two letters have been permanently revegetated; part in fall 2009 and the remainder in spring 2010.

As documented in the CCRs (TtEC 2009s, 2009t), remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the

environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. No caps, covers, or treatment facilities are required by the ROD for this remediation project, so no long-term O&M is required. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs. The EPA approved the two CCRs: Part 1 was approved May 5, 2009; Part 2 was approved February 22, 2010.

4.2.3.14 Secondary Basins Soil Remediation, NCSA-2d (Basin B Drainage Ditch) Contingent Soil Volume (#37)

The selected remedy in the On-Post ROD for the Basin B Drainage Ditch (Sand Creek Lateral medium group) component of the soil remedy requires:

> *Excavation and landfill of human health exceedance soil and excavation and consolidation to Basin A of soil posing a potential risk to biota. The consolidated material is contained under the Basin A cover. The excavated area is backfilled with on-post borrow material.*

The ROD remediation standards that apply to the project include:

> *Excavate all contaminated soil identified in the ROD for treatment, landfilling, or consolidation that corresponds to the areal and vertical extent detailed by the soil volume calculations in the administrative record.*
>
> *Meet air quality and odor standards that are ARARs.*

The ROD remediation goals that apply to the project include:

> *Control emissions, as necessary, during remediation.*
>
> *Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.*

The Secondary Basins Soil Remediation project is comprised of the following seven sites: Basin C (NCSA-2a), Basin D (NCSA-2b), Basin B Drainage Ditches (NCSA-2d), Basin F Exterior Biota Surficial Soil (NCSA-4b), HHE Surficial Soil, Section 26 Biota Surficial Soil, and Priority 1 Surficial Soil.

The original Secondary Basins Soil Remediation project addressed remediation of HHE and biota soils within Basins C and D and areas adjacent to these basins, including five ditch segments (collectively identified as NCSA-2d: Basin B Drainage Ditches). All remediation required by the Secondary Basins Soil Remediation project 100 percent design was completed between April 2001 and February 2003, as documented in the Secondary Basins Soil Remediation project CCR (TtEC 2009r).

In May 2007, additional confirmatory sampling was conducted at various locations throughout the RMA. This sampling was being conducted as a result of an EPA review of ditches at RMA that concluded that aerial photography evidence existed indicating that at least one of the NCSA-2d sites (ditch B-2) had been dredged or cleaned out in the past; that the dredging activity had not been known at the time of the ROD; and that sample locations were selected in areas where

spoil piles had been observed on the aerial photographs. One of eight confirmatory samples taken within SAR site NCSA-2d indicated that surface soil in a portion of one ditch exceeded HHE soil contamination criteria. In addition, this sample location that exceeded HHE criteria exhibited odors and was in an area containing visible brick debris. A CSV removal area was delineated with concurrence from the Regulatory Agencies. An area around the exceedance sample location was delineated where debris, visual staining, and some odor were observed. An EPA representative observed the delineated area and noted other debris outside the area, so the following note was added to the CSV tracking form: "Minimum 1-foot excavation. Excavation continues to remove all visible debris and stained soil."

The work at the NCSA-2d CSV site involved excavation of HHE soil to a minimum depth of 1 ft in an area encompassing 1,852.5 square ft. Thus, a minimum of 69 cy of HHE soil was to be removed along with any visible debris or stained soil. This initial 69 cy, plus nearly 2,168 cy of additional debris and soil (total of 2,237 cy of CSV), was excavated and disposed in the ELF. The excavation area was backfilled with soils from the southeast Basin F perimeter area. The epilogue at the end of the Executive Summary and Section 1.0 present a description of additional actions related to this backfill.

Air and odor monitoring were conducted in accordance with site-wide air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not met or exceeded during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the project met ROD remediation goals for the control of air emissions.

Remediation of the NCSA-2d CSV site was carried out during the winter of 2007/2008.

The USFWS performed revegetation in April 2008.

As documented in the CCR (TtEC 2009r), remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. No caps, covers, or treatment facilities are required by the ROD for this remediation project, so no long-term O&M is required. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs. The EPA approved the CCR on June 11, 2009. Nonetheless, remediation activities at this site were not final, as described below.

In May 2008, after completion of the Secondary Basins NCSA-2d CSV project, concern was raised about the potential for residual contamination in the soils being excavated from the perimeter of Basin F due to the use and contamination history of areas around the perimeter of Basin F and that the perimeter of Basin F was not an approved borrow source. Some of these soils had been used to backfill the NCSA-2d CSV excavation. Because of these concerns, the RVO agreed to sample the topsoil stockpiles, the backfill placed in NCSA-2d, and the final perimeter surface outside Basin F.

The result of the sampling and analysis indicated that the backfill placed in the NCSA-2d CSV excavation contained contamination and posed Residual Ecological Risk and had a hazard quotient (HQ) of 12.9. Because soil with an HQ greater than 10 cannot be used as common fill outside AMAs, and this site will not remain within Army-retained areas, it was agreed that the backfill would be removed and replaced with soil from Borrow Area 3.

Removal of the Residual Ecological Risk backfill and replacement of the backfill was carried out during fall 2008 as part of the Basin F Cover project. The Basin F Cover project CCR will document the Residual Ecological Risk soil removal from this site because implementation was performed as part of the Basin F Cover construction project.

4.2.3.15 Complex (Army) Disposal Trenches Subgrade Construction (#38)

The applicable portion of the selected remedy in the On-Post ROD for Complex Trenches requires:

> *Construction of a RCRA-equivalent cap, including a 6-inch-thick layer of concrete, over the entire site.*

Although the RCRA-equivalent cover construction is being completed as part of the ICS project, discussed in Section 4.2.1.3, subgrade construction was completed and documented separately.

The ROD remediation standards that apply to the project include:

> *Identify, transport off-post, neutralize, and destroy explosives/explosive residue.*
>
> *Excavate all contaminated soil identified in the ROD for treatment, landfilling, or consolidation that corresponds to the areal and vertical extent detailed by the soil volume calculations in the administrative record.*
>
> *Meet air quality and odor standards that are ARARs.*

The ROD remediation goals that apply to the project include:

> *Control emissions, as necessary, during remediation.*
>
> *Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.*

Performance of the Complex (Army) Trenches Subgrade Construction project was carried out during the fall and winter 2005 and the spring and summer 2006.

After completion of subgrade construction the final surface was track walked, in lieu of temporary revegetation, to reduce erosion between the time of subgrade completion and construction of the RCRA-equivalent cover.

All modifications to the approved design package drawings and specifications (TtEC 2005c) were documented in the project files through approved DCNs.

Due to the nature of this project there was no excavation of contaminated soil.

No CSV removal occurred during the Complex (Army) Trenches Subgrade Construction project. Two confirmatory soil samples were collected in Section 3, during railroad ballast removal to be used as gradefill material, and the results identified no CSV for excavation.

Personal health and safety sampling and analysis was performed in accordance with the NIOSH Manual of Analytical Methods. The results indicated that there were no action levels exceeded that would require PPE upgrade during the Complex (Army) Trenches Subgrade Construction project.

Air and odor monitoring were conducted in accordance with site-wide air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not met or exceeded during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the project met ROD remediation goals for the control of air emissions.

The Pre-Final and Final Inspections were conducted in conjunction with representatives of the PMC Project Team and RVO.

The property involved in this project is subject to restrictions on land and water use because waste will be left in place and therefore, a RCRA-equivalent cover will be constructed over the subgrade and will be included in the RMA-wide FYRs of remedial action.

As documented in the CCR (TtEC 2008d), the construction of this phase of the project has been completed. As a construction project this portion of the selected remedy is not subject to long-term O&M. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs. The EPA approved the CCR on July 17, 2008.

4.2.3.16 Miscellaneous Southern Tier Soil Remediation, Sand Creek Lateral (#27) and Section 35 Soil Remediation, Sand Creek Lateral (#41)

The selected remedy in the On-Post ROD for the Sand Creek Lateral component of the soil remedy requires:

> *Excavation and landfill of human health exceedance soil and excavation and consolidation to Basin A of soil posing a potential risk to biota. The consolidated material is contained under the Basin A cover. The excavated area is backfilled with on-post borrow material.*

The selected remedy in the On-Post ROD for the Ditches/Drainage Areas component of the soil remedy requires:

> *Excavation and consolidation to Basin A of soil posing a potential risk to biota. The consolidated material is contained under the Basin A cover. The excavated area is backfilled with on-post borrow material.*

The selected remedy in the On-Post ROD for revegetation is:

Remedy components for all sites include reconditioning the surface soil and revegetating areas disturbed during remediation with locally adapted perennial vegetation.

