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URANIUM MILL TAILINGS REMEDIAL ACTION PROJECT 1993 ENVIRONMENTAL REPORT

Prepared for
U.S. Department of Energy
UMTRA Project Office
Albuquerque, NM

Prepared by
Jacobs Engineering Group Inc.
Albuquerque, NM

and
MK-Ferguson Co.
A Morrison Knudsen Co.
Albuquerque, NM

MASTER

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CITIZENS' SUMMARY

ENVIRONMENTAL PROGRAM OVERVIEW

This annual report documents the Uranium Mill Tailings Remedial Action (UMTRA) Project environmental monitoring and protection program. The UMTRA Project routinely monitors radiation, radioactive residual materials, and hazardous constituents at associated former uranium tailings processing sites and disposal sites.

At the end of 1993, surface remedial action was complete at 10 of the 24 designated UMTRA Project processing sites: Canonsburg, Pennsylvania; Durango, Colorado; Green River, Utah; Lakeview, Oregon; Lowman, Idaho; Riverton, Wyoming; Salt Lake City, Utah; Shiprock, New Mexico; Spook, Wyoming; and Tuba City, Arizona. Surface remedial action was ongoing at eight sites: Ambrosia Lake, New Mexico; Falls City, Texas; Grand Junction, Colorado; Gunnison, Colorado; Mexican Hat, Utah; Monument Valley, Arizona; and Rifle, Colorado (two sites). Remedial action has not begun at the six remaining UMTRA Project sites that are in the planning stage: Belfield and Bowman, North Dakota; Maybell, Colorado; Naturita, Colorado; and Slick Rock, Colorado (two sites). The ground water compliance phase of the UMTRA Project started in 1991.

In 1993, the UMTRA Project Office revised the UMTRA Project Environmental Protection Implementation Plan, as required by U.S. Department of Energy (DOE) Order 5400.1, *General Environmental Protection Program*. This comprehensive plan identifies the elements of the UMTRA Project environmental protection program detailed in compliance and monitoring plans and guidance documents. The UMTRA Project Office also implemented all environmental protection programs required by DOE Order 5400.1, including a waste minimization and pollution prevention awareness program, a ground water protection management program, and an environmental monitoring program. Implementation of these programs ensures that UMTRA Project activities are in compliance with all radiological and nonradiological environmental requirements and are performed in a safe and environmentally sound manner. The UMTRA Project Office continually evaluates compliance with environmental regulations and UMTRA Project requirements by conducting internal appraisals at Project sites to review records and work practices.

Because the UMTRA Project sites are in different stages of remedial action, the breadth of the UMTRA environmental protection program differs from site to site. In general, sites actively undergoing surface remedial action have the most comprehensive environmental programs for sampling media. At sites where surface remedial action is complete and at sites where remedial action has not yet begun, the environmental program consists primarily of surface water and ground water monitoring to support site characterization, baseline risk assessments, or disposal site performance assessments.

CITIZENS' SUMMARY

COMPLIANCE SUMMARY

In accordance with DOE policy, the UMTRA Project complies with all applicable federal and state environmental requirements. In 1993, activities at UMTRA sites complied with all applicable regulations, including those pertaining to hazardous material management, underground storage tanks, air emissions, surface water discharges, community-right-to-know notifications, plans for spill prevention control and countermeasures, and environmental impact analyses. Chapter 2 of this report contains a complete summary of compliance issues and activities. Chapters 5 through 14 give more detailed, site-specific information on compliance issues and activities.

ENVIRONMENTAL MONITORING SUMMARY

The UMTRA Project Office has developed an environmental monitoring plan that describes the types of environmental monitoring activities that will be conducted at UMTRA sites. To assess the conditions of concern at each site, this plan is implemented through a series of site-specific monitoring plans. Environmental monitoring was conducted at UMTRA sites during 1993 for airborne radionuclides and fugitive dust, environmental penetrating gamma radiation, and radiological and nonradiological contaminants in surface water and ground water. Chapter 3 of this report contains details on the monitoring methodologies applied at UMTRA sites.

The most comprehensive monitoring programs (which covered air, surface water, and ground water) were conducted at active sites where surface remedial action occurred in 1993. At nonactive sites where surface remedial action has not yet begun or is complete, the program typically consists of surface and ground water monitoring. The environmental monitoring program at each UMTRA site is discussed in detail in the site-specific sections (Chapters 5 through 14) of this report.

Airborne Radioactivity

Air monitoring for radon-222 gas and for thorium-230 airborne radioactive particulates was conducted at all UMTRA sites undergoing surface remedial action. Air particulate and radon gas sampling stations were established adjacent to these active sites and in nearby residential areas. Air monitoring was continuous from 1 month before the start of remedial action to 1 month following completion of the radon barrier on a disposal cell.

The annual average thorium-230 concentrations were below the DOE limits established in DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. Average annual radon-222 concentrations at all sites monitored were below the DOE limit of 3×10^{-9} microcuries per milliliter ($\mu\text{Ci/mL}$) above background, with the exception of one monitoring station at the Ambrosia Lake, New Mexico, site. This site reported an annual average value less than 10 percent above the limit. Although this station detected annual radon-222 concentrations slightly above the DOE limit, as a result of remedial action, these concentrations decreased significantly throughout the year; the fourth quarter was 13 percent below the DOE limit. Radon concentrations at this site should drop to background levels after surface remedial action is complete. Background levels of radon-222 are expected to be higher at the Ambrosia Lake site, on the average, than in other areas

CITIZENS' SUMMARY

in New Mexico. This is due to the natural abundance of uranium in the area immediately surrounding Ambrosia Lake and radon contributions from open uranium mine air vents and from the Quivera uranium mill tailings site adjacent to the radon monitoring station. These factors are unrelated to the UMTRA Project.

Fugitive Dust

Fugitive dust emissions (total suspended particulates) are of concern only at active sites. In most cases, active sites are not required to monitor specifically for fugitive dust emissions; usually, dust suppression programs are all that is required. However, total suspended particulates were monitored at Colorado processing sites undergoing surface remedial action, in accordance with site-specific state permits. Air sampling stations were installed around the site boundaries.

In 1993, the total suspended 24-hour particulate threshold limit value of 150 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) established by the state of Colorado and adopted from the U.S. Environmental Protection Agency (EPA), was exceeded on two and three occasions at the Grand Junction and Rifle site, respectively. All but one of the exceedances were the result of off-site activities not associated with the UMTRA Project. This exceedance at the Rifle site, caused by heat and wind conditions, resulted in increased dust control activities. All exceedances were reported immediately to the DOE through the DOE Occurrence Reporting and Processing System.

The annual geometric mean of $60 \mu\text{g}/\text{m}^3$ was not exceeded. The state issued no violations or citations. There were no exceedances of the annual guidelines in 1993 or in the first quarter of 1994.

Environmental Penetrating Gamma Radiation

Environmental dosimetry monitoring for penetrating gamma radiation was conducted at all UMTRA sites undergoing surface remedial action. A monitoring network at these sites measured the external penetrating gamma radiation dose to the public. The sampling locations and schedules used to monitor environmental penetrating gamma radiation were used to monitor airborne radioactivity.

The annual gamma radiation/dose levels for all sites monitored were below the DOE guideline of 100 millirem above background established in DOE Order 5400.5.

Surface Water

The surface water monitoring program is designed to monitor 1) compliance with discharge permits, 2) the effects of construction activities on surface water bodies adjacent to active sites, and 3) the impact of ground water contamination on surface water quality.

Surface water discharged from UMTRA Project sites is monitored using methods and frequencies identified in federal and state discharge permits. The issuing agencies determine which constituents will be monitored and

CITIZENS' SUMMARY

their acceptable release limits. In 1993, no sites had off-site discharges that required monitoring.

Samples were collected from surface water bodies at active sites to assess the potential environmental impacts of site remedial action activities and discharges to local sewer systems. Taken quarterly and after storm events, these samples were analyzed for thorium-230 and radium-226. Wherever possible, samples were taken from upstream and downstream locations as well as from standing water bodies. Monitoring results from these sites showed concentrations of these radionuclides in surface waters were less than the derived concentration guide values in DOE Order 5400.5.

The impact of ground water contamination on surface water quality was assessed at 18 UMTRA sites in 1993. Samples were analyzed for radiological and nonradiological constituents identified in the proposed EPA ground water standards for UMTRA Project sites. Site-specific constituents of concern were identified, based on previous site characterization information and historical records on the uranium processing methods used at the sites. This round of surface water sampling generally coincided with the site ground water sampling. Ground water contamination at most UMTRA sites did not influence surface water quality in 1993 and in the first quarter of 1994.

Ground Water

Ground water was monitored at 19 UMTRA sites in 1993 to observe changes in ground water quality before, during, and after surface remedial action and to support UMTRA Ground Water Program baseline risk assessments. At five of these sites, ground water monitoring also supported assessments of disposal site performance and determined compliance with ground water protection standards. Ground water samples were analyzed for major ions and the hazardous constituents listed in the proposed EPA ground water protection standards and indicator parameters. The ground water data were used to identify the extent of contamination of hazardous constituents and indicator parameters. Constituent concentrations were compared with background levels and EPA-proposed maximum concentration limits.

Quality Assurance

Quality assurance in the UMTRA Project environmental monitoring program is consistent with DOE Order 5700.6C, *Quality Assurance*, and includes the applicable portions of the 11 quality assurance elements identified in DOE Order 5400.1. Trained personnel implement environmental monitoring and compliance activities and follow formal sampling, chain-of-custody, analysis, and data validation procedures. Instruments are routinely calibrated with National Institute of Standards and Technology reference materials. Vendors and laboratories are certified and accredited where necessary, and are audited for compliance with program requirements. These measures ensure consistent quality throughout the UMTRA Project environmental monitoring program. Chapter 4 of this report presents details of the UMTRA Project quality assurance program.

FOREWORD

From 1943 to 1970, most uranium ore mining in the United States was conducted by private companies under contract to the U.S. Atomic Energy Commission. The uranium ore was used in national defense research, weapons development, and the emerging nuclear industry. After fulfilling their contracts, many of the uranium mills closed, leaving large quantities of waste (such as uranium mill tailings and abandoned mill buildings) at the mill sites. At some sites, no effort was made to prevent the spread of mill tailings by wind and water erosion or to prevent their use in local construction projects. As a result, uranium mill tailings were spread beyond the mill site boundaries into areas referred to as vicinity properties.

In the 1960s and 1970s, direct gamma radiation, radon gas, and radon gas decay products at the abandoned mill sites were determined to be potential health hazards. In 1972, concern for the potential long-term adverse health effects of uranium mill tailings used in construction projects led Congress to pass legislation authorizing the cleanup of structures contaminated with uranium mill tailings in Grand Junction, Colorado. Continued public concern about other abandoned uranium mill sites led to engineering and radiological studies to identify other mill sites in need of cleanup. As a result, Congress passed Public Law 95-604, the *Uranium Mill Tailings Radiation Control Act* on November 8, 1978 (42 USC §7901 *et seq.*). This act led the U.S. Department of Energy (DOE) to establish the Uranium Mill Tailings Remedial Action (UMTRA) Project to manage the cleanup and disposal of mill tailings at 24 designated inactive mill sites.

The DOE is committed to conducting UMTRA Project operations in an environmentally sound manner to protect human health and the environment. To achieve this goal, UMTRA Project activities must be consistent with the requirements of DOE Order 5400.1, *General Environmental Protection Program*. UMTRA Project activities also must follow all applicable federal, state, tribal, and local environmental protection laws and regulations, executive orders, and DOE policies. Accordingly, the DOE and its contractors have implemented an ongoing environmental monitoring program required by DOE Order 5400.1 at the 24 UMTRA Project sites to demonstrate adherence to these requirements.

FOREWORD

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TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
CITIZENS' SUMMARY	CS-1
CHAPTER 1 — INTRODUCTION	1-1
Purpose	1-1
Scope	1-1
UMTRA Project Mission	1-2
Project Information	1-2
Environmental Monitoring Program	1-4
UMTRA Regulatory Arena	1-5
U.S. Environmental Protection Agency Standards	1-5
U.S. Nuclear Regulatory Commission Standards	1-6
U.S. Department of Energy Orders	1-6
Participation by Federal Agencies, States, and Indian Tribes	1-7
U.S. Department of Energy	1-7
U.S. Nuclear Regulatory Commission	1-7
U.S. Environmental Protection Agency	1-7
States and Indian Tribes	1-8
UMTRA Project Public Participation Program	1-8
1993 UMTRA Project Accomplishments	1-9
References	1-10
CHAPTER 2 — ENVIRONMENTAL COMPLIANCE SUMMARY	2-1
Compliance Summary	2-1
Uranium Mill Tailings Radiation Control Act	2-1
Superfund Amendments and Reauthorization Act	2-1
Resource Conservation and Recovery Act	2-2
Clean Water Act	2-2
National Environmental Policy Act	2-3
Safe Drinking Water Act	2-4
Endangered Species Act	2-4
Executive Order 11988, <i>Floodplain Management</i>	2-5
Executive Order 11990, <i>Protection of Wetlands</i>	2-5
National Historic Preservation Act	2-5
Clean Air Act	2-6
Hazardous Materials Transportation Act	2-6
Federal Insecticide, Fungicide, and Rodenticide Act	2-7
State Regulatory Requirements	2-7
Granted States Regulatory Authority	2-7
State-Specific Requirements	2-7
Special Permits-Requirements	2-8
DOE Environmental Audits	2-8
Site Compliance Status	2-8
Ambrosia Lake, New Mexico	2-8
Gunnison, Colorado	2-9

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
Rifle, Colorado	2-9
Falls City, Texas	2-9
Grand Junction, Colorado	2-10
Mexican Hat, Utah	2-10
Monument Valley, Arizona	2-10
References	2-10
 CHAPTER 3 — ENVIRONMENTAL MONITORING METHODOLOGIES	 3-1
Air Particulate Monitoring	3-1
Nonradiological Air Particulate Monitoring	3-1
Radiological Air Particulate Monitoring	3-2
Radon Monitoring	3-2
Real-Time (Active) Radon Gas Monitoring	3-2
Passive Radon Gas Monitoring	3-3
External Gamma Radiation Dose Monitoring	3-4
Surface Water Monitoring	3-4
Discharge Water	3-4
Surface Water Assessments	3-5
Ground Water Monitoring	3-5
Site Characterization	3-5
Ground Water Protection	3-6
Baseline Risk Assessments	3-6
Ecological Assessment	3-6
Upland Vegetation	3-7
Wetland Vegetation	3-7
Nonthreatened and Endangered Wildlife	3-7
Threatened and Endangered Species	3-7
References	3-8
 CHAPTER 4 — QUALITY ASSURANCE PROGRAM FOR THE UMTRA PROJECT	
ENVIRONMENTAL MONITORING PROGRAM	4-1
Data Quality Objectives	4-1
Remedial Action Contractor Quality Assurance	4-1
Environmental Gamma Radiation	4-1
Active Radon Monitoring	4-2
Passive Radon Monitoring	4-2
Radioactive Airborne Particulate Monitoring	4-2
Surface Water Radionuclide Monitoring	4-3
Water Discharge Monitoring	4-4
Laboratory Cross-Check Radiological Data	4-4
Technical Assistance Contractor Quality Assurance	4-7
Sampling Procedures	4-7
Analytical Methods	4-7
Analytical Quality Control	4-8
Analytical Quality Assurance	4-8
Analytical Data Validation	4-8