The ROD remediation standards that apply to the projects include the following:

Excavate all contaminated soil identified in the ROD for treatment, landfilling, or consolidation that corresponds to the areal and vertical extent detailed by the soil volume calculations in the administrative record.

Meet air quality and odor standards that are ARARs.

The ROD remediation goals that apply to the project include:

Control emissions, as necessary, during remediation.

Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.

Efforts in 2004 related to characterization of terrestrial ecological risks led to the discovery of contaminated soils associated with historical operation of the Sand Creek Lateral. Based upon review of aerial photographs, it appeared that in the 1950s the Army dredged the Sand Creek Lateral and placed the spoils on the southwestern or western bank. Subsequently, parts of the Sand Creek Lateral that were remediated as part of the Miscellaneous Southern Tier and Section 35 Remediation projects became recontaminated because the spoils and the bank of Sand Creek Lateral were used as backfill. These spoils contained concentrations of aldrin and dieldrin at HHE and biota risk levels, warranting additional characterization and remediation.

Analytical results from sampling along the Sand Creek Lateral showed contamination was present along the banks of the Sand Creek Lateral in both Section 2 and Section 35. Given the discovery of contamination along the banks of the Sand Creek Lateral, a review of other ditches was performed to determine whether similar conditions were evident. Aerial photographs were reviewed to look for evidence of dredging or other activities that might have resulted in additional areas of contamination. Several ditches from the original Section 35 Soil Remediation project, comprising ditch site NCSA-5b, were identified as potential candidates. Sampling conducted along the banks of these ditches resulted in delineation of two additional areas of HHE soil.

Sampling along the banks of Sand Creek Lateral in 2005 resulted in additional contaminated soil being identified, requiring the removal of contaminated soil from three SAR sites (SSA-2b, NCSA-5b, and NCSA-5c). The removal of contaminated soil was incorporated into the Miscellaneous Southern Tier Soil and Section 35 Soil Remediation projects via approved DCNs. In 2006 additional sampling resulted in the excavation of biota risk soil from two areas in SAR site SSA-2a. This removal action was incorporated into the Miscellaneous Southern Tier Soil project via an approved DCN.

Remediation at the Miscellaneous Southern Tier Soil and Section 35 project sites involved excavation of both HHE and biota risk soils, sanitary sewer removal, backfilling, and/or regrading. All design and CSV HHE soil and associated miscellaneous debris was transported to the HWL and ELF, and all design and CSV biota risk soil and associated miscellaneous debris was disposed in Basin A.

Remediation of the Miscellaneous Southern Tier Soil and Section 35 projects was executed from January 2006 through the end of 2006.

All modifications to the approved design package drawings and specifications were documented in the project files through approved DCNs.

Disposal of contaminated soil and miscellaneous debris was documented using a waste tracking system as specified in the RWMP (TtEC 2006i). A total of 65,640 bcy of HHE soil was disposed in the HWL/ELF during the course of this project, and 95,962 bcy of biota risk soil was disposed in the Basin A Notch.

Twenty-eight confirmatory samples were collected during the Miscellaneous Southern Tier Soil project. Nine confirmation samples were collected during the Section 35 project. The confirmatory samples resulted in approximately 5,796 bcy of CSV being excavated from the Miscellaneous Southern Tier Soil sites and 864 bcy of CSV excavated from Section 35 sites, based on the exceedance samples results.

Air and odor monitoring were conducted in accordance with site-wide air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not met or exceeded during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the project met ROD remediation goals for the control of air emissions.

The USFWS is responsible for permanent revegetation in all areas that were part of this project. Permanent seeding was placed by the USFWS on the southern portion of NSCA-5c site in 2006. The remaining area of NCSA-5c and all of NCSA-5b, SSA-2a, and SSA-2b will be revegetated by the USFWS. The USFWS has certified in two letters to the EPA that the requirements of the ESD for Groundwater Remediation and Revegetation Requirements (TtEC 2006c) have been met and the areas outside the AMA will be restored to achieve the statutory purposes of the Refuge to the satisfaction of the USFWS.

As documented in the CCR (TtEC 2008j), remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. No caps, covers, or treatment facilities are required by the ROD for this remediation project, therefore no long-term O&M is required. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs. The EPA approved the CCR on September 2, 2008.

4.2.3.17 Basin F Wastepile Remediation (#43)

The selected remedy in the On-Post ROD for the Basin F Wastepile component of the soil remedy requires:

> *Excavation of approximately 600,000 BCY of principal threat soil and liner materials from the wastepile and containment in dedicated triple-lined landfill cells at the on-post hazardous waste landfill facility. Excavation is conducted using vapor- and odor-suppression measures as necessary. If the wastepile soil fails EPA's paint filter test, the moisture content of the soil will be reduced to acceptable levels by using a dryer in an enclosed structure. Any volatile organics (and possibly some semivolatile organics) released from the soil during the drying process are captured and treated; however, the main objective of this process is drying. Prior to excavation of the wastepile, overburden from the existing cover is removed and set aside. The excavation area is backfilled with on-post borrow material and stockpiled overburden.*

The ROD remediation standards that apply to the project include the following:

> *Excavate all contaminated soil identified in the ROD for treatment, landfilling, or consolidation that corresponds to the areal and vertical extent detailed by the soil volume calculations in the administrative record.*
>
> *Ensure dried material passes EPA paint filter test.*
>
> *Comply with requirements of Basin F closure plan and design documents.*
>
> *Control emissions and odors for Basin F Wastepile excavation and Former Basin F remediation, in accordance with Basin F closure plan and design documents.*
>
> *Meet air quality and odor standards that are ARARs.*

The ROD goals that apply to the project include the following:

> *Control emissions, as necessary, during remediation.*
>
> *Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.*

Remediation of the Basin F Wastepile involved excavation of HHE soil; demolition of several aboveground structures; disposal of leachate, contaminated stormwater, and decontamination water; and backfilling and/or regrading. Though referred to as HHE soils throughout this report, the soils within the Wastepile were designated in the On-Post ROD as Principal Threat soil, a specific category of HHE soil having an additional cancer risk of 1 in 1,000 and/or increased risk of chronic health effects. All HHE soils and debris were transported to the on-site RMA ELF. Remediation of the Basin F Wastepile project was carried out from the fall 2005 through summer 2007.

All modifications to the approved design package drawings and specifications (FWENC 2003a) were documented in the project files through approved DCNs.

Disposal of contaminated soil and miscellaneous debris was documented using a waste tracking system as specified in the RWMP (TtEC 2006i) A total of 487,148 bcy of contaminated soil was disposed in the ELF during the course of this project.

A sludge management and drying facility was constructed to process any Basin F Wastepile material determined to contain excess moisture. Construction and commissioning of the drying facility was performed in accordance with the approved design package drawings and specifications.

The Basin F Wastepile Drying Facility was not used to dry any wet Basin F Wastepile material. However, 1 to 2 cy of decontamination solids were dried in the facility on a few occasions. The building was predominately used to store odor-control foam product and equipment. A few pieces of equipment were decontaminated inside the facility. The liquid generated drained to the slab low-point and was collected and transferred to the leachate storage tank.

A CSV tracking form was used to identify, document, track, and record approvals for CSV for the Basin F Wastepile remediation sites. Sixteen confirmatory soil samples were collected during this project; no CSV soil was excavated based on the sample results. Approximately 2,248 bcy of non-CSV-stained soil, including subcell sump overexcavation, was excavated based on visual observation.

Personal health and safety sampling and analysis was performed in accordance with the NIOSH Manual of Analytical Methods. The results indicated that there were no action levels exceeded that would require PPE upgrade during the Basin F Wastepile Remediation project.

Air and odor monitoring were conducted in accordance with site-wide and project-specific air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not exceeded at the RMA fenceline during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the project met ROD remediation goals for the control of air emissions.

Permanent revegetation of the project area was not required or performed as part of this project. Required revegetation was performed as part of the Basin F Cover Construction (see Section 4.2.1.5).

As documented in the CCR (TtEC 2008c), remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. This soil remediation phase of the project does not require any long-term O&M. Long-term O&M is required for the required cover, however. Cover construction will be documented in a future CCR. The property involved in this project and the waste left in place will be subject to evaluation in future FYRs. The EPA approved the CCR on June 11, 2009.