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
Interlaboratory Performance Evaluation Programs	4-9
Performance Evaluation Program Results	4-10
References	4-13
CHAPTER 5 - ARIZONA	5-1
Monument Valley, Arizona, Site	5-3
Site Description and Location	5-3
Site History and Ownership	5-5
Site Characterization and Cleanup	5-6
Environmental Compliance Status	5-6
Superfund Amendments and Reauthorization Act	5-6
Resource Conservation and Recovery Act	5-7
Clean Water Act	5-7
National Pollutant Discharge Elimination System	5-7
Spill Prevention Control and Countermeasures Plan	5-7
Septic/Holding Tanks	5-7
Storm Water	5-7
Clean Air Act	5-8
National Environmental Policy Act	5-8
Hazardous Materials Transportation Act	5-8
Environmental Compliance Permits	5-8
Environmental Monitoring	5-8
Air Monitoring	5-9
Nonradiological Air Particulate Monitoring	5-9
Radiological Air Particulate Monitoring	5-9
Radon Monitoring	5-11
Air Monitoring Conclusions	5-12
Environmental Gamma Radiation Monitoring	5-12
Environmental Gamma Radiation Monitoring Conclusions	5-12
Surface Water Monitoring	5-12
Surface Water Results and Conclusions	5-14
Ground Water Monitoring	5-15
Ground Water Results	5-20
Ground Water Conclusions	5-20
Tuba City, Arizona, Site	5-23
Site Description and Location	5-23
Site History and Ownership	5-23
Site Characterization and Cleanup	5-25
Environmental Compliance Status	5-25
Environmental Monitoring	5-25
Surface Water Monitoring Results and Conclusions	5-26
Ground Water Monitoring	5-26
Ground Water Results	5-29
Ground Water Conclusions	5-31
References	5-32

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
CHAPTER 6 - COLORADO	6-1
Durango, Colorado, Site	6-3
Site Description and Location	6-3
Site History and Ownership	6-3
Site Characterization and Cleanup	6-6
Environmental Compliance Status	6-6
Environmental Monitoring	6-7
Surface Water Monitoring	6-7
Surface Water Results and Conclusions	6-7
Ground Water Monitoring	6-9
Processing Site	6-9
Ground Water Results	6-11
Ground Water Conclusions	6-11
Disposal Site	6-11
Ground Water Results	6-13
Ground Water Conclusions	6-16
Grand Junction, Colorado, Site	6-21
Site Description and Location	6-21
Site History and Ownership	6-21
Site Characterization and Cleanup	6-23
Environmental Compliance Status	6-24
Superfund Amendments and Reauthorization Act	6-24
Clean Water Act	6-25
National Pollutant Discharge Elimination System	6-25
Spill Prevention Control and Countermeasures Plan	6-25
Septic/Holding Tanks	6-25
Clean Air Act	6-25
Total Suspended Particulates	6-25
National Environmental Policy Act	6-26
Hazardous Materials Transportation Act	6-26
Noise Control	6-26
Environmental Permits	6-27
Environmental Monitoring	6-27
Air Monitoring	6-27
Nonradiological Air Particulate Monitoring	6-27
Radiological Air Particulate Monitoring	6-27
Radon Monitoring	6-27
Air Monitoring Conclusions	6-34
Environmental Gamma Radiation Monitoring	6-36
Environmental Gamma Radiation Monitoring Conclusions	6-36
Surface Water Monitoring	6-36
Surface Water Results and Conclusions	6-37
Ground Water Monitoring	6-38
Processing Site	6-38
Ground Water Results	6-40
Ground Water Conclusions	6-40

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
Cheney Reservoir Disposal Site	6-45
Gunnison, Colorado, Site	6-47
Site Description and Location	6-47
Site History and Ownership	6-47
Site Characterization and Cleanup	6-49
Environmental Compliance Status	6-50
Superfund Amendments and Reauthorization Act	6-50
Resource Conservation and Recovery Act	6-50
Clean Water Act	6-51
National Pollutant Discharge Elimination System	6-51
Spill Prevention Control and Countermeasures Plan	6-51
Septic/Holding Tanks	6-51
Clean Air Act	6-51
National Environmental Policy Act	6-51
Hazardous Materials Transportation Act	6-51
Environmental Permits	6-52
Environmental Monitoring	6-52
Air Monitoring	6-52
Nonradiological Air Particulate Monitoring	6-52
Radiological Air Particulate Monitoring	6-52
Radon Monitoring	6-54
Air Monitoring Conclusions	6-58
Environmental Gamma Radiation Monitoring	6-58
Environmental Gamma Radiation Monitoring Conclusions	6-59
Surface Water Monitoring	6-61
Surface Water Results	6-62
Surface Water Conclusions	6-62
Ground Water Monitoring	6-64
Processing Site	6-64
Site Ground Water Results	6-68
Ground Water Conclusions	6-68
Disposal Site	6-69
Ground Water Results	6-75
Ground Water Conclusions	6-76
Ecological Monitoring	6-76
Rifle, Colorado, Site	6-77
Site Description and Location	6-77
Site History and Ownership	6-77
Site Characterization and Cleanup	6-80
Environmental Compliance Status	6-80
Superfund Amendments and Reauthorization Act	6-81
Resource Conservation and Recovery Act	6-81
Clean Water Act	6-81
National Pollutant Discharge Elimination System	6-81
Spill Prevention Control and Countermeasures Plan	6-82
Septic/Holding Tanks	6-82

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
Storm Water	6-82
Clean Air Act	6-82
Total Suspended Particulates	6-82
National Emission Standards for Hazardous Air Pollutants	6-82
National Environmental Policy Act	6-82
Hazardous Materials Transportation Act	6-83
Noise Control	6-83
Environmental Compliance Permits	6-83
Environmental Monitoring	6-83
Air Monitoring	6-83
Nonradiological Air Particulate Monitoring	6-83
Radiological Air Particulate Monitoring	6-84
Radon Monitoring	6-90
Air Monitoring Conclusions	6-90
Environmental Gamma Radiation Monitoring	6-93
Environmental Gamma Radiation Monitoring Conclusions	6-93
Surface Water Monitoring	6-93
Rifle Surface Water Results and Conclusions	6-95
Ground Water Monitoring	6-98
New Rifle Ground Water Results	6-105
Old Rifle Ground Water Results	6-114
Ground Water Conclusions	6-117
References	6-122
 CHAPTER 7 - IDAHO	 7-1
Lowman, Idaho, Site	7-3
Site Description and Location	7-3
Site History and Ownership	7-3
Site Characterization and Cleanup	7-4
Environmental Compliance Status	7-4
Environmental Monitoring	7-4
Surface Water Monitoring	7-4
Surface Water Results and Conclusions	7-4
Ground Water Monitoring	7-6
Ground Water Results and Conclusions	7-6
References	7-9
 CHAPTER 8 - NEW MEXICO	 8-1
Ambrosia Lake, New Mexico, Site	8-3
Site Description and Location	8-3
Site History and Ownership	8-3
Site Characterization and Cleanup	8-5
Environmental Compliance Status	8-6
Superfund Amendments and Reauthorization Act	8-6
Resource Conservation and Recovery Act	8-6
Clean Water Act	8-6

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
National Pollutant Discharge Elimination System	8-6
Spill Prevention Control and Countermeasures Plan	8-6
Septic/Holding Tanks	8-7
Clean Air Act	8-7
Hazardous Materials Transportation Act	8-7
Environmental Compliance Permits	8-7
Environmental Monitoring	8-7
Air Monitoring	8-8
Nonradiological Air Particulate	8-8
Radiological Air Particulate Monitoring	8-8
Radon Monitoring	8-11
Air Monitoring Conclusions	8-11
Environmental Gamma Radiation Monitoring	8-14
Environmental Gamma Radiation Monitoring Conclusions	8-14
Shiprock, New Mexico, Site	8-17
Site Description and Location	8-17
Site History and Ownership	8-17
Site Characterization and Cleanup	8-19
Environmental Compliance Status	8-19
Environmental Monitoring	8-20
Surface Water Monitoring	8-20
Surface Water Results and Conclusions	8-22
Ground Water Monitoring	8-23
Terrace Ground Water Monitoring	8-23
Terrace Ground Water Results	8-25
Terrace Ground Water Conclusions	8-26
Floodplain Ground Water Monitoring	8-26
Floodplain Ground Water Results	8-29
Floodplain Ground Water Conclusions	8-29
References	8-33
 CHAPTER 9 - NORTH DAKOTA	 9-1
Belfield, North Dakota, Site	9-3
Site Description and Location	9-3
Site History and Ownership	9-3
Site Characterization and Cleanup	9-3
Environmental Compliance Status	9-5
Environmental Compliance Permits	9-5
Environmental Monitoring	9-5
Surface Water Monitoring	9-5
Ground Water Monitoring	9-6
Processing Site	9-6
Ground Water Results	9-6
Ground Water Conclusions	9-8
Bowman, North Dakota, Site	9-13
Site Description and Location	9-13

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
Site History and Ownership	9-13
Site Characterization and Cleanup	9-13
Environmental Compliance Status	9-15
Environmental Monitoring	9-15
Surface Water Monitoring	9-15
Ground Water Monitoring	9-15
Processing and Disposal Site	9-15
Ground Water Results	9-16
Ground Water Conclusions	9-16
References	9-22
 CHAPTER 10 - OREGON	 10-1
Lakeview, Oregon, Site	10-3
Site Description and Location	10-3
Site History and Ownership	10-3
Site Characterization and Cleanup	10-5
Environmental Compliance Status	10-5
Environmental Monitoring	10-6
Surface Water Monitoring	10-6
Processing Site	10-6
Surface Water Results and Conclusions	10-6
Ground Water Monitoring	10-8
Processing Site	10-8
Ground Water Results and Conclusions	10-11
Disposal Site	10-13
Ground Water Results and Conclusions	10-15
Ecological Monitoring	10-16
References	10-16
 CHAPTER 11 - PENNSYLVANIA	 11-1
Burrell, Pennsylvania, Site	11-3
Site Description and Location	11-3
Site History and Ownership	11-3
Site Characterization and Cleanup	11-3
Environmental Compliance Status	11-5
Environmental Monitoring	11-5
Surface Water Monitoring	11-5
Surface Water Results and Conclusions	11-5
Ground Water Monitoring	11-7
Ground Water Results	11-7
Ground Water Conclusions	11-7
 Canonsburg, Pennsylvania, Site	 11-11
Site Description and Location	11-11
Site History and Ownership	11-11
Site Characterization and Cleanup	11-13

TABLE OF CONTENTS

Section	Page
Environmental Compliance Status	11-14
Environmental Monitoring	11-14
Surface Water Monitoring	11-14
Surface Water Results and Conclusions	11-14
Ground Water Monitoring	11-14
Ground Water Results	11-16
Ground Water Conclusions	11-17
References	11-21
 CHAPTER 12 - TEXAS	 12-1
Falls City, Texas, Site	12-3
Site Description and Location	12-3
Site History and Ownership	12-3
Site Characterization and Cleanup	12-5
Environmental Compliance Status	12-6
Superfund Amendments and Reauthorization Act	12-6
Clean Water Act	12-7
National Pollutant Discharge Elimination System	12-7
Spill Prevention Control and Countermeasures Plan	12-7
Septic/Holding Tanks	12-7
National Environmental Policy Act	12-7
Safe Drinking Water Act	12-7
National Historic Preservation Act	12-7
Clean Air Act	12-8
Hazardous Materials Transportation Act	12-8
Noise Control	12-8
Environmental Compliance Permits	12-8
Environmental Monitoring	12-8
Air Monitoring	12-8
Nonradiological Air Particulate Monitoring	12-8
Radiological Air Particulate Monitoring	12-9
Radon Monitoring	12-9
Air Monitoring Conclusions	12-11
Environmental Gamma Radiation Monitoring	12-11
Environmental Gamma Radiation Monitoring Conclusions	12-12
Surface Water Monitoring and Results	12-13
Ground Water Monitoring	12-13
Ground Water Results and Conclusions	12-16
References	12-20

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
CHAPTER 13 - UTAH	13-1
Green River, Utah, Site	13-3
Site Description and Location	13-3
Site History and Ownership	13-3
Site Characterization and Cleanup	13-5
Environmental Compliance Status	13-5
Environmental Monitoring	13-5
Surface Water Monitoring	13-5
Surface Water Results	13-6
Surface Water Conclusions	13-6
Ground Water Monitoring	13-6
Processing Site	13-8
Ground Water Results	13-8
Ground Water Conclusions	13-11
Disposal Cell	13-12
Ground Water Results	13-12
Ground Water Conclusions	13-16
Mexican Hat, Utah, Site	13-17
Site Description and Location	13-17
Site History and Ownership	13-17
Site Characterization and Cleanup	13-19
Environmental Compliance Status	13-20
Superfund Amendments and Reauthorization Act	13-20
Clean Water Act	13-21
National Pollutant Discharge Elimination System	13-21
Spill Prevention Control and Countermeasures Plan	13-21
Septic/Holding Tanks	13-21
Clean Air Act	13-21
National Environmental Policy Act	13-21
Hazardous Materials Transportation Act	13-21
Environmental Permit Compliance Status	13-21
Site-Specific Requirements	13-22
Environmental Monitoring	13-23
Air Monitoring	13-23
Nonradiological Air Particulate Monitoring	13-23
Radiological Air Particulate Monitoring	13-23
Radon Monitoring	13-23
Air Monitoring Conclusions	13-25
Environmental Gamma Radiation Monitoring	13-25
Environmental Gamma Radiation Monitoring Conclusions	13-26
Ground Water Monitoring	13-26
Ground Water Results	13-29
Ground Water Conclusions	13-29
Salt Lake City, Utah, Sites	13-31
Site Description and Location	13-31
Site History and Ownership	13-31