4.2.3.18 Former Basin F Principal Threat Soil Remediation (#44)

The selected remedy in the On-Post ROD for the Former Basin F component of the soil remedy requires:

> *In-situ solidification/stabilization of principal threat volume (190,000 bcy); construct RCRA-equivalent cap over entire site (including Basin F Wastepile footprint).*

A change in the ROD-selected remedy for the Lime Basins also led to selection of a new remedy for the Basin F Principal Threat soils. Based on the comparative analysis presented in the amendment to the On-Post ROD for Section 36 Lime Basins and Former Basin F, the selected remedial alternative for Basin F Principal Threat soils was changed from solidification to excavation and disposal in the ELF.

The ROD remediation standards that apply to the project include the following:

> *Excavate all contaminated soil identified in the ROD for treatment, landfilling or consolidation that corresponds to the areal and vertical extent detailed by the soil volume calculations in the administrative record.*
>
> *Ensure dried material passes EPA paint filter test.*
>
> *Comply with requirements of Basin F Closure Plan and design documents.*
>
> *Control emissions and odors for Basin F Wastepile excavation and Former Basin F remediation, in accordance with Basin F closure plan and design documents.*
>
> *Meet air quality and odor standards that are ARARs.*
>
> *Demolish and remove the existing Basin F Drying Facility and decontamination pad and landfill in the ELF.*

The ROD remediation goals that apply to the project include the following:

> *Control emissions, as necessary, during remediation.*
>
> *Control air emissions as necessary to meet criteria being developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.*

As part of the Basin F/Basin F Exterior—Part 1 design activities, the boundary of Basin F was modified to more accurately correspond to the historical limits of the basin. Soil samples were collected from areas between the ROD boundary and the modified boundary to justify the modification. Analytical results indicated no remediation-level contamination (all results were below detection limits for HHE and biota risk site evaluation criteria), except the southeastern corner and a single sub-chronic (acute) HHE exceedance near the northeastern basin limit. Analytical results in the southeastern corner led to reclassification of approximately 2.5 acres of ROD-classified Principal Threat soil to HHE soil that was transferred to the Basin F/Basin F Exterior Remediation—Part 1 project. This reclassification resulted in reducing the ROD-estimated Principal Threat soil volume from 191,000 bcy to the 165,000 bcy cited in the Amendment to the ROD for Section 36 Lime Basins and Former Basin F (TtEC 2005a).

The Basin F Principal Threat project involved the following:

- Excavation of Principal Threat soil from within Basin F and disposal of this soil in the ELF
- Excavation of HHE soil from within Basin F and the haul roads between Basin F and C Street to fill remaining ELF waste capacity
- Transfer of a portion of the IRA cover/overburden soil and a small quantity of soil adjacent to Basin F for placement within the select fill component of the ELF grading design
- Consolidation of additional contaminated soils within Basin F and non-contaminated soils from outside Basin F as gradefill placed within Basin F
- Remediation of Priority 1 soils in Borrow Area 4 and Terrestrial Residual Ecological Risk soil from two locations in Section 26 and consolidation of these soils as gradefill placed within Basin F
- Removal of other soils adjacent to Basin F and consolidation of these soils as gradefill placed within Basin F per Regulatory Agency request
- Additional backfill/gradefill placement within Basin F
- Demolition of the Basis F Drying Facility and other aboveground structures and disposal of these demolished structures in the ELF

Remediation of the Basin F Principal Threat project sites, including demolition of the Basin F Drying Facility, was carried out from July 2007 through early April 2008.

Disposal of contaminated soil and miscellaneous debris was documented as specified in the RWMP (TtEC 2006i). During the course of the project, 234,521 bcy of Principal Threat soil, 74,732 bcy of HHE soils selected by the Regulatory Agencies to fill remaining ELF capacity, and 18,539 bcy of IRA cover/overburden and other soil were placed as waste or gradefill in the ELF. The 74,732 bcy of HHE soils consisted of 69,984 bcy HHE CSV removed from Areas 1, 2, 5, and 6 and 4,748 bcy removed from haul roads.

All modifications to the approved Former Basin F Principal Threat Soil Remediation project 100 percent design package (TtEC 2007c) and Basin F Drying Facility Closure Plan drawings and specifications were documented in the project files through approved DCNs.

A CSV tracking form was used to identify, document, and track approvals for CSV for the Basin F Principal Threat remediation sites. Fifty-nine confirmatory soil samples and verification soil samples were collected during this project; approximately 12,152 bcy of CSV soil was excavated based on the sample results and disposed in the ELF. This volume included soil removed from HHE Area 6 (after the HHE Area 6 design volume was removed) and the haul road(s) between Basin F and the ELF. Additional CSV volume included 501 cy of Principal Threat soil identified in the design and 62,580 cy of HHE soil (designated by the design) removed to fill surplus ELF capacity.

Personal health and safety sampling and analysis was performed in accordance with the NIOSH Manual of Analytical Methods. The results indicated that there were no action levels exceeded requiring personal protective equipment upgrade during the Basin F Principal Threat Remediation project.

Air and odor monitoring were conducted in accordance with site-wide and project-specific air and odor monitoring plans as discussed in Section 6.3.4. Although project odor action levels at the RMA fenceline were exceeded for two brief periods on October 5, 2007, odor monitoring conducted after odor controls were implemented showed that the controls were effective in limiting additional impacts and no odor ARARs were exceeded. No off-site transport of fugitive dust was noted during project implementation. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria.

Revegetation activities were restricted to placement of soil amendments in the two Terrestrial Residual Ecological Risk sites. All other disturbed areas will be revegetated after completion of the Basin F RCRA-equivalent cover. Permanent revegetation of the project area was not required or performed as part of this project. Required revegetation of areas within the AMA was performed as part of the Basin F Cover Construction (see Section 4.2.1.5).

The USFWS is responsible for permanent revegetation in areas outside the AMA that were not permanently revegetated as part of this project. The USFWS has certified in a letter to the EPA that the requirements of the ESD for Groundwater Remediation and Revegetation Requirements (TtEC 2006c) have been met and that the areas outside the AMA will be restored to achieve the statutory purposes of the Refuge to the satisfaction of the USFWS.

The Final Report—Construction Quality Assurance for the Basin F Wastepile Drying Facility Closure (Golder 2008) was completed to document that the closure of the Basin F Drying Facility meets the approved plans and specification for the project (i.e., in accordance with the Basin F Drying Facility Closure Plan). This report was certified by the independent Construction Quality Assurance Engineer (CQAE), reviewed by the EPA, CDPHE, and TCHD, and approved by the CDPHE.

As documented in the CCR (TtEC 2009d), remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. This soil remediation phase of the project does not require any long-term O&M. Long term O&M is required for the required cover, however. Cover construction will be documented in a future CCR. The property involved in this project and the waste left in place will be subject to evaluation in future FYRs. The EPA approved the CCR on July 16, 2009.

4.2.3.19 Basin F/Basin F Exterior Remediation Part 1/Phase 1 (#45)

The selected remedy in the On-Post ROD for the Surficial Soil component of the Basin F and Basin F Exterior Remediation Phase 1 requires:

> *Excavation and landfill of human health exceedance soil and excavation and consolidation to Basin A of Former Basin F of soil posing a potential risk to biota*

> *from this medium group…. The consolidated material is contained under the Basin A cover or Basin F cap, and the human health exceedance area is backfilled.*

The selected remedy in the On-Post ROD for the Sand Creek Lateral component of the Basin F/Basin F Exterior Remediation requires:

> *Excavation and landfill of human health exceedance soil and excavation and consolidation to Basin A of soil posing a potential risk to biota. The consolidated material is contained under the Basin A cover. The excavated area is backfilled with on-post borrow material.*

The selected remedy in the On-Post ROD for revegetation is:

> *Remedy components for all sites include reconditioning the surface soil and revegetating areas disturbed during remediation with locally adapted perennial vegetation.*

The On-Post ROD remediation standards that apply to the project include:

> *Excavate all contaminated soil identified in the ROD for treatment, landfilling, or consolidation that corresponds to the areal and vertical extent detailed by the soil volume calculations in the Administrative Record.*
>
> *Control emissions and odors for Basin F Wastepile excavation and Former Basin F remediation, in accordance with Basin F closure plan and design documents.*
>
> *Meet air quality and odor standards that are ARARs.*

The On-Post ROD goals that apply to the project include the following:

> *Control emissions, as necessary, during remediation.*
>
> *Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.*

The Basin F/Basin F Exterior Remediation project, as identified in the On-Post ROD and other documents, included excavation of HHE and biota risk soils outside Basin F and construction of a RCRA-equivalent cover over the Basin F area. The Basin F/Basin F Exterior Remediation project was separated into two designs (Part 1 and Part 2). The design for the Part 1 Basin F/Basin F Exterior Remediation project addressed remediation of remaining HHE and biota risk soils outside Basin F. The Part 2 Basin F/Basin F Exterior Remediation project addressed the RCRA-equivalent cover to be constructed over the Basin F area.

The Basin F Exterior Remediation project—Part 1 was executed in two phases: Phase 1 implementation was performed in 2002 and completed the removal of all HHE soils and biota risk soils not destined for consolidation within Basin F, as described here. Phase 2 of the Basin F Exterior Remediation project is described in the next section.

The Basin F Exterior Remediation project—Part 1 is comprised of three sites: Deep Well Injection Site (NCSA-4a), Basin F Exterior Soil Site (NCSA-4b), and Sand Creek Lateral Site (NCSA-5c). Part 2 included additional biota risk soil removal from NCSA-4b and construction of a RCRA-equivalent cover over Former Basin F.

Remediation at the three sites involved excavation of HHE and biota risk soils, demolition of subgrade structures encountered during excavation (e.g., footers, headwalls, manholes, vitrified clay pipe), backfilling and regrading, and surface revegetation. Biota risk soil and debris were disposed in Basin A or the HWL. All HHE soil and debris were transported to the HWL for disposal. The design allowed disposal of specific areas of biota risk soil in the HWL. This exception was intended to streamline constructability by allowing biota risk soil and HHE soil to be commingled during excavation of irregular shapes within contiguous HHE and biota risk soil excavations.

During project implementation, in an effort to ensure protectiveness, evaluation of isolated detections of contaminants located at greater depths was performed. This effort identified soils exceeding acute site evaluation criteria that, in the absence of additional ICs, warranted remediation. As a result, excavation of this soil as CSV and disposal in the HWL was incorporated into this project.

Disposal of contaminated soil was documented using a waste tracking system as specified in the RWMP (TtEC 2006i). A total of 168,424 bcy of contaminated soil was disposed in the HWL during the course of this project. This soil included 129,449 bcy of HHE soil; 7,990 bcy of biota risk soil; 18,955 bcy of CSV; and 12,030 bcy of additional soil removed at the direction of the Regulatory Agencies. The Regulatory Agencies directed the removal of CSV and the additional soil based on confirmatory sample results, odor, and soil staining. The 12,030 bcy of additional soil identified for removal by the Regulatory Agencies was located within the ROD-defined limits of Former Basin F and therefore not considered CSV. Approximately 73,368 bcy of biota risk soil was disposed in Basin A.

To meet requirements of the On-Post ROD, a confirmatory sampling program has been developed for implementation projects to determine whether contingent soils will be excavated. Accordingly, following excavation of design volumes during the project, 72 confirmatory soil samples were collected during the project and 18,955 bcy of CSV was excavated based on the sample results. All soils removed were verified by pre-and post-excavation surveys.

The project sites were seeded with locally adapted perennial vegetation upon completion of the remediation activities.

Personal health and safety sampling and analysis was performed in accordance with the NIOSH Manual of Analytical Methods. The results indicated that there were no action levels exceeded that would require PPE upgrade during Part 1 of the Basin F Exterior Remediation project.

Air and odor monitoring were conducted in accordance with site-wide air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not met or exceeded during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring

conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the project met ROD remediation goals for the control of air emissions.

As documented in the CCR (TtEC 2005b), remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. No caps, covers, or treatment facilities are required by the ROD for this remediation project, so no long-term O&M is required. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs. The EPA approved the CCR on September 21, 2006.

4.2.3.20 Basin F/Basin F Exterior Remediation Part 1/Phase II—Remaining Biota Soil (#45)

The selected remedy in the On-Post ROD for the Surficial Soil component of the Basin F and Basin F Exterior Remediation requires:

> *Excavation and landfill of human health exceedance soil and excavation and consolidation to Basin A of Former Basin F of soil posing a potential risk to biota from this medium group. The consolidated material is contained under the Basin A cover or Basin F cap, and the human health exceedance area is backfilled.*

The selected remedy in the On-Post ROD for revegetation is:

> *Remedy components for all sites include reconditioning the surface soil and revegetating areas disturbed during remediation with locally adapted perennial vegetation.*

The ROD remediation standards that apply to the project include:

> *Excavate all contaminated soil identified in the ROD for treatment, landfilling, or consolidation that corresponds to the areal and vertical extent detailed by the soil volume calculations in the Administrative Record.*
>
> *Meet air quality and odor standards that are ARARs.*

The ROD goals that apply to the project include the following:

> *Control emissions, as necessary, during remediation.*
>
> *Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.*

Phase 2 of the Basin F Exterior Remediation project implementation, consisted of remediation of biota risk soil, located in the northern part of Basin F Exterior site, which was designated for consolidation within Basin F. The Phase 2 Basin F Exterior Remediation project is comprised of the Deep Well Injection Site (NCSA-4a) and the Basin F Exterior Soil Site (NCSA-4b).

Remediation at the two sites involved excavation of biota risk soils, regrading, and preparation for surface revegetation. All biota risk soil was consolidated within the Basin F area that will be covered with a RCRA-equivalent cover.

The Phase 2 Basin F Exterior Remediation project was carried out during the fall and winter of 2007/2008.

Disposal of contaminated soil and miscellaneous debris was documented as specified in the RWMP (TtEC 2006i). A total of 172,758 bcy of biota risk soil was consolidated within the Basin F area during the course of this project.

A CSV tracking form was used to identify, document, and track approvals for CSV for the Phase 2 Basin F Exterior Remediation sites. A total of seven confirmatory soil samples were collected during this project; the results of two of these samples resulted in the identification of approximately 2,766 bcy of CSV that was removed and consolidated within Basin F.

Personal health and safety sampling and analysis was performed in accordance with the NIOSH Manual of Analytical Methods. The results indicated that there were no action levels exceeded that would require PPE upgrade during the Phase 2 Basin F Exterior Remediation project.

Air and odor monitoring were conducted in accordance with site-wide air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not met or exceeded during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the project met ROD remediation goals for the control of air emissions.

Soil amendments were placed over most of the remediated area (areas anticipated to be disturbed during the Basin F Cover project were not amended). The USFWS is responsible for permanent revegetation in areas outside the AMA that were not permanently revegetated as part of this project. The USFWS has certified in a letter to the EPA that the requirements of the ESD for Groundwater Remediation and Revegetation Requirements (TtEC 2006c) have been met and the areas outside the AMA will be restored to achieve the statutory purposes of the Refuge to the satisfaction of the USFWS.

As documented in the CCR (TtEC 2008b), remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. No caps, covers, or treatment facilities are required by the ROD for this remediation project, so no long-term O&M is required. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs. The EPA approved the CCR on December 9, 2008.

4.2.3.21 Residual Ecological Risk Soil Remediation (#47a)

The On-Post ROD included a requirement for continued biomonitoring for areas where soil contamination levels are below human health concerns but may pose potential risk to biota in

order to refine design boundaries for surficial soil and aquatic contamination areas (FWENC 1996).

Identification of Residual Ecological Risk sites (Priority 1 soil, Terrestrial Residual Ecological Risk areas [BAS 2003a, 2002], and Aquatic Pathways and Receptors [BAS 2003b]) for remediation was completed in accordance with the process described in the ROD. Designation of these Residual Ecological Risk sites resulted in completion of the ROD-identified requirements for the BAS. The terrestrial biomonitoring program is discussed in Section 7.2.3.3.

Remediation of Priority 1 and Terrestrial Residual Ecological Risk soil areas was carried out under a variety of implementation projects. Typically, projects addressed areas within or adjacent to the project area or borrow areas used during the project. Completion of remedy activities for Residual Ecological Risk areas is included in each project CCR where such activity took place. In addition, two CCRs were completed to document completion of all Residual Ecological Risk remediation activities, including soil removal, tilling, and sampling. The Part 1 CCR was completed in 2006 (TtEC 2006f) and the Part 2 CCR was completed in 2009 (TtEC 2009q).

No caps, covers, or treatment facilities are required this remedial action, except for one small area located within the Basin F cover boundary. In addition, approximately 49 acres of Residual Ecological Risk area is located within the AMA adjacent to the ICS or Basin F covers. Long-term O&M requirements for the area within AMA have been developed in the LTCP (TtEC 2008i).

Air and odor monitoring were conducted in accordance with site-wide air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not met or exceeded during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria.