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
Site Characterization and Cleanup	13-33
Environmental Compliance Status	13-33
Environmental Monitoring	13-33
Surface Water Monitoring	13-34
Ground Water Monitoring	13-34
Ground Water Results and Conclusions	13-34
References	13-40
 CHAPTER 14 - WYOMING	 14-1
Riverton, Wyoming, Site	14-3
Site Description and Location	14-3
Site History and Ownership	14-3
Environmental Compliance Status	14-5
National Environmental Policy Act	14-5
Environmental Monitoring	14-5
Surface Water Monitoring	14-6
Surface Water Results	14-6
Surface Water Conclusions	14-8
Ground Water Monitoring	14-8
Ground Water Results	14-12
Ground Water Conclusions	14-19
References	14-20
 CHAPTER 15 - GLOSSARY	 15-1

LIST OF FIGURES

Figure	Page
1-1 UMTRA Project Site Location Map	1-3
5-1 Monument Valley site location	5-4
5-2 Wind rose	5-5
5-3 Environmental air and gamma radiation monitoring locations, processing site	5-10
5-4 Environmental airborne radioactive particulate (thorium-230) concentrations	5-11
5-5 Passive radon concentrations	5-11
5-6 Environmental gamma radiation monitoring	5-12
5-7 Surface water sampling locations, processing site	5-13
5-8 Ground water monitoring well locations in the alluvium, Shinarump, and De Chelly aquifers, processing site	5-16
5-9 Ground water table contours in the alluvial aquifer, processing site	5-17
5-10 Nitrate concentrations in the alluvial ground water (1992), processing site	5-21
5-11 Nitrate concentrations over time in ground water, processing site	5-22
5-12 Nitrate concentrations over time in upgradient and downgradient wells, processing site	5-22
5-13 Tuba City site location	5-24
5-14 Surface water sampling locations, disposal site	5-27
5-15 Ground water monitoring well locations and potentiometric surface of Navajo Sandstone aquifer, disposal site	5-28
5-16 Nitrate concentrations in ground water, disposal site	5-30
5-17 Nitrate concentrations over time in ground water (1988-1993), disposal site	5-31
6-1 Durango processing and disposal site locations, La Plata County	6-4
6-2 Surface water and sediment sampling locations, processing site	6-8
6-3 Ground water monitoring well locations, processing site	6-10
6-4 Ground water table contours of the raffinate pond area, processing site	6-12
6-5 Sulfate concentrations over time, raffinate pond area, processing site	6-14
6-6 Uranium concentrations over time, raffinate pond area, processing site	6-14
6-7 Ground water monitoring well locations, disposal cell	6-15
6-8 Sulfate concentrations over time, alluvial wells, disposal site	6-17
6-9 Uranium concentrations over time, alluvial wells, disposal site	6-18
6-10 Ground water elevations, alluvial wells, disposal site	6-19
6-11 Grand Junction site location	6-22
6-12 Wind rose	6-23
6-13 Environmental air and gamma radiation monitoring stations, processing site	6-29
6-14 Total suspended particulates, processing site	6-30
6-15 Environmental air and gamma radiation monitoring stations, Cotter transfer site rail facility	6-31
6-16 Environmental air and gamma radiation monitoring stations, Cheney disposal site	6-32
6-17 Environmental airborne radioactive particulate (thorium-230) concentrations	6-33
6-18 Real-time radon concentrations	6-34
6-19 Passive radon concentrations	6-35
6-20 Environmental gamma radiation monitoring	6-37
6-21 Surface water and sediment sampling locations near the processing site	6-39
6-22 Ground water monitoring well locations, processing site	6-41

LIST OF FIGURES

Figure	Page
6-23 Ground water water table contours of the alluvium, processing site	6-42
6-24 Uranium concentrations in the alluvial aquifer, processing site	6-43
6-25 Uranium concentrations over time in the alluvial aquifer, processing site	6-45
6-26 Gunnison site location	6-48
6-27 Wind rose	6-49
6-28 Environmental air and gamma radiation monitoring stations, processing site	6-55
6-29 Total suspended particulates, processing site	6-56
6-30 Environmental air and gamma radiation monitoring stations, disposal site	6-57
6-31 Environmental airborne radioactive particulate (thorium-230) concentrations	6-58
6-32 Real-time radon concentrations	6-59
6-33 Passive radon concentrations	6-60
6-34 Environmental gamma radiation monitoring	6-61
6-35 Surface water, sediment, and fish sampling locations in the processing site vicinity	6-63
6-36 Ground water monitoring well locations, processing site	6-66
6-37 Potentiometric surface for intermediate monitoring wells, processing site	6-67
6-38 Sulfate concentrations in the alluvial aquifer, processing site	6-70
6-39 Uranium concentrations for intermediate monitoring wells, processing site	6-71
6-40 Sulfate concentrations over time in the alluvial aquifer, processing site	6-72
6-41 Uranium concentrations over time in the alluvial aquifer, processing site	6-72
6-42 Monitoring well locations, disposal site	6-73
6-43 Potentiometric surface of the Tertiary gravel aquifer, disposal site	6-74
6-44 Rifle site locations	6-78
6-45 Wind rose	6-79
6-46 Environmental air and gamma radiation monitoring stations	6-85
6-47 Total suspended particulates, New Rifle processing site	6-86
6-48 Environmental air and gamma radiation monitoring stations, Estes Gulch disposal site	6-87
6-49 Air and gamma radiation monitoring background stations	6-88
6-50 Environmental airborne radioactive particulate (thorium-230) concentrations	6-89
6-51 Real-time radon concentrations	6-91
6-52 Passive radon concentrations	6-92
6-53 Environmental gamma radiation monitoring	6-94
6-54 Surface water sampling locations, Old and New Rifle sites	6-96
6-55 Ground water monitoring well locations, New Rifle processing site	6-100
6-56 Ground water monitoring well locations, Old Rifle processing site	6-101
6-57 Ground water table contours for alluvial aquifer, New Rifle processing site	6-102
6-58 Potentiometric surface for the Wasatch Formation, New Rifle processing site	6-103
6-59 Potentiometric surface for the Wasatch Formation, Old Rifle processing site	6-104
6-60 Sulfate concentrations for the alluvial aquifer, New Rifle processing site	6-108
6-61 Uranium concentrations for the alluvial aquifer, New Rifle processing site	6-109
6-62 Sulfate concentrations over time in the alluvial aquifer, New Rifle processing site	6-110
6-63 Uranium concentrations over time in the alluvial aquifer, New Rifle processing site	6-111
6-64 Sulfate concentrations for ground water in the Wasatch Formation, New Rifle processing site	6-112
6-65 Uranium concentrations for ground water in the Wasatch Formation, New Rifle processing site	6-113

LIST OF FIGURES

Figure	Page
6-66 Sulfate concentrations over time in the Wasatch Formation, New Rifle processing site	6-115
6-67 Uranium concentrations over time in the Wasatch Formation, New Rifle processing site	6-116
6-68 Sulfate concentrations for the alluvial aquifer, Old Rifle processing site	6-118
6-69 Uranium concentrations for the alluvial aquifer, Old Rifle processing site	6-119
6-70 Sulfate concentrations over time in the alluvial aquifer, Old Rifle processing site	6-120
6-71 Uranium concentrations over time in the alluvial aquifer, Old Rifle processing site	6-121
7-1 Lowman site location	7-2
7-2 Surface water and ground water sampling locations and potentiometric surface, disposal cell	7-5
7-3 Barium concentrations over time in ground water, disposal site	7-8
7-4 Nitrate concentrations over time in ground water, disposal site	7-8
8-1 Ambrosia Lake site location	8-4
8-2 Wind rose	8-5
8-3 Environmental air and gamma radiation monitoring stations, processing site	8-9
8-4 Environmental airborne radioactive particulate (thorium-230) concentrations	8-10
8-5 Real-time radon concentrations	8-12
8-6 Passive radon concentrations	8-13
8-7 Environmental gamma radiation monitoring	8-15
8-8 Shiprock site location	8-18
8-9 Surface water and sediment sampling locations	8-21
8-10 Ground water monitoring well locations	8-24
8-11 Uranium concentrations over time, terrace area	8-27
8-12 Ground water table contours and gradient on floodplain	8-28
8-13 Sulfate concentrations in alluvium	8-30
8-14 Uranium concentrations in alluvium	8-31
8-15 Nitrate concentrations in alluvium	8-32
9-1 Belfield site location	9-4
9-2 Ground water monitoring well locations, processing site	9-7
9-3 Potentiometric surface of the upper aquifer, processing site	9-9
9-4 Potentiometric surface of the lignite aquifer, processing site	9-10
9-5 Uranium concentrations in the upper and lignite aquifers, processing site	9-11
9-6 Bowman site location	9-14
9-7 Ground water monitoring well locations, processing site	9-17
9-8 Potentiometric surface of the upper aquifer, processing site	9-19
9-9 Potentiometric surface of the lignite aquifer, processing site	9-20
9-10 Uranium concentrations in the upper and lignite aquifers, processing site	9-21
10-1 Lakeview site location	10-4
10-2 Surface water sediment sampling and ground water monitoring well locations, processing site vicinity	10-7
10-3 Potentiometric surface of shallow monitoring wells, processing site	10-10

LIST OF FIGURES

Figure	Page
10-4 Sulfate concentrations in the lacustrine aquifer, processing site	10-12
10-5 Sulfate concentrations over time in the lacustrine aquifer	10-13
10-6 Ground water table contours for the lacustrine aquifer	10-14
11-1 Burrell site location	11-4
11-2 Surface water sampling and ground water monitoring well locations, disposal site	11-6
11-3 Ground water table of the unconsolidated materials, disposal site	11-9
11-4 Potentiometric surface of the shallow bedrock, disposal site	11-10
11-5 Canonsburg site location	11-12
11-6 Surface water sampling and ground water monitoring well locations, disposal site	11-15
11-7 Potentiometric surface of the unconsolidated materials, disposal site	11-18
11-8 Potentiometric surface of the shallow bedrock, disposal site	11-19
11-9 Uranium concentrations in the alluvial and shallow bedrock, disposal site	11-20
12-1 Falls City site location	12-4
12-2 Wind rose	12-5
12-3 Environmental air and gamma radiation monitoring stations	12-10
12-4 Real-time radon concentrations	12-11
12-5 Environmental gamma radiation monitoring	12-12
12-6 Potentiometric surface of the Deweesville/Conquista aquifer	12-14
12-7 Potentiometric surface of the Dilworth aquifer	12-15
12-8 Ground water monitoring well locations	12-17
12-9 Distribution of tailings-contaminated ground water	12-19
13-1 Green River site location	13-4
13-2 Ground water monitoring well locations, processing site	13-7
13-3 Ground water table of the Brown's Wash alluvium, processing site	13-9
13-4 Uranium concentrations in the Brown's Wash alluvium, processing site	13-10
13-5 Ground water monitoring well locations, disposal site	13-13
13-6 Potentiometric surface of the Upper Cedar Mountain Formation, disposal site	13-15
13-7 Arsenic concentrations over time in the Upper Cedar Mountain Formation, disposal site	13-16
13-8 Mexican Hat site location	13-18
13-9 Wind rose	13-19
13-10 Environmental air and gamma radiation monitoring stations	13-24
13-11 Real-time radon concentrations	13-25
13-12 Seep and ground water monitoring well locations	13-27
13-13 Potentiometric surface, Honaker Trail Formation	13-28
13-14 Vitro processing site and South Clive disposal site locations	13-32
13-15 Surface water sampling and ground water monitoring well locations, Vitro processing site	13-35
13-16 Ground water table contours of the unconfined aquifer, Vitro processing site	13-37
13-17 Sulfate concentrations in the unconfined aquifer, Vitro processing site	13-39
14-1 Riverton site location	14-4
14-2 Surface water sampling locations	14-7

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
14-3 Ground water table contour in the surficial aquifer	14-9
14-4 Potentiometric surface of the semiconfined sandstone aquifer	14-10
14-5 Potentiometric surface of the confined sandstone aquifer	14-11
14-6 Domestic well locations	14-13
14-7 Ground water monitoring well locations	14-14
14-8 Uranium concentrations in the surficial aquifer	14-15
14-9 Molybdenum concentrations in the surficial aquifer	14-16
14-10 Sulfate concentrations in the surficial aquifer	14-17
14-11 Uranium concentrations over time in ground water	14-18
14-12 Molybdenum concentrations over time in ground water	14-19
14-13 Sulfate concentrations over time in ground water	14-19

LIST OF TABLES

Table	Page
1-1 Status of remediation activities—UMTRA Surface Project sites (1993)	1-4
4-1 Water evaluation intercomparison study	4-5
4-2 Air filter evaluation intercomparison study	4-5
4-3 Water performance evaluation intercomparison study	4-6
4-4 Soil evaluation intercomparison study, quality assurance program	4-6
4-5 Air evaluation intercomparison study, quality assurance program	4-6
4-6 Water evaluation intercomparison study, quality assurance program	4-7
4-7 Summary of the 1993 Technical Assistance Contractor quarterly performance evaluation program	4-10
5-1 Active permits	5-9
5-2 Surface water quality results	5-15
5-3 Ground water quality results	5-18
5-4 Surface water quality results	5-26
5-5 Ground water quality results	5-29
6-1 Surface water and sediment quality results, processing site	6-9
6-2 Ground water quality results, processing site	6-13
6-3 Ground water quality results, disposal cell	6-16
6-4 Active permits	6-28
6-5 Radiological surface water results	6-38
6-6 Surface water quality results, processing site	6-40
6-7 Ground water quality results, processing site	6-44
6-8 Active permits	6-53
6-9 Radiological surface water results	6-62
6-10 Surface water quality results, processing site	6-64
6-11 Ground water quality results, processing site	6-69
6-12 Active permits	6-84
6-13 Radiological surface water results	6-95
6-14 Surface water quality results, New Rifle processing site	6-97
6-15 Surface water quality results, Old Rifle processing site	6-98
6-16 New Rifle processing site alluvial ground water quality results	6-106
6-17 Wasatch ground water quality results, New Rifle processing site	6-107
6-18 Alluvial ground water quality results, Old Rifle processing site	6-117
7-1 Surface water quality results (surface location 561)	7-6
7-2 Ground water quality results, Lowman site	7-7
8-1 Active permits	8-7
8-2 San Juan River surface water and sediment quality results	8-22
8-3 Terrace and floodplain ground water quality results	8-25
9-1 Ground water quality results, processing site	9-8
9-2 Ground water quality results, processing site	9-18