Interim, temporary, or permanent seeding was completed for each area depending on the potential for future disturbance and the need to provide cover for weed control and stability. During Part 2, seeding and irrigation within the AMA were performed in accordance with the Basin F Cover and ICS Design Project Technical Specifications. For areas outside the AMA, the USFWS has certified that the requirements of the Explanation of Significant Differences for Groundwater Remediation and Revegetation Requirements have been met and that the areas outside the AMA will be restored to achieve the statutory purposes of the Refuge to the satisfaction of the USFWS.

As documented in the Part 1 CCR (TtEC 2006f) and Part 2 CCR (TtEC 2009q) remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. Project area located outside the AMA does not require any long-term O&M. The project area located inside the AMA is subject to the long-term O&M requirements presented in the LTCP as discussed above. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs. The EPA approved the CCRs on March 30, 2006, and September 3, 2009, respectively.

4.2.3.22 Basin F Wastepile Operations and Management (#65)

The Basin F Wastepile was operated and managed, following completion of the IRA in June 1989, as described in Section 4, IRA Summary Report, Basin F Liquids, Sludges, and Soil Remediation at Basin F Wastepile. O&M continued, as described in the report, until October 2005, when the project transitioned from O&M to remediation. The volume of leachate removed from the Wastepile during the O&M activities from November 1989 to October 2005 was 924,993 gallons. After October 2005, routine O&M ceased and leachate management activities at the Wastepile were taken over by the remediation subcontractor through the completion of the Basin F Wastepile remedy. Routine Basin F Wastepile O&M adhered to all provisions of the On-Post ROD with leachate being regularly collected and shipped off-site for disposal in accordance with RCRA. No significant changes to the performance or operation of the Wastepile as described in the 2005 FYR were noted.

The physical completion of the Wastepile remedy was achieved in August 2007, as discussed in 4.2.3.17, and documented in the Basin F Wastepile CCR. The CCR discusses leachate management activities during the remedy implementation.

4.3 On-Post Structures Remedy Selection and Implementation

The RAOs from the On-Post ROD for the structures medium include:

Human Health

- *Prevent contact with the physical hazards and contaminant exposure associated with structures.*
- *Limit inhalation of asbestos fibers to applicable regulatory standards.*
- *Limit releases or migration of COCs from structures to soil or water in excess of remediation goals for those media or to air in excess of risk-based criteria for inhalation as developed in the HHRC.*

Ecological Protection

- *Prevent contact with the physical hazards associated with structures.*
- *Prevent biota from entering structures that are potentially contaminated.*

The selected remedy in the On-Post ROD for the structures medium group requires:

> *All No Future Use Structures will be demolished.*
>
> *Agent History structures will be monitored for the presence of Army chemical agent, and treated by caustic washing as necessary prior to disposal.*
>
> *Both Agent History and Significant Contamination History Group structural debris will be disposed in the on-site hazardous waste landfill.*
>
> *Other Contamination History Group structural debris will be used a grade fill in Basin A, which will be subsequently covered as part of the soil remediation*
>
> *Structural assessments and review of ACM and PCB contamination status and disposition of ACM or PCB-contaminated materials will be performed ….*

Process-related equipment not remediated as part of the Chemical Process-Related Activities IRA will be disposed in the on-post hazardous waste landfill."

Additionally, the On-Post ROD remediation standards that apply to the demolition of structures include:

Certify 3X decontamination or caustic washes of soil and structural debris to achieve 3X decontamination.

Ensure disposal of 3X-decontaminated soil and structural debris in the on-post RCRA landfill.

Demolish all structural material identified in the ROD for landfilling or consolidation.

Remove structural materials with PCB concentrations of 50 ppm or greater that exist above ground level, as well as contaminated parts of floor slabs and foundations identified for removal, and dispose in the on-post TSCA-compliant landfill.

PCB-contaminated sections of floor slabs or foundations that are not identified for removal, and that have PCB concentrations of less than 50 ppm, will be left in place.

All Shell buildings to be demolished during the final remedy will be inspected for equipment containing fluids potentially contaminated with PCBs prior to demolition. Potentially contaminated fluids will be drained and sent off-post for disposal in compliance with applicable TSCA regulations. Equipment that contained these fluids, as well as all other equipment, will be disposed in the on-post TSCA-compliant HWL. The SCH structures will be demolished and the resulting debris will be placed in the on-post TSCA-compliant HWL. The OCH structures will be evaluated by Shell and EPA for any visual evidence of leaks or spills. If observed in areas where potential PCB releases may have reasonably occurred, the affected debris will be disposed in the on-post TSCA-compliant HWL. Examples of this type of visual evidence would include stains near equipment potentially containing PCB fluids or stains in buildings where there are numerous instances of equipment potentially containing PCB-contaminated fluids.

Removal of asbestos and ACM to attain TSCA requirements.

Meet air quality and odor standards that are ARARs.

Where soil remediation was required to support structures demolition and removal, the On-Post ROD remediation standard for soil excavation applies to the demolition projects and requires:

Excavate all contaminated soil identified in the ROD for treatment, landfilling, or consolidation that corresponds to the aerial and vertical extent detailed by the soil volume calculations in the administrative record.

The On-Post ROD remediation goals that apply to the structure demolition include:

Control emissions, as necessary, during remediation.

Control air emissions as necessary to attain criteria that will be developed via an air pathway analysis program that will ensure that the remedial action will be protective of human health and the environment and minimize nuisance odors.

4.3.1 On-Post Structures Remedies Under Construction

4.3.1.1 Miscellaneous RMA Structures Demolition and Removal Phase IV (#30)

The Miscellaneous RMA Structures Demolition and Removal Phase IV project includes demolition and removal of the CWTF (Structure 318), which is inside the ICS AMA. The remainder of this project consists of demolition of the remaining Submerged Quench Incinerator (SQI) building foundation, and the plugging of sanitary sewers near the SQI area, all of which are outside the AMA.

The RAOs, selected remedy, remediation standards, and remediation goals from the On-Post ROD that apply to the Miscellaneous RMA Structures Demolition and Removal Phase IV project are listed in Section 4.3. For the sanitary sewer plugging component of this project, the applicable selected remedy, remediation standards, and remediation goals are presented in Section 4.2.3.12.

The design for the Miscellaneous RMA Structures Demolition and Removal project was completed in January 2000 and included all ROD-identified structures outside North Plants and South Plants (FWENC 2000b). During the design, the project was divided into three phases to account for anticipated short-term and long-term use of structures during the remediation schedule. Demolition of Structure 318 was initially planned during Phase III. However, in 2006 an ESD was completed adding mass removal systems for the South Tank Farm Plume and the South Plants North Plume in the vicinity of the Lime Basins. The CWTF was identified for treatment of the extracted groundwater, extending the remediation use for the structure until June 2010 (TtEC 2006e). To accommodate the extended use of the CWTF, the design was modified to add a Phase IV to the project for CWTF demolition following completion of the mass removal project (TtEC 2009n, 2009l).

Remediation includes demolition and removal of the buildings and any remaining equipment, removal of the surrounding roads, parking areas and fencing, and plugging of sewer manholes serving the CWTF and the SQI area. No caps, covers, or treatment facilities are required by the ROD for this remediation project. However, long-term O&M is required since the CWTF is located within the AMA surrounding the ICS covers. Also, inspections of the plugged sanitary sewers and brass sewer line identification markers will be performed as part of the CERCLA FYR process. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs.

A CCR will be completed to address the work performed under the Phase IV project. Completion of the CCR is expected in early 2011.

4.3.2 Completed On-Post Structures Remedies

4.3.2.1 Miscellaneous RMA Structures Demolition and Removal Phase II (#30)

The RAOs, selected remedy, remediation standards, and remediation goals from the On-Post ROD that apply to the Miscellaneous RMA Structures Demolition and Removal Phase II project are listed in Section 4.3. This project phase was for structures not located in South Plants or North Plants.