LIST OF TABLES

<u>Table</u>	<u>Page</u>
10-1 Surface water quality results, processing site	10-8
10-2 Ground water quality results, processing site	10-11
11-1 Ground water quality results	11-8
11-2 Ground water quality results	11-17
12-1 Active permits	12-9
12-2 Radiological surface water results, downstream	12-13
12-3 Ground water quality data	12-18
13-1 Surface water quality results	13-8
13-2 Ground water quality results, processing site	13-11
13-3 Ground water quality results, disposal site	13-15
13-4 Active permits	13-22
13-5 Seep water quality results, June 1993	13-29
13-6 Surface water and sediment quality results	13-36
13-7 Shallow unconfined aquifer ground water quality results, processing site	13-38
14-1 Surface water quality results	14-6
14-2 Surficial aquifer ground water quality results	14-18

LIST OF ACRONYMS AND ABBREVIATIONS

AEC	U.S. Atomic Energy Commission
APHA	American Public Health Association
BLS	below land surface
CAA	Clean Air Act
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CWA	Clean Water Act
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
°F	degrees Fahrenheit
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FM-1344	Farm-to-Market Road 1344
ft	feet
HAZWRAP	Hazardous Waste Remedial Action Program
HMTA	Hazardous Materials Transportation Act
μCi/mL	microcuries per milliliter
μg/m ³	micrograms per cubic meter
mg/L	milligrams per liter
mrem	millirem
MSL	mean sea level
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NIST	National Institute of Standards and Technology
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
pCi/g	picocuries per gram
pCi/L	picocuries per liter
pCi/m ² s	picocuries per square meter per second
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
UMTRA	Uranium Mill Tailings Remedial Action
UMTRCA	Uranium Mill Tailings Radiation Control Act
USACE	U.S. Army Corps of Engineers
Vitro	Vitro Rare Metals Company

LIST OF ACRONYMS AND ABBREVIATIONS

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UWATPA PROJECT

CHAPTER 1 INTRODUCTION

CHAPTER 1 — INTRODUCTION

PURPOSE

In accordance with U.S. Department of Energy (DOE) Order 5400.1, *General Environmental Protection Program*, the DOE prepares an annual report to document the activities of the Uranium Mill Tailings Remedial Action (UMTRA) Project environmental monitoring program. This monitoring must comply with appropriate laws, regulations, and standards and it must identify apparent and meaningful trends. The results of all monitoring activities must be communicated to the public. The UMTRA Project has prepared annual environmental reports to the public since 1989. This report was formerly titled the "Annual Environmental Monitoring Report."

SCOPE

This annual report to the public presents representative data from environmental monitoring activities conducted during 1993. It follows the organization shown below.

Chapter 1

Introduction - Programmatic information related to the UMTRA Project environmental protection program.

Chapter 2

Compliance summary - Summary of 1993 compliance with environmental regulations and codes applicable to the UMTRA Project. Site-specific regulatory compliance issues are also addressed in this chapter.

Chapter 3

Monitoring methodology - An overview of UMTRA Project environmental monitoring methodologies, describing the monitoring programs, methods, and procedures that govern field sampling activities and sample analyses.

Chapter 4

Quality assurance - An overview of the UMTRA Project's quality assurance programs and procedures. It describes elements and responsibilities of the quality assurance programs conducted by both the Remedial Action Contractor and the Technical Assistance Contractor.

Chapters 5 through 14

UMTRA Project sites - Organized by state, site-specific environmental data for all sites sampled in 1993 in support of the UMTRA environmental protection program. Each chapter includes general site information, site-specific regulatory compliance information, and environmental monitoring data. These data typically include air, surface water, and ground water monitoring data. However, not all sites were sampled; those that were sampled may not have been sampled for all media. For example, air monitoring was not conducted at sites where surface remedial action is complete or has not begun. Data are illustrated with tables and graphs. Conclusions are provided for each sampling media and for each site. Each chapter contains a list of references cited in that section.

Chapter 15

Glossary

Additional information may be obtained through the DOE UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New

CHAPTER 1 — INTRODUCTION

Mexico, or by calling the following toll free numbers: 1-800-523-6495 (outside New Mexico) or 1-800-423-2539 (inside New Mexico).

UMTRA PROJECT MISSION

In 1978, Congress authorized the DOE to clean up mill tailings at 24 designated inactive uranium mill sites in 10 states. The DOE established the UMTRA Project to carry out this mission. The UMTRA Project responds to public concern regarding the potential health hazards associated with radon exposure, particularly in confined areas. In the first phase of the Project, residual radioactive materials from vicinity properties (residences, businesses, and open lands where tailings were either carried by wind or water or were used as construction materials) and mill tailings are consolidated and isolated in engineered disposal cells. Following completion of the surface cleanup, the Project will evaluate the need to conduct ground water restoration as required to meet proposed U.S. Environmental Protection Agency (EPA) standards (40 CFR Part 192) on a site-by-site basis. The federal government and affected states share UMTRA remediation costs, with DOE paying 90 percent. On Indian tribal lands, DOE pays the full cost of remediation. The Surface Project is expected to be complete in 1996; the Ground Water Project is planned for completion by 2014.

Jacobs Engineering Group Inc. is the Technical Assistance Contractor for the UMTRA Project. With its three teaming partners—Roy F. Weston, Inc.; Geraghty & Miller Environmental Services; and AGRA E&E; Jacobs provides technical and management support for the Project, including planning and design development. Approximately 140 employees from these four companies work full time on the Project. MK-Ferguson Company, the Remedial Action Contractor, is responsible for engineering and designing approved remedial action, managing construction activities, and accomplishing remedial action. MK-Ferguson has 180 full-time employees on the Project; an additional 675 subcontractor employees assist MK-Ferguson in the field.

PROJECT INFORMATION

The UMTRA Project consists of the Surface Project and the Ground Water Project. Under the UMTRA Surface Project, the DOE remediates surface contamination (including uranium mill tailings and abandoned mill buildings) at 24 abandoned processing sites and at numerous vicinity properties near those sites (*Figure 1-1*). Remedial action controls exposure and dispersion of the tailings by stabilizing these materials in engineer-designed disposal cells. The first site to be remediated was the Canonsburg, Pennsylvania, site; surface remediation is now complete at 10 sites, is under way at 8 sites, and was in the planning stages at the remaining 6 sites (*Table 1-1*).

The UMTRA Ground Water Project addresses ground water contamination, if any, at the 24 UMTRA Project sites. The purpose of

Figure 1-1
UMTRA Project Site Location Map

CHAPTER 1 — INTRODUCTION

Table 1-1 Status of remediation activities—UMTRA Surface Project sites (1993)

Remediation complete — 10 sites	
Canonsburg-Burrell, Pennsylvania	Riverton, Wyoming
Durango, Colorado	Salt Lake City, Utah
Green River, Utah	Shiprock, New Mexico
Lakeview, Oregon	Spook, Wyoming
Lowman, Idaho	Tuba City, Arizona
Remediation under way — 8 sites	
Ambrosia Lake, New Mexico	Mexican Hat, Utah
Falls City, Texas	Monument Valley, Arizona
Grand Junction, Colorado	Rifle, Colorado (2 sites)
Gunnison, Colorado	
Remediation planned — 6 sites	
Belfield, North Dakota	Naturita, Colorado
Bowman, North Dakota	Slick Rock, Colorado (2 sites)
Maybell, Colorado	

the Ground Water Project is to protect human health and the environment by complying with ground water protection standards proposed by the EPA. The DOE is preparing an UMTRA Project programmatic environmental impact statement (in preparation) that will satisfy the requirements of the National Environmental Policy Act (NEPA) (42 USC §4321 *et seq.*) by assessing the potential impacts of the Ground Water Project on the areas that need remediation. This assessment will be used in planning the Ground Water Project. Site-specific NEPA documents such as environmental assessments will be based on the programmatic environmental impact statement.

Additional information on the UMTRA Surface and Ground Water Projects is available from the DOE UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

ENVIRONMENTAL MONITORING PROGRAM

Because radioactive and hazardous constituents occur at UMTRA Project sites, federal and state environmental protection requirements apply to all UMTRA sites. UMTRA Project personnel continually monitor and investigate the effects of these constituents on the environment. The UMTRA Project environmental monitoring program is basic to this effort.

CHAPTER 1 — INTRODUCTION

Like any other complex program or investigation, the environmental monitoring program was developed after careful consideration of many components. For example, both radioactive and nonradioactive hazardous materials present at the former processing sites may be released to the environment by air and liquid discharges. The monitoring program follows the anticipated movement of these materials through air, surface, and ground water pathways, measuring the amount of radioactive and nonradioactive materials leaving the sites and entering the surrounding environment.

Focusing on results, the environmental monitoring program also includes the following activities:

- Evaluates the impact of site activities (past and present) on the environment.
- Estimates the radiation dose to area residents from current cleanup efforts at the sites.
- Measures progress in correcting problems from past site activities and in implementing improved environmental management practices.
- Identifies significant and meaningful trends in monitoring results.
- Prepares an annual report on the sampling conducted each year to demonstrate that the sites comply with DOE and EPA requirements (i.e., this report).
- Addresses exposure pathways and contaminants that could result in unacceptable risk to the public or the environment.

UMTRA REGULATORY ARENA

Pursuant to the Uranium Mill Tailings Radiation Control Act (UMTRCA) (42 USC §7901 *et seq.*), the DOE administers the UMTRA Project following U.S. Nuclear Regulatory Commission (NRC)- and EPA-promulgated regulations for remediating residual radioactive materials and associated ground water contamination and for subsequent long-term care of disposal sites. This chapter gives an overview of these UMTRA-specific regulations and the DOE environmental protection guidelines applicable to the UMTRA Project. Other environmental regulations applicable to the UMTRA Project are discussed in Chapter 2.

U.S. Environmental Protection Agency Standards

In 1983, the EPA published environmental protection standards for residual radioactive materials at designated processing sites (40 CFR Part 192). The UMTRCA defines residual radioactive materials as uranium mill tailings and other nonradiological processing site wastes. The EPA standard is divided into three subparts that affect the

CHAPTER 1 — INTRODUCTION

UMTRA Project. Subpart A identifies standards for controlling residual radioactive materials at designated processing and disposal sites. Subpart B identifies standards for cleaning up land and buildings contaminated with processing site residual radioactive materials. Subpart C provides guidance for implementing the provisions of Subparts A and B. Subpart C also establishes the criteria the implementing agencies follow when they apply supplemental standards. The implementing agencies are the DOE, NRC, and affected states and Indian tribes.

In 1985, the U.S. Court of Appeals for the Tenth Circuit set aside portions of the EPA-proposed standards (40 CFR §192.20(a)(2) and (3)) related to ground water protection and required the EPA to replace them. The EPA proposed new ground water protection standards in 1987 (52 FR 36000 (1987)). A draft final rule is still in review. Section 108 of the UMTRCA requires DOE compliance with the proposed standards until final standards are promulgated.

The primary objectives of these human health and environmental protection standards are to isolate and stabilize residual radioactive materials to prevent misuse by people and dispersal by natural forces, to control radon emissions, to remediate contaminated ground water, and to protect ground water resources from being adversely affected by potential contaminant migration.

U.S. Nuclear Regulatory Commission Standards

NRC licensing requirements in 10 CFR §40.27, *General License for Custody and Long-Term Care of Residual Radioactive Material Disposal Sites*, took effect November 30, 1990 (55 FR 45591 (1990)). The NRC general license (mandated by the UMTRCA) provides the mechanism for licensing residual radioactive materials for each UMTRA Project disposal site as the NRC accepts each site-specific long-term surveillance plan. Long-term care includes monitoring and maintenance necessary to protect public health and safety.

U.S. Department of Energy Orders

DOE Order 5400.1, *General Environmental Protection Program*, established environmental protection program requirements for DOE operations, including the UMTRA Project, for ensuring compliance with applicable federal, state, and local environmental protection laws, regulations, and executive orders. The DOE has also established requirements to protect the public, workers, and the environment from radiological hazards in DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. These and all other applicable requirements are routinely incorporated into UMTRA Project activities.

PARTICIPATION BY FEDERAL AGENCIES, STATES, AND INDIAN TRIBES

U.S. Department of Energy

The responsibility for fulfilling the UMTRCA legislative mandate is divided primarily between the DOE, NRC, EPA, and the affected states and Indian tribes. Their roles are described below.

As the lead agency carrying out the UMTRCA mandate, the DOE is responsible for overall management of the UMTRA Project. The DOE is responsible for making all programmatic decisions and for reviewing and supervising the work of the DOE contractors. Through cooperative agreements, the DOE coordinates its activities with the affected state, tribal, and local governments and the NRC.

Within the DOE, the Assistant Secretary for Environmental Management at DOE Headquarters oversees administration of the UMTRA Project. The DOE Albuquerque Operations Office is the responsible field organization. The DOE UMTRA Project Office in Albuquerque, New Mexico, manages UMTRA Project daily operations.

U.S. Nuclear Regulatory Commission

The UMTRCA designated the NRC as the federal regulatory oversight agency for the UMTRA Project, with the following responsibilities for the UMTRA Surface and Ground Water Projects:

- Ensure that DOE's selection of remedial action will meet EPA standards.
- Ensure that remedial action was completed as designed.
- License completed disposal sites.
- Sign the cooperative agreements.

The NRC provides technical and regulatory review of UMTRA Project decision and planning documents, including remedial action plans, completion reports, long-term surveillance plans, and certification reports. NRC concurrence with these documents is required before NRC will license a site, pursuant to a memorandum of understanding between DOE and NRC. In addition, the NRC provides concurrence on all supplemental standards applications for vicinity properties.

U.S. Environmental Protection Agency

As amended by the UMTRCA, the Atomic Energy Act of 1954 requires the EPA to set general standards for protecting public health, safety, and the environment (including air and ground water) from radiological hazards (e.g., uranium and radon) and nonradiological hazards (e.g., nitrate, molybdenum, and arsenic) associated with residual radioactive materials. In establishing standards, the EPA must consider the potential risk to public health, safety, and the

CHAPTER 1 — INTRODUCTION

environment; the environmental and economic costs of applying the standards; and other appropriate factors.

The EPA has prepared a final rule revising the ground water cleanup and protection standards in 40 CFR Part 192. This final rule currently is with the Office of Management and Budget awaiting approval to publish in the *Federal Register*.

States and Indian Tribes

The UMTRCA requires the affected states to participate fully in remediating designated processing sites. The affected Indian tribes are consulted when remedial action is planned on tribal lands. The roles of the states and Indian tribes in the UMTRA Project are defined through cooperative agreements. These agreements establish the funding, real estate actions, and technical review requirements needed to conduct remedial action. Each state provides 10 percent of the remedial action costs for each of its sites and, if necessary, acquires title to the processing or disposal sites. When remedial action is complete, where applicable, states are required to transfer ownership of the disposal sites to the federal government for long-term custodial care. Indian tribes share none of the remedial action costs. Custody of disposal sites on Indian lands will be transferred to the DOE through a long-term custodial agreement to allow the DOE to conduct surveillance and monitoring activities at the sites.

State and tribal participation in the UMTRA Ground Water Project includes their review and comment on major technical documents and concurrence on remedial action plans. The existing cooperative agreements are mechanisms for state and tribal participation in the UMTRA Ground Water Project, but the agreements may need modification to incorporate issues specific to ground water activities. In addition, the states and tribes will assist in implementing appropriate institutional controls during ground water remediation where they are deemed necessary.

UMTRA PROJECT PUBLIC PARTICIPATION PROGRAM

The UMTRCA requires public involvement in remedial action planning. The Secretary of Energy must hold public meetings in states that contain processing sites, vicinity properties, or disposal sites.

However, public participation in the UMTRA Project is not limited to the mechanisms formally required by law. The public is involved in informational meetings, workshops, local citizen task forces, and advisory groups.

The UMTRA Project *Public Information Plan* (DOE, 1993a) describes the procedures and methods used to inform the public about all aspects of the UMTRA Project, so as to encourage informed UMTRA Project participation by the public and by government officials. Information is

disseminated to federal, state, and local officials; the media; special interest groups; and all other interested parties.

1993 UMTRA PROJECT ACCOMPLISHMENTS

During the 1993 reporting period, the following milestones were achieved:

- The Spook, Wyoming, disposal cell was brought under NRC general license for UMTRA Project sites. This is the first UMTRA Project disposal cell for which licensing is complete.
- The Project completed tailings placement at the Falls City, Texas, site and reduced environmental radon levels at the Grand Junction, Colorado, site from initial levels of 16.1 picocuries per liter (pCi/L) to the present level of 1.2 pCi/L.
- Tailings haul began at the Rifle and Gunnison, Colorado, sites.
- The train haul of mill tailings was completed for the Grand Junction, Colorado, processing site.
- Relocation of uranium mill tailings from the Monument Valley site to the Mexican Hat disposal cell was completed in October 1993.
- Tailings consolidation began at the Ambrosia Lake, New Mexico, site.
- Efficient use of wastewater for on-site dust control enabled the Project to prevent discharging potentially contaminated water at all sites.
- An effective waste minimization program and recycling program reduced Project-generated waste material by recycling paper, oil, antifreeze, batteries, and some metal materials. In addition, hazardous products/materials were eliminated or substituted with nonhazardous materials, accomplishing operations without producing more hazardous waste.
- Continuous adherence to the UMTRA Project environmental plans and programs helped ensure compliance with all environmental permits and regulations.
- The *Technical Approach to Ground Water Restoration* (DOE, 1993b) was published. This document describes the approach the UMTRA Project will follow to achieve compliance with the ground water cleanup standards at processing sites with ground water contamination.

CHAPTER 1 — INTRODUCTION

- Twenty-three scoping and community assessment meetings were held for the programmatic environmental impact statement for the Ground Water Project.
- A draft programmatic impact statement and implementation plan were prepared for the Ground Water Project.
- Preparations began for site-specific baseline risk assessments and water sampling and analysis plans for the Ground Water Project.

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DOE Orders

Order 5400.1, *General Environmental Protection Program*, November 9, 1988, U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Order 5400.5, *Radiation Protection of the Public and the Environment*, U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

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52 FR 36000, *Standards for Remedial Action at Inactive Uranium Processing Sites; Proposed Rule*, U.S. Environmental Protection Agency, September 24, 1987.

55 FR 45591, *Custody and Long-Term Care of Uranium and Thorium Mill Tailings Disposal Sites*, U.S. Nuclear Regulatory Commission, October 30, 1990.

CHAPTER 1 — INTRODUCTION

United States Code

42 USC §4321 *et seq.*, *National Environmental Policy Act*, January 1, 1970.

42 USC §7901 *et seq.*, *Uranium Mill Tailings Radiation Control Act*, November 8, 1978.

CHAPTER 1 — INTRODUCTION

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CHAPTER 2 ENVIRONMENTAL COMPLIANCE SUMMARY

CHAPTER 2 — ENVIRONMENTAL COMPLIANCE SUMMARY

The Uranium Mill Tailings Remedial Action (UMTRA) Project must follow the environmental protection requirements established by the agencies that govern activities at the 24 UMTRA Project sites. These requirements fall into three general categories:

- Requirements imposed by federal statutes and regulations.
- Site-specific requirements imposed through agreements with regulatory, state, and local agencies and Indian tribes.
- Requirements imposed by U.S. Department of Energy (DOE) Orders and directives.

Activities on the UMTRA sites must follow regulations for hazardous materials management and transportation, underground storage tank removal, discharge to surface water, ground water protection, airborne emissions, community right-to-know notifications, and spill prevention control and countermeasures.

COMPLIANCE SUMMARY

This chapter summarizes the statutes and regulations applicable to the 24 UMTRA Project sites.

Uranium Mill Tailings Radiation Control Act

The Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978 (42 USC §7901 *et seq.*) requires the DOE to remediate designated processing sites in accordance with U.S. Environmental Protection Agency (EPA) standards for cleanup and disposal of residual radioactive materials prescribed in 40 CFR Part 192 and proposed ground water protection standards (52 FR 36000 (1987)). The UMTRCA also requires the DOE to care for the permanent disposal sites in accordance with U.S. Nuclear Regulatory Commission general license requirements in 10 CFR Part 40.

In 1993, remedial action consisted of excavating surface contamination and placing it in engineered disposal cells at seven UMTRA sites in accordance with remedial action plans. To assess disposal cell performance, point-of-compliance ground water monitoring was conducted at five completed disposal sites in accordance with long-term surveillance plans developed to meet 10 CFR Part 40 licensing requirements. The UMTRA Project met 40 CFR Part 192 cleanup and disposal standards and obtained the concurrence of all appropriate implementing agencies. Ground water remediation activities were not conducted in 1993.

Superfund Amendments and Reauthorization Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC §9601 *et seq.*) requires notification of state and local emergency response authorities for hazardous

CHAPTER 2 — ENVIRONMENTAL COMPLIANCE SUMMARY

material spills of specified reportable quantities. These specific requirements are governed by the Superfund Amendments and Reauthorization Act (SARA) (Public Law 99-499). All 1993 UMTRA Project activities met SARA requirements. No spills of hazardous materials exceeded reportable quantities during 1993 at any UMTRA site.

Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) (42 USC §6901 *et seq.*) mandates a comprehensive program to regulate and manage hazardous waste (including underground storage tanks) from generation to disposal. During 1993, the UMTRA Project was active in Arizona, Colorado, New Mexico, Texas, and Utah. Depending on location, either a state agency or the EPA enforced RCRA compliance. Residual radioactive material regulated under 40 CFR Part 192 is not subject to RCRA hazardous waste regulations. The UMTRA Project rarely generates RCRA wastes, and none were generated in 1993.

Subtitle I of the Hazardous and Solid Waste Act (Public Law 98-616) (amendments to RCRA) regulates underground tanks that contain RCRA-regulated substances. The EPA has delegated full regulatory authority to each state; state regulations must be at least as stringent as those of the EPA. During 1993, one UMTRA site in New Mexico was involved in underground storage tank compliance activities.

The UMTRA Project requires all chemical products used on the site to be consumed in the remediation process, reused, or recycled to minimize waste. Qualified local vendors are contracted to recycle most bulk products such as oil, fuels, antifreeze, greases, and batteries on a scheduled basis. Other waste items (such as spray paint cans) are not discarded until empty. Site procedures implement waste minimization and recycling activities. Also, waste minimization and pollution prevention activities reduce the generation of hazardous wastes.

Clean Water Act

The Clean Water Act (CWA) (33 USC §1251 *et seq.*) sets requirements to protect, maintain, and restore the chemical, physical, and biological integrity of the nation's water. The CWA established the National Pollutant Discharge Elimination System (NPDES), which requires permits for all point-source effluent discharges to water sources. In 1993, specific state, federal, and tribal regulations enforced the CWA at all sites in remediation.

All UMTRA sites undergoing remediation were required to comply with NPDES requirements. In 1993, active sites in New Mexico, Colorado, Texas, Utah, and Arizona did not release water under NPDES permits because the water was used on the site for dust control or evaporated in retention ponds.

CHAPTER 2 — ENVIRONMENTAL COMPLIANCE SUMMARY

Site-specific spill prevention control and countermeasures plans address requirements for spill response and reporting and for secondary spill containment systems for bulk chemical storage areas. Lined earthen berms that meet spill prevention control and countermeasures requirements have been constructed around all aboveground storage tanks and oil drum storage areas at all active UMTRA Project sites; these secondary containment systems are designed to control spills adequately. In 1993, spill prevention control and countermeasures plans, including procedures for berm inspection, spill detection, emergency spill response, and spill cleanup, were implemented for active fuel and oil storage areas. No significant spills occurred in 1993.

At UMTRA sites undergoing remediation, sanitary waste is disposed of in holding tanks or through local sewer systems. Holding tanks are emptied at least yearly, or as needed. Temporary portable toilets are available at all active UMTRA sites; waste from these facilities is disposed of in accordance with state and local requirements.

National Environmental Policy Act

The National Environmental Policy Act (NEPA) of 1969 (42 USC §4321 *et seq.*) requires federal agencies to prepare a detailed statement identifying and analyzing the potential environmental impacts of proposed actions that could significantly affect the quality of the human environment.

NEPA-related documents (environmental impact statements and environmental assessments) that analyze the site-specific impacts of proposed surface remediation are complete for 18 of the sites and are being developed for the remaining 6 sites. No NEPA documents were finalized in 1993.

Because the UMTRA Ground Water Project is considered a new federal action, the DOE has determined that additional NEPA documentation is needed to address the potential impacts of complying with the proposed EPA standards. A ground water programmatic environmental impact statement is being prepared to provide a framework for the Ground Water Project. Between November 18, 1992, and May 4, 1993, 23 public meetings were held in 16 communities to solicit public input for this effort. The UMTRA Project completed a draft programmatic environmental impact statement and its implementation plan (both in preparation) in 1993 and transmitted these documents to DOE headquarters for review.

Ecological monitoring is necessary on the UMTRA Project to meet site-specific and regulatory requirements. As part of the NEPA process, activities such as surveys for threatened and endangered species and cultural resources, assessments of wetlands and floodplains, or plans for environmental mitigative action may be

CHAPTER 2 — ENVIRONMENTAL COMPLIANCE SUMMARY

needed. When necessary, the UMTRA Project conducts ecological risk assessments for the Ground Water Project baseline risk assessments and to address site-specific ecological concerns.

Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) (42 USC §300f *et seq.*) is an environmental statute intended to protect drinking water resources. Primary drinking water standards promulgated under the SDWA apply to water at the tap as delivered by public or private supply systems.

The UMTRA Project does not own or operate a drinking water supply system at any site. Local, publicly owned water works supply potable water, when possible. Bottled water is purchased from appropriate local vendors for use at remote locations. Also, proper well construction techniques help prevent ground water contamination in an effort to protect drinking water resources.

Endangered Species Act

The Endangered Species Act (16 USC §1531 *et seq.*) prohibits federal agencies from taking any action that would jeopardize the existence of endangered or threatened species or result in the destruction or adverse modification of critical habitat. Federal agencies are required to prepare a site-specific biological assessment if species of concern are determined to be in a proposed area of influence. The biological assessment determines the effects of proposed remedial action on endangered species (listed and proposed) and determines whether the proposed action may affect any listed species or critical habitat. The biological assessment is sent to the U.S. Fish and Wildlife Service for review; U.S. Fish and Wildlife Service prepares a biological opinion on the assessment and returns it to the originating agency (the DOE).

The DOE contacts the appropriate regional U.S. Fish and Wildlife Service office and state wildlife resources agencies as early as possible in project planning. When the DOE receives the U.S. Fish and Wildlife Service list of threatened and endangered species, the DOE determines the status of these species at each site and prepares a site-specific biological assessment. The status of a species may be determined from published information or may require a site-specific survey. The DOE's biological assessment, the U.S. Fish and Wildlife Service biological opinion, and all agreed-upon mitigation documentation become part of the site-specific NEPA documentation. This NEPA documentation is included in the environmental assessments or environmental impact statements for UMTRA Project sites.

During 1993, ecological assessments were performed for threatened and endangered species at four UMTRA sites as part of the NEPA compliance process.

CHAPTER 2 — ENVIRONMENTAL COMPLIANCE SUMMARY

Executive Order 11988, Floodplain Management

Executive Order 11988, *Floodplain Management*, instructs federal agencies to consider the effects of proposed actions on floodplains, avoid adverse impacts associated with the occupancy and modification of floodplains to the extent possible, and avoid direct or indirect support of floodplain development when there is a practical alternative. Agencies must determine whether proposed remedial action may affect a floodplain, assess the impacts on such floodplains, and consider alternatives to the proposed action. A floodplain evaluation is required for federal remedial action that may significantly affect the quality of the human environment. The evaluation may be included in any assessment prepared under Section 102(2)(c) of the NEPA.

Remedial action at some UMTRA sites involves removing tailings-contaminated soil and/or vegetation from floodplains. In accordance with 10 CFR Part 1022, *Compliance With Floodplain/Wetlands Environmental Review Requirements*, the DOE prepares a floodplain assessment for each of these sites and incorporates it into the site-specific environmental assessment or environmental impact statement.

Executive Order 11990, Protection of Wetlands

Executive Order 11990, *Protection of Wetlands*, requires federal agencies to consider the effects of proposed actions on wetlands, avoid adverse impacts associated with destruction and modification of wetlands, and avoid direct or indirect support of wetlands development when there is a practical alternative. Agencies must determine if a wetland may be affected by remedial action, assess the impacts on such areas, and consider alternative action. The intent of this Executive Order is to protect wetlands and minimize the adverse effects of development in or around wetlands. Project-related impacts are also addressed in a U.S. Army Corps of Engineers (USACE) Section 404 Permit, if USACE-regulated wetlands are present.

Remedial action at UMTRA sites involves removing tailings, contaminated soil, and/or vegetation from wetlands. The DOE addresses impacts to wetlands in a wetlands assessment consistent with the requirements of 10 CFR Part 1022. This assessment describes the wetland, the predicted impacts, alternative courses of action, and mitigation measures.

The USACE is consulted when an UMTRA site includes USACE-regulated wetlands. Typically, a USACE biologist visits the site to verify the presence and extent of regulated wetlands. The application for a Section 404 Permit includes boundary information, projected Project plans, the projected impact of those plans on the wetland, and proposed mitigation plans.