The Miscellaneous Structures Demolition and Removal Phase II project consists of the following 77 elements:

- Structures: 372, 785, 786, 787, 788, 791, 792, 793, 794, 795, 796, 797, 798, 801, 836, 1605, 1728, NN0202, NN2301, NN2405, UNK
- Miscellaneous Debris Piles: MD0101, MD0102, MD0103, MD0602, MD0603, MD0604, MD0801, MD1101, MD1201, MD1202, MD1203, MD1902, MD2001, MD2401, MD2503, MD2504, MD2601, MD2602, MD2603, MD3001, MD3101, toxiMD3501
- Additional Miscellaneous Debris Piles: MD0104, MD0105, MD0201, MD0203, MD0301, MD0302, MD0303, MD0605, MD1903, MD2201, MD2301, MD2505, MD2506, MD2507, MD2508, MD2509, MD2510, MD2511, MD2701, MD2702, MD2901, MD2902, MD3002, MD3003, MD3004, MD3005, MD3103, MD3104, MD3106, MD3401, MD3502
- Closure of Irondale pipeline and NN28 and NN33

Remediation involved excavation of Priority 1 soil; demolition of 21 aboveground and belowground structures; removal of 53 miscellaneous debris piles; closure of Irondale pipeline; backfilling and/or regrading or ripping; and surface revegetation as required. All Agent History debris and ACM was transported to the HWL, and Priority 1 soil from around Structure 836 (Borrow Area 5), Other Contaminated History debris, and miscellaneous debris from debris pile removal were disposed in Basin A and the HWL. Priority 1 soil located around warehouses 795, 794 and 793 (Borrow Area 9C) was stockpiled within Borrow Area 9C for future use by others. Well abandonment was performed at sites NN28 and NN33 by the Site-Wide Drilling and Sampling Services Project, but well closure documentation was referenced in this project's design in order to complete the connection between ROD-listed structures and individual well identifiers. In addition to the 77 elements identified above, 7 ROD-identified substations (SS 0809A through SS 0809F and SS 0836) were removed under the Program Support Contract and documented in this project's CCR. Chemical agent screening was not required during the project because all Agent History Structures were documented 3X certified (agent free) during design.

Disposal of Priority 1 soil, structural debris, and miscellaneous debris was documented using a waste tracking system as specified in the RWMP (TtEC 2006i). Waste was transported to the Basin A (1,574 loads) and the HWL (1,173 loads) for disposal. Approximately 800 gallons of wastewater was transported to the CWTF for disposal. A total of 592 tons of scrap metal was transported off site to a PMC-approved metal recycling facility.

In addition, while conducting the FYR and responding to Regulatory Agency comments, the Miscellaneous Structures Demolition and Removal Phase II project documented, via DCN

MSD2-013 (TtEC 2005d), both the disposition of structures that could not be located and the redesignation of some structures for Future Use.

To meet requirements of the On-Post ROD, a confirmatory sampling program was developed for Implementation Projects to determine whether contingent soils will be excavated. Accordingly, following excavation of design volumes during the project, one confirmatory sample was taken; no CSV soil was excavated. All soils removed were verified by pre- and post-excavation surveys.

Personal health and safety sampling and analysis was performed in accordance with the NIOSH Manual of Analytical Methods. The results indicated that there were no action levels exceeded that would require PPE upgrade during the Miscellaneous RMA Structures Demolition and Removal Phase II project.

Air and odor monitoring were conducted in accordance with site-wide air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not met or exceeded during work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the project met ROD remediation goals for the control of air emissions.

Permanent seeding was placed by the USFWS at the following former structure sites: 372, 785, 786, 787, and 788 and former debris site MD1902. Interim seeding was placed at the following former structure sites: 791, 792, 793, 794, 795, 796, 797, 798, and 836.

As documented in the CCR (TtEC 2006e), remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. No caps, covers, or treatment facilities are required by the ROD for this remediation project, so no long-term operations or maintenance is required. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs. The EPA approved the CCR on March 30, 2006.

4.3.2.2 Miscellaneous RMA Structures Demolition and Removal Phase III (#30)

The RAOs, selected remedy, remediation standards, and remediation goals from the On-Post ROD that apply to the Miscellaneous RMA Structures Demolition and Removal Phase III project are listed in Section 4.3.

The Miscellaneous RMA Structures Demolition and Removal Phase III project consists of the following sites:

- Section 25 Asbestos Remediation (Borrow Area 9A Parcel 3 [including Section 25 foundation] and Site 25CC-3).
- Section 29 Magazine Area Munitions Response.

- Structures: 111, 112B, 114, 378, 392, 393, 605, 607, 618, 619, 628 Pad, 628 MH, 630, 632, 840 Debris, 890, 895, 1717, 1718, 1726, NN0303, NN0304, SQIO1, NBTS01 and Vault0l.
- Substations: SS 0111, SS 0378, SS 0392, SS 0393, SS 0616, SS 0618, SS 0618-2 and SS0619.

The Miscellaneous RMA Structures Demolition and Removal Phase III project was carried out during fall 2007 through spring 2009. Remediation involved excavation of asbestos-containing soil and miscellaneous construction debris (Section 25 Asbestos Remediation) and transportation for disposal in the ELF; Section 29 Magazine Area Munitions Response, that included soil excavation and clearance of the soil beneath three magazines; and demolition of 25 aboveground and belowground structures, including hazardous material abatement, and backfilling, grading, ripping, and revegetation as required. Asbestos-containing soil and ACM (i.e., non-friable transite and friable Thermal System Insulation) from Structures 111, 618, 619, and 1726 were disposed in the ELF. After closure of the ELF, asbestos-containing soil from Structure 111 Crawl Space Remediation and friable thermal system insulation were transported off site to a PMC-approved disposal facility. Structure demolition debris was disposed in the on-site Basin A Consolidation Area.

Eight substations were removed by the Infrastructure and Program Support Contract (of the eight substations two, i.e., SS 0111 and SS 0619, required removal of fencing and concrete pads). The substation transformers were sold to a PMC-approved recycler and documented in the Infrastructure and Program Support Contract project files, while utility poles were staged for future reuse by the USFWS.

Disposal of structural debris and miscellaneous debris was documented using a waste tracking system as specified in the RWMP (TtEC 2006i). A total of 2,976 loads of waste were transported to Basin A for disposal. Waste was transported to the ELF (804 loads) for disposal. Thirty-eight loads of asbestos-containing soil and ACM (from Structure 111 abatement activities), 4 loads of contaminated soil, and 55 drums of hazardous and non-hazardous materials were transported off site to a PMC-approved disposal facility approved to accept asbestos per state regulations and the Toxic Substance Control Act (TSCA). Approximately 1,000 gallons of wastewater was transported to the CWTF for disposal. A total of 622 tons of scrap metal was transported off-site to a PMC-approved metal recycling facility.

A CSV tracking form was used to identify, document, and track approvals for CSV for the project remediation sites. Eight confirmatory soil samples were collected during this project; no CSV was excavated.

Personal health and safety sampling and analysis was performed in accordance with the NIOSH Manual of Analytical Methods. The results indicated that there were no action levels exceeded that would require PPE upgrade during the Miscellaneous RMA Structures Demolition and Removal Phase III project.

Air and odor monitoring were conducted in accordance with site-wide air and odor monitoring plans as discussed in Section 6.3.4. Project odor action levels were not met or exceeded during

work execution nor was off-site transport of fugitive dust noted. Ambient air monitoring conducted during the project implementation period indicated no exceedances of on-post and fenceline acute and chronic criteria. Therefore the project met ROD remediation goals for the control of air emissions.

Revegetation was performed by the USFWS. Soil amendments and mulching were performed by Marty Farms.

As documented in the CCR (TtEC 2009m), remedial actions under this project have been completed, have achieved the intent of the ROD to be protective of human health and the environment, and, having been inspected by the RVO and Regulatory Agencies, are functioning as intended. No caps, covers, or treatment facilities are required by the ROD for this remediation project, so no long-term operations or maintenance is required. The property involved in this project is subject to restrictions on land and water use, which will be evaluated in future FYRs. The EPA approved the CCR on December 8, 2009.

4.4 Other Remedy Components

4.4.1 Other Operating Remedy Components

4.4.1.1 Site-Wide Biota Monitoring (#48)

Although included on Table 2.0-2 as an operating project, this subject matter is more appropriately addressed as a topic for data review in Section 6.3.3 and assessment in Section 7.2.3.3.

4.4.1.2 Site-Wide Air Monitoring (#49)

Although included on Table 2.0-2 as an operating project, this subject matter is more appropriately addressed as a topic for data review in Section 6.3.4 and for assessment in Section 7.2.3.4.

4.4.1.3 Unexploded Ordnance (UXO) Management (#51)

The selected remedy in the On-Post ROD for the Additional Component addressing UXO management requires:

> *Any UXO encountered during remediation will be excavated and transported offpost for detonation (unless the UXO is unstable and must be detonated onpost) or other demilitarization process.*

From a program perspective, the PMC UXO Department is responsible for the PMC component of the RMA munitions response action. PMC management of this action is primarily accomplished through three tasks; each task is intended to address the RMA military munitions-related hazards present during the remedy. These tasks consist of the following:

- Support the RMA On-scene Coordinator during RMA Category I Anomaly Responses—anomaly responses may result in recovered MEC and/or RCWM.
- Manage and/or perform military munitions-related operations on the RMA confirmed munitions response areas/sites.