National Historic Preservation Act

The National Historic Preservation Act (NHPA) (16 USC §470 *et seq.*) requires a federal agency to consider the effects of its proposed actions on properties listed or eligible for listing on the National Register of

CHAPTER 2 — ENVIRONMENTAL COMPLIANCE SUMMARY

Historic Places. Potential impacts on prehistoric, historic, and other cultural resources are addressed in site-specific environmental assessments and environmental impact statements.

The DOE consults with federal land managing agencies, local Indian tribes, and appropriate state historic preservation officers concerning specific compliance requirements and cultural resource preservation planning. Consultation with the Advisory Council on Historic Preservation may also be required in some cases and often includes appropriate local historical organizations and interested individuals or groups.

Clean Air Act

The Clean Air Act (CAA) (42 USC §7401 *et seq.*) requires facilities that release airborne toxic and nuisance materials to obtain permits. A tribal, state, or federal agency enforces CAA compliance, as appropriate.

All UMTRA Project sites undergoing remediation in 1993 applied for air quality permits before construction began. CAA activities on the Project ranged from complying with state requirements for controlling visible fugitive dust to extensively monitoring total suspended particulates at sites in Colorado. (Individual site compliance is described in site-specific chapters.) Citations were not issued at any UMTRA Project site during 1993; all audits show the fugitive dust emissions program was in compliance with the CAA.

National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations governing radionuclide emissions are delineated in 40 CFR Part 61. The UMTRA Project is programmatically exempt from the DOE monitoring requirements of Subparts H and Q of 40 CFR Part 61. Subpart T of 40 CFR Part 61 regulates disposal of uranium mill tailings at UMTRA Project sites, limiting radon emissions to 20 picocuries per square meter per second ($\text{pCi}/\text{m}^2\text{s}$) and require monitoring when a disposal cell is completed to demonstrate compliance. Flux monitoring was required at the Falls City, Texas, and Grand Junction, Colorado, sites in 1993.

Hazardous Materials Transportation Act

Enforced by the U.S. Department of Transportation (DOT), the Hazardous Materials Transportation Act (HMTA) (49 USC §1801 *et seq.*) is the major transportation-related statute affecting the DOE. The HMTA improves regulatory and enforcement authority and protects the public from risk to life and property when hazardous materials are transported.

Uranium mill tailings with a total specific activity exceeding 2000 picocuries per gram (pCi/g) are classified as radioactive (i.e., hazardous) material. The HMTA regulates transport of these tailings

CHAPTER 2 — ENVIRONMENTAL COMPLIANCE SUMMARY

and radiological samples (exceeding 2000 pCi/g). The HMTA also regulates calibration standards for testing equipment.

The DOE acquired a DOT exemption (E-10594) for the UMTRA Project to transport the tailings at or above 2000 pCi/g in bulk shipments. The exemption grants the use of special placards for haul trucks, shipping documentation, and training to address the tailings hazards. All activities for which DOT Exemption E-10594 did not apply were carried out under applicable DOT regulations.

Compliance with the DOT regulation was achieved through use of UMTRA Project hazardous materials and truck transportation manuals for each site when required, and site-specific subcontract provisions, procedures, and plans that were in full compliance with the HMTA.

In 1993, all active UMTRA sites that transported tailings under DOT Exemption E-10594 conducted training in mill tailings radiation hazards and emergency shipping procedures prescribed by the exemption.

Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (7 USC §136 *et seq.*) requires registration of all pesticides, restricts use of certain pesticides, and regulates application, disposal, and transportation of pesticides. A pesticide is defined as any substance intended to prevent, destroy, repel, or mitigate a pest.

No unusual events associated with FIFRA compliance occurred in 1993.

State Regulatory Requirements

UMTRA Project sites comply with all appropriate state, county, and city regulatory requirements. In the compliance section for each site, this document details the regulatory requirements unique to individual states and sites.

Granted States Regulatory Authority

Many federal environmental acts (CAA, CWA, RCRA) enacted by Congress give regulatory authority to individual states for enforcement so long as individual state compliance programs meet or exceed the corresponding federal requirements.

State-Specific Requirements

Each state has a regulatory agency or division with the authority to enforce the CAA. Some states require permits for facilities (including UMTRA sites) that release airborne toxic and nuisance materials such as fugitive dust.

Site facilities or activities that may affect surface or ground water supplies (e.g., underground storage tanks, monitoring wells, abandoned wells, fuel storage tanks, septic systems and holding tanks for sanitary wastes, and surface water discharges) fall under the regulatory

CHAPTER 2 — ENVIRONMENTAL COMPLIANCE SUMMARY

authority of the state agencies/divisions. In most cases, as regulatory authorities under the CWA, individual states may issue permits for surface water discharge.

Special Permits- Requirements

Local agencies (city/county) or state departments administer UMTRA site activities such as land use, haul road construction, highway access, and noise control. Tribes are consulted, if required.

DOE ENVIRONMENTAL AUDITS

The DOE Office of Environmental Audit (EH-24) conducted an environmental baseline audit in June 1991 to assess UMTRA Project compliance with environmental regulations at the Grand Junction, Gunnison, and Rifle, Colorado, sites. Although the audit resulted in 48 findings, the audit team indicated these deficiencies did not represent conditions or actions significant enough to warrant cessation of operations (DOE, 1991a). In December 1991, the UMTRA Project submitted a final action plan in response to the audit (DOE, 1991b). The UMTRA Project completed the final corrective action in December 1993 to close out this audit.

The DOE Office of Environmental Audit also performed an environmental management audit of the UMTRA Project in October-November 1992. This audit assessed the adequacy of the UMTRA Project's environmental programs and management organization in ensuring environmental protection and compliance with federal, state, and DOE requirements. Although the audit resulted in 18 findings, the audit team concluded that the UMTRA Project has made good progress in developing and implementing environmental programs (DOE, 1993a). The action plan for this audit was submitted in July 1993 (DOE, 1993b). The UMTRA Project follows the action plan and all corrective action is expected to be complete in 1994.

SITE COMPLIANCE STATUS

The significant compliance-related issues for 1993 and the first quarter of 1994 are discussed below.

Ambrosia Lake, New Mexico

The state of New Mexico reviewed the DOE strategy for managing eight drums of nonhazardous solid waste contaminated with residual radioactive material at the Ambrosia Lake site. The New Mexico Environment Department concurred with the UMTRA Project proposal to treat this waste on the site before placing the drums in the disposal cell.

A previously undiscovered underground storage tank was uncovered at the Ambrosia Lake site. Soil samples taken at the site demonstrated the tank had not leaked. In accordance with all state of New Mexico regulations, the tank was emptied and the contents (diesel oil) sent to a recycler for processing. The tank was rendered inert, compacted, and deposited in the disposal cell.

CHAPTER 2 — ENVIRONMENTAL COMPLIANCE SUMMARY

EPA Region VI issued a general storm water permit in October 1993. Wastewater and storm water were not discharged at this site in 1993.

Gunnison, Colorado

During phase I demolition activities, eight drums of waste materials were discovered. These materials included diesel fuel, tank resin, fiberglass, grease, and tar that were radiologically contaminated with residual radioactive materials. In 1992, the Hazardous Materials and Waste Management Department of the Colorado Department of Public Health and Environment concurred on proposed disposal methods. The materials were disposed of in 1993 under the UMTRA Project guidelines, using these approved methods.

An amendment was granted to the processing site wastewater discharge permit in May 1993. The Colorado Department of Public Health and Environment issued the disposal site wastewater discharge permit in July 1993. In addition, a general storm water permit was issued in August 1993. Wastewater was not discharged during 1993 at the disposal site or the processing site.

Rifle, Colorado

Wastewater was not discharged under the Rifle site wastewater discharge permits during 1993. However, a discharge caused by intense rainfall did occur from the retention basin at the disposal site before tailings were placed in the cell (May 1993). During this heavy rainfall event, the retention basin operated under a construction dewatering permit (No. COG-070206).

Approximately 6 million gallons of water were treated for total dissolved solids and discharged under this dewatering permit. When tailings placement began, the permit was terminated (May 25, 1993).

The Rifle site recorded total suspended particulate readings higher than the threshold limit of 150 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) on June 6, July 21, and October 1, 1993. Wind caused the June 6 exceedance. The exceedance of July 21 was caused by site activities, heat, and wind. Aggressive measures were instituted (increased operational hours of dust suppression equipment/dust control strategies). Off-site activities caused the October 1 exceedance. No violations were issued for this site.

Falls City, Texas

An NPDES wastewater discharge permit (TWC-3382) was issued to the site in January 1993. An industrial activity storm water permit (TWC-EOOB708) was issued in May 1993. By using efficient measures to manage nonradiological and radiologically contaminated water (use of water for dust suppression, aeration by sprays and evaporation ponds), the site avoided any wastewater discharges in 1993.

CHAPTER 2 — ENVIRONMENTAL COMPLIANCE SUMMARY

Grand Junction, Colorado

The Grand Junction site complied with all wastewater and storm water discharge permits in 1993.

The Grand Junction site recorded total suspended particulate readings higher than the threshold limit of $150 \mu\text{g}/\text{m}^3$ on June 24 and September 1, 1993. Off-site activities (a farmer was plowing a dry, non-irrigated field near the monitoring station) caused both these exceedances. In 1993, the Air Pollution Control Division of the Colorado Department of Public Health and Environment audited total suspended particulate stations. A calculation discrepancy found during the audit was corrected immediately.

Mexican Hat, Utah

EPA Region IX issued a storm water discharge permit (No. UTR10A05F) to the site on December 17, 1993. Storm water was not discharged at the Mexican Hat site during 1993.

Monument Valley, Arizona

The EPA Region IX is reviewing an NPDES wastewater discharge permit application for the Monument Valley site.

The site was granted a general storm water discharge permit in 1993.

On August 10, 1993, an estimated 200,000 gallons of water exited the site when an extremely heavy, off-site rainfall runoff breached a Project-constructed berm and continued through two catchment basins. The exiting water was well below EPA radiological cleanup limits. An additional diversion berm was constructed at the site to divert possible flood events greater than a 10-year flood from mountains west of the site.

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CHAPTER 2 — ENVIRONMENTAL COMPLIANCE SUMMARY

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Code of Federal Regulations	<p>10 CFR Part 40, <i>Domestic Licensing of Source Material</i>, U.S. Nuclear Regulatory Commission (1994).</p> <p>10 CFR Part 1022, <i>Compliance with Floodplains/Wetlands Environmental Review Requirements</i>, U.S. Department of Energy (1994).</p> <p>40 CFR Part 61, <i>National Emission Standards for Hazardous Air Pollutants</i>, U.S. Environmental Protection Agency (1994).</p> <p>40 CFR Part 192, <i>Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings</i>, U.S. Environmental Protection Agency (1994).</p>
Executive Orders	<p>Executive Order 11988, <i>Floodplain Management</i>, May 24, 1977, Office of the President, Washington, D.C.</p> <p>Executive Order 11990, <i>Protection of Wetlands</i>, May 24, 1977, Office of the President, Washington, D.C.</p>
Federal Register	52 FR 36000, <i>EPA's Proposed Standards for Remedial Action at Inactive Uranium Processing Sites with Ground Water Contamination</i> , U.S. Environmental Protection Agency, September 24, 1987.
Public Laws	<p>98-616, <i>Hazardous and Solid Waste Amendments of 1984</i>, amendments to RCRA, November 9, 1984.</p> <p>99-499, <i>Superfund Amendments and Reauthorization Act</i>, amendment to CERCLA, October 17, 1986.</p>
United States Code	<p>7 USC §136 <i>et seq.</i>, <i>Federal Insecticide, Fungicide, and Rodenticide Act</i>, October 21, 1982.</p> <p>15 USC §1531 <i>et seq.</i>, <i>Endangered Species Act of 1973</i>, December 28, 1973.</p> <p>16 USC §470 <i>et seq.</i>, <i>National Historic Preservation Act</i>, October 15, 1966.</p> <p>33 USC §1251 <i>et seq.</i>, <i>Clean Water Act</i>, October 18, 1972.</p>

CHAPTER 2 — ENVIRONMENTAL COMPLIANCE SUMMARY

42 USC §300f *et seq.*, *Safe Drinking Water Act*, December 16, 1974.

42 USC §4321 *et seq.*, *National Environmental Policy Act*, January 1, 1970.

42 USC §6901 *et seq.*, *Resource Conservation and Recovery Act*, October 21, 1976.

42 USC §7401 *et seq.*, *Clean Air Act*, December 17, 1963.

42 USC §7901 *et seq.*, *Uranium Mill Tailings Radiation Control Act of 1978*, November 8, 1978.

42 USC §9601 *et seq.*, *Comprehensive Environmental Response, Compensation, and Liability Act*, December 11, 1980.

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UWTPDA PROJECT

CHAPTER 3 ENVIRONMENTAL MONITORING METHODOLOGIES

CHAPTER 3 — ENVIRONMENTAL MONITORING METHODOLOGIES

The Uranium Mill Tailings Remedial Action (UMTRA) Project follows specific standard operating procedures for monitoring well installation; surface water, ground water, sediment, and soil sampling; sample preservation and transportation; air monitoring; chain of custody; sample analysis; quality assurance; and analytical data management and validation. These procedures are reviewed annually and updated to reflect changes in industry standards, best management practices, state and local protocols, and U.S. Department of Energy (DOE) or U.S. Environmental Protection Agency (EPA) guidance. These procedures were developed specifically for the UMTRA Project and are consistent or compatible with regulations of the EPA, the American Public Health Association, and similar DOE programs and with applicable industry standards.

AIR PARTICULATE MONITORING

The UMTRA Project monitors the air for pollutants that may be carried from sites as particulate distribution in the environment. The primary sources of these air pollutants are fugitive dust and radionuclide particulates from construction, remediation activities, and wind erosion.

Throughout remedial action at the UMTRA Project sites, releases of nonradiological and radiological airborne materials are monitored. Radiological air monitoring demonstrates the effectiveness of remedial action (by comparing airborne radioactivity levels before and after remedial action) and provides information to the public regarding radioactive concentrations in the surrounding environment. To ensure that radioactive airborne particulate concentrations are well below regulatory limits, monitoring results are compared with the derived concentration guidelines in DOE Order 5400.5, *Radiation Protection of the Public and the Environment*.

Nonradiological Air Particulate Monitoring

When required by state regulations, total suspended particulate samples are collected to monitor nonradiological airborne particulate concentrations. Sampling locations and frequencies must follow site-specific protocols developed in accordance with state guidelines and UMTRA Project standard operating procedures.

Calibrated, high-flow air sampling pumps and glass fiber filters are used to collect air particulate samples. The sample filters are sent to a laboratory for analysis.