- Provide military munitions-related construction support during remedial efforts which have the potential to result in recovered Material Potentially Presenting an Explosive Hazard and RCWM.

Consistent with munitions response actions performed under CERCLA, it is not possible to state that all potential hazards resulting from previous military munitions-related operations on RMA have been removed as a function of the RMA iteratively-approved munitions response actions. The Army responsibility for military munitions-related hazards on RMA is nontransferable and will remain with the Army after the RMA remedy is complete. This said, prior to remedy completion the RVO has committed to provide the USFWS with military munitions awareness training. This training is intended to heighten USFWS personnel awareness of military munitions-related hazards and to inform the USFWS of the Army notification process, if potential military munitions are encountered by Refuge employees/patrons after remedy completion. The Army-provided awareness training is not intended to grant the USFWS or its representative authorization to perform any action on potential military munitions, but to ensure notification and response by trained Army representatives.

All MEC recovered during the FYR period have been considered unstable and were explosively disposed on post using donor explosives. MEC recovered on RMA have been subjected to extreme heat, shock, and friction as a result of some variation of a previous functioning/disposal attempt. MEC subjected to these types of forces are considered unstable. The degree of instability is left up to the munitions response experts to determine, based upon extensive publication research and previous experience. At RMA, the degree of instability has consistently been determined to be safe for on-site transportation. The assurance of safely transporting off site is highly subjective, essentially requiring the MEC to be in as-manufactured condition. Given those considerations, the MEC has been determined unsuitable for transportation off site.

Long-term management of the potential to encounter military munitions, or remnants thereof, on RMA will be managed according to the *Response Plan for Recovered Material Potentially Presenting an Explosive Hazard (MPPEH)* (TtEC 2010g). All MPPEH identified by RMA Refuge personnel will be inspected/recovered by local law enforcement or Department of Defense personnel trained in military munitions response.

4.4.1.4 Operation of CERCLA Wastewater Treatment Facility (#60)

The CWTF has supported various RMA remediation projects. It began as an IRA, was included as part of the ROD, and has been an integral part of the ongoing remedy.

Treated water from the CWTF was previously conveyed to the Basin A Neck treatment plant by an underground pipeline, combined with effluent from the plant at a maximum rate of 5 gpm, and reinjected in the Basin A Neck recharge trenches. Previous to demolition, the CWTF was used for treatment of water extracted under the Groundwater Mass Removal project (South Tank Farm and Lime Basins mass removal) and the Lime Basins Slurry Wall Dewatering project, and this water was reinjected in the South Tank Farm and Lime Basins areas under an exemption that allowed recharge of groundwater at concentrations that exceeded the CBSGs (Washington Group International 2005). Groundwater from the Lime Basins Slurry Wall Dewatering project will be conveyed to and treated at the BANS treatment plant once the CWTF has been decommissioned.

The facility has been operating in batch mode in compliance with all On-Post ROD specifications. All liquid discharges have met appropriate discharge standards. All solid wastes generated have been properly disposed of either off site or on site in the HWL. The facility has therefore been meeting all applicable provisions of the On-Post ROD.

4.4.1.5 On-Post Institutional Controls (#99)

The RMA FFA (EPA 1989) established ICs restricting the current and future use of real property and resources within the RMA boundaries. The ICs identified in the FFA are also required by the ROD for the On-Post OU. These primary ICs prohibit residential development, use of ground or surface water as potable, consumption of fish and game, agricultural activities (except those required for remedial actions or erosion control), and major alteration of the hydrogeologic characteristics of RMA. The FFA ICs also require preservation and management of wildlife habitat to protect endangered species, migratory birds, and bald eagles. Additionally, in accordance with the February 3, 1993, letter from Lewis D. Walker (Walker 1993) the Army and the USFWS will neither build, use, or allow use of any basements at RMA unless the Army or USFWS prepares a feasibility study that addresses the impact of the use of basements on human health and the environment, and substantiates that such impacts are minimal.

The 2003 Interim Institutional Control Plan (ICP) (PMRMA 2008a) provides a framework for ensuring that workers and visitors at RMA are safe and facilities are protected. The ICP incorporated the primary ICs required by the FFA and the On-Post ROD, provided discussion on access controls and activity management, and described other institutional or engineering controls for specific areas of RMA. The Rocky Mountain Arsenal National Wildlife Refuge Public Use Plan (Landolt et al. 2004) identifies the access controls used by the USFWS in implementing Public Use programs at the Refuge.

During the 2010 FYR period, the ICP was revised twice, first in March 2006 and more recently in August 2008 (PMRMA 2008a). These revisions did not alter the primary restrictions, access control requirements, or activity management procedures. Area-specific controls were added, revised, or deleted as necessary to correspond to remedy activities or current status of property.

The Army continued to use a multi-tiered access and control program that governs all site activities during the 2010 FYR period. A perimeter fence restricts unauthorized access. Controlled access points (west, south and north gates) limit access to those people having proper identification and legitimate business at RMA. Access to the Central Remediation Area, in effect through April 2010 where the cleanup is in progress, was restricted to workers having a Central Remediation Area badge or visitors who are escorted by Central Remediation Area-badged workers. Access to individual project sites is limited to those Central Remediation Area-badged workers who have the proper training, health monitoring, and prescribed PPE required for that site. The Central Remediation Area badging program was ended in April 2010 when exposure risks were minimized with the completion of the caps and covers; however, RMA orientation and project-specific health and safety training continue to be conducted for workers accessing the former Central Remediation Area. Signs throughout the site identify boundaries of restricted areas and provide access restrictions. Signs are removed or relocated as necessary as restricted area boundaries change.

RMA activities are managed and monitored through a centralized database called Safe RMA Access and Control. All proposed major actions involving people and equipment on the ground must be entered into Safe RMA Access and Control and approved in advance. Visitor tours are also required to provide a Safe RMA Access and Control submittal and obtain approval prior to the tour.

The ICP also lists other areas that require additional ICs. These provide specific limitations commensurate with the risk presented by the area or the feature being protected. Included are additional ICs for the previously excavated lake sediments (SSA-3b), access restrictions for the covers, for protection of groundwater remedy structures, and for lake level maintenance.

Areas of RMA where property and management authority have been transferred to the USFWS are governed by National Wildlife Refuge System regulations in Title 50, Subchapter C of the CFR. These regulations provide the USFWS with the authority to manage the entire National Wildlife Refuge System, including the Refuge. These regulations also close all areas of RMA included in the National Wildlife Refuge System to the public unless these areas are opened by regulation, individual permit, or public notice.

The Rocky Mountain Arsenal National Wildlife Refuge Public Use Plan identifies access controls that are used by the USFWS for both weekday and weekend visitor programs. On weekdays, vehicle passes that must be displayed in the windshield are issued to Public Use visitors at the south gate, and visitors are directed to the Visitor Center. On weekends, C Street is gated immediately north of the Visitor Center driveway to prevent visitors from accessing unauthorized areas. Weekday programs are suspended if necessary to ensure that remedial activities do not impact visitors.

Access restrictions and ICs have been implemented and revised as necessary. They have effectively prevented individuals from exposure to unacceptable levels of risk. There was one trespass incident reported in FY07 and two incidents reported in FY08. None of the trespasses threatened the integrity or effectiveness of the remedy, and none created any potential for exposure.

Pursuant to an amendment to the On-Post ROD completed in October 2005, annual monitoring of land use controls is required to ensure they remain effective and are protective of human health and the environment. The ROD amendment also specifies that results of the monitoring will be provided in an annual monitoring report. In January 2010, a monitoring report was issued to document land use control monitoring activities for FY09 (TtEC 2010f). Subsequent discussions related to this report resulted in a decision to modify the report to include discussion of land use controls for FY06 through FY09 because no reports had been issued in the previous years. Revisions to this report are in progress.

As a result of monitoring activities, two issues related to land use controls were identified that required corrective action. Several markers installed during remedy activities along the abandoned sanitary sewer were damaged or missing. Also, review of the Commerce City Prairie Gateway Planned Unit Development (PUD) revealed a use-by-right included as “(p)ublic gardening and similar cultivation of land, nursery, and supplementary to the primary public use”

for a parcel of the Prairie Gateway. This use appears inconsistent with the land use restrictions delineated in the Refuge Act, which prohibit non-remedy agricultural activities, although the Commerce City Planning Division stated that they believed the use would be interpreted consistent with the FFA and Refuge Act restrictions. In addition, the PUD process includes notification to adjacent landowners of proposed amendments to the PUD. However, the Army has not been included in the notification list. These issues are discussed further in Section 8.0 of this FYRR.