The filters are analyzed in accordance with the contract laboratory's standard operating procedures, which meet or exceed industry standards. In addition to total suspended particulates, the filters are analyzed for lead, arsenic, and vanadium metals, which are the most common contaminants resulting from former processing activities.

CHAPTER 3 — ENVIRONMENTAL MONITORING METHODOLOGIES

Radiological Air Particulate Monitoring

Radiological air particulate monitoring at UMTRA Project sites follows a comprehensive sampling strategy. Sampling locations for the monitoring stations are based on wind direction, population distribution, and the availability of electrical power for the sampling pumps. Calibrated, low-flow air sampling pumps and glass-fiber filter sampling media are used to collect air particulate samples pursuant to UMTRA Project standard operating procedures. Sampling is conducted continuously for approximately 3 to 4 days.

Sampling results are compared with the derived concentration guide in DOE Order 5400.5 to determine if environmental concentrations are below or above guidelines, which do not include naturally occurring radionuclides or background concentrations. The concentration guideline is 500×10^{-16} microcuries per milliliter ($\mu\text{Ci/mL}$) above background for thorium-230. Class W thorium-230 was chosen as the overall limit for the nuclides emitted at UMTRA sites because laboratory analyses of soil samples indicate the presence of Class W thorium-230, a conservative standard. In 1993, the minimum detectable activity for this sampling method was well below the concentration limit for insoluble thorium-230.

After collection, sample filters are stored for 3 to 4 days to allow short-lived radionuclides (radon daughters) to decay. The sample filters are analyzed on the site for gross alpha activity in accordance with UMTRA Project standard operating procedures. Because on-site analytical capabilities are limited to gross alpha concentrations in air, the thorium-230 concentration is determined by multiplying the gross alpha concentration by a conversion factor. This conversion factor is a conservative ratio of the radiochemical laboratory thorium-230 concentrations to the laboratory gross alpha concentrations.

RADON MONITORING

Radon is a radioactive gas occurring naturally in the environment. Exposure to radon is part of the background radiation environment and is always present in outdoor air.

In addition to the radon found naturally in the environment, tailings piles at UMTRA Project sites contain radium that decays to radon. The UMTRA Project environmental monitoring program has monitored radon levels at each site during active remediation in compliance with the requirements of DOE Order 5400.5. The DOE monitors all releases applicable to site-specific activities and assesses radiation exposure to the public.

At the UMTRA Project sites, real-time radon gas monitors and passive radon gas monitors are used to determine radon concentrations.

Real-Time (Active) Radon Gas Monitoring

A real-time (active) radon gas monitor is a filtered air monitor that continuously measures radon gas concentrations with a zinc-sulfide

CHAPTER 3 — ENVIRONMENTAL MONITORING METHODOLOGIES

passive radon detection system. A microprocessor controls the monitor and produces printed 1- and 24-hour averages.

Radon sampling locations are selected based on wind direction, population distribution, and the availability of electrical power for the samples. The radon gas monitors operate continuously, starting 1 month before remedial action and ending 1 month after the radon barrier is placed on the disposal cell. The radon gas monitor provides hourly and daily average radon concentrations. Radon sampling follows UMTRA Project standard operating procedures and the manufacturer's operating instructions.

The daily average radon concentrations determine a weekly average concentration. The weekly concentration is compared with the radon-222 derived concentration guide in DOE Order 5400.5 to determine if environmental concentrations differ from the guideline of 3×10^{-9} $\mu\text{Ci/mL}$. The guideline value does not include naturally occurring radon or background concentrations.

Passive Radon Gas Monitoring

A passive radon detector is a device containing a special plastic film. When the passive radon detectors are exposed to radon, alpha particles from radon decay products interact with a small piece of plastic polymer film, producing microscopic tracks in the film. At the laboratory, a chemical etching process enhances these tracks. The tracks are counted under a microscope and the radon concentration is determined by calibrating the relationship between radon concentration and track density.

Radon is monitored with passive detectors, following UMTRA Project standard operating procedures and the manufacturer's operating instructions. Sampling locations are based on wind direction and population distribution. During 1993, three passive radon detectors at each monitoring station were exposed for approximately 3-month periods throughout the year. The number of passive radon detectors deployed at each sampling location and the sampling frequencies were selected to detect anomalies and improve the overall counting statistics. After the passive radon detectors were retrieved from the field, they were packaged and promptly sent to an approved contract laboratory for analysis.

The 3-month radon concentrations were compared to the 3×10^{-9} $\mu\text{Ci/mL}$ radon-222 guideline action level in DOE Order 5400.5. This guideline does not include naturally occurring radon or background concentrations.

CHAPTER 3 — ENVIRONMENTAL MONITORING METHODOLOGIES

EXTERNAL GAMMA RADIATION DOSE MONITORING

Gamma radiation levels are monitored with lithium fluoride thermoluminescent dosimeters. The monitoring network is designed to indicate how moving radioactive tailings materials affects ambient radiation levels at the site. Lithium fluoride thermoluminescent dosimeters are used for environmental monitoring on the Project because of their linear energy response to gamma radiation and their closeness to human tissue in atomic composition and because the dose does not fade significantly over 3-month periods. The thermoluminescent dosimeters are placed in the field for 3 months and then analyzed to determine the doses at those locations. Sampling station locations are selected based on wind direction, the need for perimeter monitoring locations, and the locations of nearby residents.

Thermoluminescent dosimeters use small crystals to measure the cumulative radiation dose for the exposure period. Each environmental thermoluminescent dosimeter consists of five lithium fluoride crystals packaged in a rugged plastic container to protect the crystals from the environment. Each dosimeter simulates human tissue. This simulation measures the penetrating gamma dose to humans in the area. Because neither alpha nor beta radiation can penetrate the thermoluminescent dosimeter package, the dosimeter measures the dose equivalent from gamma radiation only. After exposure, the dosimeters are appropriately packaged and sent to a Project-approved contract laboratory for analysis.

The 3-month environmental gamma radiation data are compared to the DOE Order 5400.5 guideline of 100 millirems per year, which does not include naturally occurring background radiation.

SURFACE WATER MONITORING

Surface water monitoring at UMTRA sites undergoing surface remediation assesses compliance with National Pollutant Discharge Elimination System (NPDES) permit requirements for discharge water and radionuclide guidelines for water defined in DOE Order 5400.5. Surface water samples are also collected for site hydrogeologic studies to investigate the potential for ground water contaminant discharge to surface water. UMTRA guidelines for surface water are based on a contaminant's most soluble chemical form. This approach assumes that soluble chemical forms have a higher potential to become ingestive pathways than insoluble chemical forms.

Discharge Water

The UMTRA Project monitors surface water discharges from the sites, when applicable, to ensure compliance with NPDES permits. Samples are collected prior to scheduled water discharges from retention ponds and/or water treatment facilities. Additionally, effluent discharge surface water samples are collected from established site and vicinity sampling points to determine if construction activities meet NPDES permit requirements.

CHAPTER 3 — ENVIRONMENTAL MONITORING METHODOLOGIES

All samples are collected, packaged, and shipped pursuant to UMTRA Project standard operating procedures. The samples are analyzed for radionuclide and nonradionuclide constituents by a Project-approved contract laboratory in accordance with the laboratory's standard operating procedures.

Surface Water Assessments

Surface water samples are collected routinely upstream and downstream from a site to assess the potential environmental impact of remedial action activities. The samples are analyzed for total concentrations of radium-226 and thorium-230.

Surface water samples are also collected upstream, downstream, and adjacent to the site to establish baseline surface water quality for hydrological assessments and to evaluate the potential for contaminated ground water to affect surface water quality. Surface samples from rivers and streams are usually collected at the low-water stage to maximize the potential of detecting adverse impacts from contaminated ground water. The samples are analyzed for radionuclide and nonradionuclide constituents.

All samples are collected, packaged, and shipped pursuant to Project standard operating procedures. All analyses are performed by a Project-approved contract laboratory in accordance with the laboratory's standard operating procedures. The results are compared to the appropriate EPA standards and DOE guidelines for surface water assessments and regulatory compliance.

GROUND WATER MONITORING

Ground water monitoring at UMTRA Project sites supports site characterization, support developing ground water compliance strategies and remedial action strategies, and evaluates the effectiveness of remedial action. Ground water monitoring results are used for many purposes, such as site baseline risk assessments, compliance for ground water protection, disposal site compliance, and evaluation of the extent and migration of ground water contaminants. The UMTRA ground water sampling program is conducted in accordance with project standard operating procedures that comply with applicable DOE guidance and industry standards.

Site Characterization

Site characterization is performed to provide data for disposal cell design, potential surface water discharges, the presence and movement of ground water, background ground water quality, and prediction of any potential effects of surface remedial action on ground water. These data are typically collected from ground water monitoring wells before, during, and after surface remediation.

The ground water monitoring program at each site begins during site characterization and continues through surface remediation and ground water restoration. The ground water monitoring program may be

CHAPTER 3 — ENVIRONMENTAL MONITORING METHODOLOGIES

included in the formal, long-term surveillance plan after construction is complete. Sampling frequency is determined by site-specific factors such as ground water flow rate, seasonal variations in ground water quality and quantity, and potential risk to human health and the environment.

Ground Water Protection

The DOE has proposed a site-specific strategy for ground water protection at each UMTRA disposal site except Canonsburg, Shiprock, and Salt Lake City. These strategies must meet EPA-proposed ground water protection standards. These standards stipulate the following criteria at each site:

- All contaminants at each site must be identified.
- A list of concentration limits for those contaminants must be proposed.
- A point of compliance must be established.

The list of hazardous constituents is based on the composition of the residual radioactive material and the process chemicals still in the tailings. Proposed concentration limits are based on either background concentration for each constituent, its regulated maximum concentration limit or alternate concentration limit, or supplemental standards. The disposal cell point of compliance is a vertical surface extending downward through the uppermost aquifer along the hydraulically downgradient limit of the disposal cell. Monitoring wells will be installed as close to the disposal cell as practical to provide access for monitoring ground water quality.

Additional ground water monitoring is required to further characterize the uranium processing sites during the UMTRA Ground Water Project. During this project, the DOE must demonstrate that proposed ground water cleanup actions at the processing sites will bring ground water quality into compliance with the proposed standards for 40 CFR Part 192, Subpart B (52 FR 36000).

Baseline Risk Assessments

Ground water monitoring also supports the development of site-specific baseline risk assessments, which examine the potential effects of ground water contamination on public health and the environment at the former processing sites.

ECOLOGICAL ASSESSMENT

Ecological assessments provide site-specific ecological data and information at UMTRA Project sites. These data are collected in enough detail to perform an impact assessment, if necessary. Information collected for the ecological assessment will identify areas that may need study during the baseline risk assessment.

CHAPTER 3 — ENVIRONMENTAL MONITORING METHODOLOGIES

Upland Vegetation

Upland vegetation sampling is qualitative or quantitative, depending upon site-specific factors. A qualitative description of the vegetation, including the major plant communities and the common plants within each community type, is often the only requirement.

Quantitative vegetation analysis typically occurs in areas that could be directly or indirectly disturbed during surface remedial activities. The type of data collected for such an effort may include vegetation density, percent of vegetation cover, species importance values, number of acres of each plant community type, and a plant-community map. The level of detail for such quantitative studies varies from site to site, depending on the sensitivity of the plant communities affected and/or whether sensitive wildlife species occur in these plant community types.

Wetland Vegetation

Wetlands boundaries are delineated based on specific criteria and following the methods established in the *Corps of Engineers Wetlands Delineation Manual* (USACE, 1987). The UMTRA Project uses this manual in all wetland evaluations. The wetlands are mapped according to plant community type; plant size and type and use by wildlife are determined. In 1993, the U.S. Army Corps of Engineers field-checked wetland delineations and prepared mitigation plans when appropriate.

Nonthreatened and Endangered Wildlife

The presence of wildlife at the UMTRA Project sites is described qualitatively or quantitatively depending on site-specific factors. At sites with little or no disturbance, wildlife is described qualitatively. This level of characterization notes common wildlife species in the area, including game species. At sites with land disturbance or indirect impact to wildlife, more detailed data regarding wildlife may be required, especially if species of concern (such as endangered game species) are affected. The level of detail for the collection of quantitative wildlife data is determined on a site-by-site basis and qualified biologists conduct the surveys.

Threatened and Endangered Species

The consideration of threatened and endangered species and other species of concern must be consistent with the requirements of the Endangered Species Act of 1973 (16 USC §1531 *et seq.*), as amended. This requires informal consultation with the U.S. Fish and Wildlife Service, and when a proposed action may affect a sensitive species, a biological assessment. The U.S. Fish and Wildlife Service responds to this assessment with a biological opinion. This opinion may agree with the biological assessment findings or it may suggest additional studies, require additional mitigation measures, or recommend formal consultation with the U.S. Fish and Wildlife Service. If field studies are required to assess the status of a particular species, the studies are conducted consistent with required methods. Surveys for species that do not have methods requirements will be consistent with methods recommended by scientists with expertise in the species in question.

CHAPTER 3 — ENVIRONMENTAL MONITORING METHODOLOGIES

Furthermore, recognized experts will conduct or supervise all surveys for the species under consideration.

REFERENCES

USACE (U.S. Army Corps of Engineers), 1987. *Corps of Engineers Wetlands Delineation Manual*, Technical Report Y-87-1, prepared by the Environmental Laboratory, Vicksburg, Mississippi, for the Department of the Army, Washington, D.C.

Code of Federal Regulations

40 CFR Part 192, *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings*, U.S. Environmental Protection Agency (1994).

DOE Orders

Order 5400.5, *Radiation Protection of the Public and the Environment*, February 8, 1990, U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Federal Register

52 FR 36000, *Standards for Remedial Actions at Inactive Uranium Processing Sites; Proposed Rule*, September 24, 1989.

United States Code

16 USC §1531 *et seq.*, *Endangered Species Act of 1973*, December 28, 1973.

UMTRA PROJECT

CHAPTER 4 QUALITY ASSURANCE PROGRAM FOR THE UMTRA PROJECT ENVIRONMENTAL MONITORING PROGRAM

CHAPTER 4 — QUALITY ASSURANCE PROGRAM FOR THE UMTRA PROJECT ENVIRONMENTAL MONITORING PROGRAM

Accurate data are essential to all environmental sampling and analysis programs. The U.S. Department of Energy (DOE) developed the Uranium Mill Tailings Remedial Action (UMTRA) Project Office Quality Assurance Program Plan (DOE, 1993) and the UMTRA Project Environmental Monitoring Plan (DOE, 1992) to establish quality assurance policies and guidelines for all environmental monitoring activities on the UMTRA Project. The quality assurance program is based on DOE Order 5700.6C, *Quality Assurance*. These plans are supported by standard operating procedures and other documents that specify how environmental sampling and analysis will be conducted. Following these standard operating procedures ensures consistency between programs and ensures the use of U.S. Environmental Protection Agency (EPA), DOE, or industry-approved practices for conducting environmental sampling and analysis. Quality assurance protocols provide the guidelines needed to monitor the performance of these standard operating procedures in a controlled and consistent manner.