4.4.2 Other Remedy Components Under Construction

4.4.2.1 Basin A Neck System—Lime Basin Groundwater Treatment Relocation and Basin A Neck Expansion (#59)

As of the end of FY09, groundwater from the dewatering of the Lime Basins area was treated at the CWTF. In 2010 the Groundwater Mass Removal project was terminated to allow for the CWTF to be decommissioned and demolished. The groundwater extracted from inside the Lime Basins area will require treatment at an alternate facility. The BANS is the closest treatment plant to the Lime Basins area, so in order to accommodate the Lime Basins area groundwater, the BANS treatment plant will be modified.

The modifications of the BANS treatment plant will include the relocation of some equipment from the CWTF as well as the addition of other new process equipment. The chemical precipitation process, chemical feed pumps, and sludge storage tanks will be relocated from the CWTF. New sludge dewatering and activated alumina processes will be installed at BANS to accommodate the Lime Basins area groundwater. In addition to these modifications, the current carbon adsorption system will be modified and a new carbon change-out facility will be added to improve the current BANS treatment plant.

The BANS treatment plant construction is being conducted in accordance with the Lime Basins Groundwater Treatment Relocation Project 100 Percent Design Package (URS Washington Division 2010) approved by the Regulatory Agencies on March 4, 2010, although procurement activities concerning modifications started in November 2009. The modifications to the BANS treatment plant are scheduled to be completed in November 2010.

4.4.3 Other Completed Remedy Components

4.4.3.1 Medical Monitoring Program (#52)

The selected remedy in the On-Post ROD for Medical Monitoring required that a medical monitoring program be instituted that would respond effectively to RMA-related health concerns of the surrounding communities during the soil cleanup. CDPHE has the lead role in the medical monitoring program. The ROD also stipulated that a Medical Monitoring Advisory Group be formed to recommend appropriate program components. As directed by the ROD, the Medical Monitoring Advisory Group had representation from affected communities that included Commerce City, Montbello, Henderson, and Green Valley Ranch; from public health agencies including CDPHE, Agency for Toxic Substances and Disease Control, EPA, Denver Department of Environmental Health, and TCHD; and from the Army, Shell, USFWS, independent technical advisors, and the Site-Specific Advisory Board (SSAB).

The Medical Monitoring Advisory Group completed its work in October 1998 and submitted a final report to CDPHE for acceptance. CDPHE formally accepted all 12 of the program recommendations developed by the Medical Monitoring Advisory Group and began program implementation. The program recommendations include systematic evaluation of air quality data and its health significance, a medical referral system to track and respond to community health concerns, systems to monitor birth defects and cancer in the neighborhoods around RMA, improvements to the RMA air quality and odor monitoring programs, improvements to emergency response programs, a process for selecting appropriate public health actions, health professional education, and public involvement and education.

Key program accomplishments during the 2005–2010 FYR period include:

- The CDPHE continued to collaborate with Rocky Mountain Poison and Drug Center to provide 24-hour, expert assistance for citizens and health care providers who may have RMA-related health questions. Inquiries received through the *RMA Health Line* are systematically tracked for patterns or trends. The CDPHE ensured that the Rocky Mountain Poison and Drug Center staff remained abreast of air quality monitoring data and RMA activities with the potential to impact the air pathway or receive public attention, including conventional ordnance destruction events, prescribed burns, visitor access suspension when Lewisite was detected in an air monitoring sample during the trenching work associated with the Lime Basins slurry wall construction, or when there were episodic dust or emission events. The CDPHE and the RVO provided the Rocky Mountain Poison and Drug Center information sessions on the RMA COCs, the air monitoring program, and birth defects and cancer surveillance results.
- Intrusive work with contaminated soils at RMA was substantively completed in autumn 2008, and the contract with Rocky Mountain Poison and Drug Center was allowed to expire at the end of December 2008. Since *RMA Health Line* inception in December 1998 through its completion at the end of 2008, 1,650 calls were received: 1,547 callers (95 percent) listened to the Health Line information recording and 104 callers (5 percent) consulted directly with a nurse. Of these 104 callers, 44 callers asked general RMA, non-health-related questions and 30 calls related to personal health concerns of the caller or family member. In each of the 30 cases, the Rocky Mountain Poison and Drug Center physicians, collaborating with the CDPHE, determined that it was unlikely that the caller's symptoms were related to the RMA cleanup, but offered to consult with caller's physician. The Rocky Mountain Poison and Drug Center and CDPHE collaborated on many of the health concern calls to collect and evaluate personal, environmental, and public health data relevant to the caller's concerns. The *RMA Health Line* was an effective service for prompt response to citizens' concerns. The *RMA Health Line* was also a useful system for CDPHE to maintain passive surveillance of community health concerns.
- The CDPHE continued to systematically evaluate RMA air quality monitoring data for its public health significance until chemical air quality monitoring ceased at the end of July 2009. Fenceline readings throughout the time the monitoring program was implemented remained within site-specific limits.

- Cancer incidence in the communities surrounding the RMA was tracked before and during the soil cleanup. The CDPHE finalized three cancer surveillance reports: one for the 18-year baseline reporting period prior to beginning the RMA cleanup, a second for the period 1997 through 2000, and a third for the time period 2000 through 2005. Thirty types of cancer were evaluated. Since the soil cleanup began, the overall number of cancer cases (i.e., all cancer combined) in the RMA study area was generally not higher than would be expected, although the 2000–2005 cancer study showed some statistically elevated results with no discernable pattern for some cancers. At this time, it is suspected that those slight elevations are probably artifacts of the rapidly expanding population in the general area surrounding RMA. There were higher rates of specific types of cancer, but no indication they were related to living near RMA. To follow up on the slight statistical elevations in 2000–2005, the CDPHE is preparing to reconcile the existing cancer data for that time period with census data that will become available in 2011 or 2012, and will publish and addendum to the 2000–2005 report in 2012 or 2013. Any additional post-2005 cancer registry data available at that time will also be incorporated into that addendum. Continued surveillance for remedy-related cancer issues in the community is unlikely after 2010, because the lack of known remedy-related exposures as documented by the air surveillance program makes such surveillance unnecessary.
- An existing state program, Colorado Responds to Children with Special Needs, is being used to track birth defects in the neighborhoods around the RMA during the remediation. Birth defect rates are being tracked and analyzed temporally and spatially. Rates in the communities were found to be stable and similar to rates for all of Colorado for the 8-year period prior to the beginning of soil remediation. Continued monitoring through March 2009 has shown that community rates have not increased above the baseline rates beyond that expected due to random fluctuations. No unusual geographic groupings have been identified. Children with birth defects born in the RMA study area continued to be referred monthly to early intervention services and support groups through Colorado Responds to Children with Special Needs Community Notification and Referral Program.
- The CDPHE continued to receive program implementation advice from the Medical Monitoring Program Citizen Advisory Board (CAB). This advice is based in part on medical monitoring program staff reporting the findings of program components to the CAB. The program also facilitated reporting by the RVO. In 2007, the CAB voted to meet on an as-needed basis. In 2008, the CDPHE sent out a query to ask the CAB if it wanted to meet in the latter part of the year. The CAB declined, and the final meeting of the CAB took place on May 4, 2010. It was decided at that time that the CAB's mission was complete except for the Cancer Surveillance Program addendum, which will be published during the next FYR period. For the future, CDPHE will continue to field calls from the citizens surrounding the RMA for general questions and health-related concerns, and will continue to maintain its Medical Monitoring Program website to serve as a clearinghouse for any future issues related to the program. The CDPHE will send out a final version of the *Health Matters* newsletter to the community during summer of 2010.
- CDPHE established a website in summer 2001. This website provides program background and implementation information, health surveillance results, CAB meeting information, contact information, and a Geographic Information System-based search

function which allows citizens to access fenceline and community air quality monitoring results. The website continued to be updated for air monitoring results through the end of the air monitoring program.

As directed by the Medical Monitoring Advisory Group recommendations, the Medical Monitoring Program has continued to monitor the success of exposure prevention efforts during the soil remediation. The program has also addressed potentially RMA-related health concerns through its toll-free health information line and birth defects and cancer monitoring. Further, the program has responded effectively to unanticipated events that could impact the air pathway.

An MCR for the Medical Monitoring Program will be prepared and submitted to the Regulatory Agencies in early 2011.

This page intentionally left blank.