DATA QUALITY OBJECTIVES

The data quality objective process begins before samples are collected. This process provides a means for decision makers and the technical team to define the level of quality needed. Regulatory, quality assurance, and technical requirements are identified and sampling and analysis plans are completed before samples are taken.

REMEDIAL ACTION CONTRACTOR QUALITY ASSURANCE

The Remedial Action Contractor supports the DOE UMTRA Project by managing remedial action at UMTRA Project sites. The Remedial Action Contractor Quality Assurance Department oversees and implements environmental monitoring for environmental gamma radiation, airborne radionuclides, waterborne radionuclides, and fugitive dust. Environmental sampling starts 1 month before remediation begins and ends 1 month after the first layer of the radon barrier is placed on the disposal cell. This schedule does not apply to fugitive dust monitoring, which is conducted only during initial remedial action activities.

The site health physics manager implements the radiological environmental monitoring quality assurance program. Trained, qualified health physics personnel perform environmental radiological monitoring in accordance with site-specific health physics monitoring plans and applicable procedures. The site industrial hygienist directs nonradiological environmental monitoring. Groups from the DOE and from the UMTRA team periodically audit the Remedial Action Contractor environmental monitoring program.

Environmental Gamma Radiation

Environmental gamma radiation is monitored with environmental thermoluminescent dosimeters. Site-specific health physics monitoring plans determine the locations of the dosimeters.

CHAPTER 4 — QUALITY ASSURANCE PROGRAM FOR THE UMTRA PROJECT ENVIRONMENTAL MONITORING PROGRAM

A vendor approved by the Remedial Action Contractor Quality Assurance Department provides environmental thermoluminescent dosimeters. The vendor is accredited under the National Voluntary Laboratory Accreditation Program; both the Remedial Action Contractor and the vendor are accredited under the DOE Laboratory Accreditation Program for personnel dosimetry systems. The vendor calibrates the dosimeters using a National Institute of Standards and Technology (NIST)-certified cesium-137 standard reference material.

Vendor analysis reports are sent to the site health physics manager and the Remedial Action Contractor Albuquerque Project Office. Anomalous data are identified during the review process. The data are then summarized and incorporated into this report.

Active Radon Monitoring

On-site radon gas monitors operate continuously, recording an hourly average and a 24-hour average radon concentration. Site-specific health physics monitoring plans determine the locations of the monitors.

A DOE-approved vendor calibrates radon gas monitors, annually and after any repairs, using NIST-traceable liquid radium-226 standard reference material. Monthly background measurements track potential radon daughter buildup and/or potential radioactive particulate contamination during construction activities. To measure background radon, the radon gas monitor operates in a closed-loop configuration with an activated charcoal cartridge in the loop. A routine check log maintains functional information for each monitor. The site health physics manager reviews these logs.

Graphs of monthly average radon concentrations compared to time reveal trends; trend analysis reveals instrument problems or significant changes in the radon concentrations.

Passive Radon Monitoring

Radon is also monitored with passive radon detectors. The passive radon detectors are placed beside radon gas monitors and at additional locations indicated in the site-specific health physics monitoring plans. An approved vendor provides the passive radon detectors.

Each quarter, passive radon detectors are placed around the site. The exposed detectors are shipped to the vendor in a foil pouch to protect the sensitive material from inadvertent exposure. Two detectors remain in their foil pouches for the entire quarter as quality control detectors.

Radioactive Airborne Particulate Monitoring

Radioactive airborne particulate concentrations are monitored by collecting particulate samples with a calibrated air sampling pump and then counting the samples for gross alpha radiation at the on-site

CHAPTER 4 — QUALITY ASSURANCE PROGRAM FOR THE UMTRA PROJECT ENVIRONMENTAL MONITORING PROGRAM

laboratory. Site-specific health physics monitoring plans determine the locations of air particulate monitoring stations.

The on-site counting systems are calibrated daily with NIST-traceable thorium-230 standard reference material. Background checks and minimum detectable activity calculations are performed daily when the system is in use.

The EPA certifies vendors every 3 years, after extensive quality assurance audits of their analysis procedures and operations. Subcontract laboratories are enrolled in the EPA laboratory intercomparison studies program conducted by the EPA Environmental Monitoring Systems Laboratory and participate in the DOE Laboratory Quality Assurance Program conducted by the DOE Environmental Measurements Laboratory.

Each quarter, a composite of each station's air particulate samples is sent to a subcontract laboratory for gross alpha, radium-226, and thorium-230 analysis. Each set of radiological analyses is accompanied by 10 percent duplicate splits, 1 percent known standards, and 1 percent blanks. The acceptance criterion for the standards and blanks is 10 percent of the known values. Efficiencies and yields for all radionuclides analyzed are obtained using NIST-traceable standard reference material.

At the Remedial Action Contractor Albuquerque Project Office, the data are reviewed and discrepancies are resolved; a computer program checks for math errors. Data are graphed monthly and forwarded to the sites. The Remedial Action Contractor Albuquerque Project Office health physics personnel and the site health physics manager review the graphs for trends. At the end of the year, the data base is summarized and incorporated into this report.

Surface Water Radionuclide Monitoring

Radionuclides in surface water are monitored by collecting quarterly surface water samples from natural water courses in the site vicinity and sending them to an approved vendor for analysis. The monitoring determines if construction activities are releasing radionuclides into nearby surface water. Surface water samples also are collected during storms at locations where water could run off the site. The water samples are analyzed for thorium-230 and radium-226. The site health physics manager designates routine and storm runoff water sampling locations.

A subcontract laboratory conducts analyses for the Remedial Action Contractor surface water sampling program. Internally, each data set is accompanied by 10-percent duplicate splits, or a minimum of one duplicate per data set. In addition, 1-percent blanks and known standards, or a minimum of one blank and one standard per data set,

CHAPTER 4 — QUALITY ASSURANCE PROGRAM FOR THE UMTRA PROJECT ENVIRONMENTAL MONITORING PROGRAM

are required. The acceptance criterion for the standards and blanks is 10 percent of the known values. The subcontract laboratory participates in the EPA Region VIII Certification Program for Radiochemical Analysis in Water. The laboratory was certified to analyze radium-226 for the Safe Drinking Water Act (SDWA) (42 USC §300f *et seq.*) during 1993. Efficiencies and yields for all radionuclides analyzed are obtained using NIST-traceable standard reference material. Analysis reports are sent to the site and the Remedial Action Contractor Albuquerque Project Office.

At the Remedial Action Contractor Albuquerque Project Office, water sample results are reviewed and discrepancies are resolved. The data are summarized at the end of the year and incorporated into this report.

Water Discharge Monitoring

Radionuclides in surface water are monitored by collecting surface water samples from water discharge points in the site vicinity and sending them to an approved vendor for analysis. Monitoring determines if construction activities meet National Pollutant Discharge Elimination System (NPDES) permit requirements. Engineering or safety personnel collect the samples prior to water discharge; the samples and chain-of-custody documentation are sent to the approved vendor for analysis. Chemical analysis also follows specific city permit requirements, as needed.

The subcontract laboratory conducts the analysis for the Remedial Action Contractor discharge water sampling program and provides sample containers and preservatives. The laboratory participates in the EPA Region VIII certification program for radiochemical analysis in water. Efficiencies and yields for all analytes are obtained using NIST-traceable or other verifiable sources.

Laboratory Cross-Check Radiological Data

The Remedial Action Contractor site laboratories do not participate in the EPA and DOE laboratory intercomparison programs because the programs do not routinely analyze the same matrixes and/or analyte samples as the site laboratories. The vendor laboratory participated in the EPA program several times during 1993; except for natural uranium and gross beta in the April tests, all results were within the appropriate control limits (*Tables 4-1 through 4-3*). The vendor laboratory participated in the DOE intercomparison programs in July 1993 and January 1994. *Tables 4-4, 4-5, and 4-6* provide the results of the DOE Laboratory Quality Assurance Program.

CHAPTER 4 — QUALITY ASSURANCE PROGRAM FOR THE UMTRA PROJECT ENVIRONMENTAL MONITORING PROGRAM

Table 4-1 Water evaluation intercomparison study

Date	Analysis	Known	Lower control limit	Upper control limit	Average of all labs	Vendor lab	Vendor lab standard deviation
March	Radium-226	9.8	7.2	12.4	9.81	11.33	0.58
September	Radium-226	14.9	11.1	18.7	14.73	14.33	0.58
March	Radium-228	18.5	10.5	26.5	17.81	21.33	0.58
September	Radium-228	20.4	11.6	29.2	19.57	22.33	1.53
February	U-Nat	7.6	2.4	12.8	7.16	7.2	0.00
August	U-Nat	25.3	20.1	30.5	24.91	21.43	0.06
January	Gross alpha	34.0	18.4	49.6	17.09	20.33	0.58
October	Gross alpha	20.0	11.3	28.7	14.08	15.33	3.51
January	Gross beta	44.0	35.3	52.7	41.99	43.00	2.00
October	Gross beta	15.0	6.3	23.7	17.01	18.33	2.08

Note: Results of analyses by Environmental Measurements Systems Laboratories. Results reported in picocuries per liter.

U-Nat — Uranium in natural isotopic abundance.

Table 4-2 Air filter evaluation intercomparison study

Analysis	Known	Lower control limit	Upper control limit	Average of all labs	Vendor lab	Vendor lab standard deviation
Gross alpha	19.0	10.3	27.7	20.00	19.00	1.73
Gross beta	47.0	38.3	55.7	49.32	42.00	5.20

Note: Results of August 1993 analyses by Environmental Measurements Systems Laboratories. Results reported in picocuries per filter.

CHAPTER 4 — QUALITY ASSURANCE PROGRAM FOR THE UMTRA PROJECT ENVIRONMENTAL MONITORING PROGRAM

Table 4-3 Water performance evaluation intercomparison study

Analysis	Known	Lower control limit	Upper control limit	Average of all labs	Vendor lab	Vendor lab standard deviation
Gross alpha	95.0	53.4	136.6	96.63	100.33	7.51
Radium-226	24.9	18.5	31.3	24.41	23.23	0.58
Radium-228	19.0	10.7	27.3	18.61	23.33	1.15
U-Nat	28.9	23.7	34.1	27.64	81.23	0.65
Gross beta	177.0	130.2	223.8	155.52	130.00	7.81

Note: Results of April 1993 analyses by Environmental Measurements Systems Laboratories. Results reported in picocuries per liter.

U-Nat — Uranium in natural isotopic abundance.

Table 4-4 Soil evaluation intercomparison study, quality assurance program

Date	Isotope	Reported value	EML value	Reported/EML
July 1993	U-Nat	71.5 ± 9	76.9	0.93 ± 0.10
January 1994	U-Nat	1.00 ± 2	1.97	0.51 ± 0.02

Note: Results of analyses by Environmental Measurements Systems Laboratories. Results reported in becquerels per kilogram.

U-Nat — Uranium in natural isotopic abundance.

Table 4-5 Air evaluation intercomparison study, quality assurance program

Date	Isotope	Reported value	EML value	Reported/EML
July 1993	U-Nat	0.0484 ± 0.0005	0.0460	1.05 ± 0.03
January 1994	U-Nat	5.64 ± 0.00	5.41	1.04 ± 0.05

Note: Results of analyses by Environmental Measurements Systems Laboratories. Results reported in becquerels per filter.

U-Nat — Uranium in natural isotopic abundance.

CHAPTER 4 — QUALITY ASSURANCE PROGRAM FOR THE UMTRA PROJECT ENVIRONMENTAL MONITORING PROGRAM

Table 4-6 Water evaluation intercomparison study, quality assurance program

Isotope	Reported value	EML value	Reported/EML
U-234	1.00 ± 0.01	1.06	0.94 ± 0.05
U-238	1.00 ± 0.01	1.08	0.93 ± 0.03
U-Nat	0.0832 ± 0.00	0.0842	0.99 ± 0.04

Note: Results of analyses by Environmental Measurements Systems Laboratories. Results reported in becquerels per liter.

U-Nat — Uranium in natural isotopic abundance.

TECHNICAL ASSISTANCE CONTRACTOR QUALITY ASSURANCE

The Technical Assistance Contractor supports the DOE UMTRA Project through technical support services, planning, and strategy development. The Technical Assistance Contractor Quality Assurance Department oversees and implements environmental sampling and quality assurance protocols for radiological and nonradiological constituents in surface water, sediments, and ground water sampling and analyses.

The quality assurance manager and the Data Management Department implement Technical Assistance Contractor quality assurance plans and data validation procedures. A trained, qualified environmental field sampling team conduct environmental monitoring. Quality assurance and environmental field sampling audits further ensure the quality of Technical Assistance Contractor data. Corrective actions are issued when discrepancies are identified and sampling procedures are revised, as needed.

Sampling Procedures

Samples are collected from ground water monitoring wells and surface water locations following Technical Assistance Contractor standard operating procedures. These standard operating procedures are the same as or equivalent to DOE Hazardous Waste Remedial Action Program (HAZWRAP) (DOE, 1990a), EPA, and industry standard procedures.

Analytical Methods

All Technical Assistance Contractor subcontract laboratories must follow EPA Contract Laboratory Program statement-of-work methods, EPA SW-846 analytical methods, American Public Health Association (APHA) analytical methods, and other EPA-approved procedures adapted to the specific laboratory environment.

The Technical Assistance Contractor has chosen analytical methods, quality control criteria, and quality assurance protocols from EPA,

CHAPTER 4 — QUALITY ASSURANCE PROGRAM FOR THE UMTRA PROJECT ENVIRONMENTAL MONITORING PROGRAM

DOE, APHA, and other guidance documents to form the basis for UMTRA analytical requirements. To meet analytical requirements in the most cost-effective way possible, subcontract laboratories are required to maintain extensive supporting documentation. However, only minimum documentation is required for routine Level C data validation. This practice reduces analytical and data reviewer costs significantly.

Analytical Quality Control

Analyses performed by the subcontract laboratories generally consist of concentration or activity determinations for test parameters in water and soil samples. The EPA Contract Laboratory Program statement of work specifies the type and frequency of quality control analyses. Although these specifications are not regulatory requirements for the UMTRA Project, they are used because they reflect standard industry practices in environmental analysis and reflect a best management practice.

Analytical Quality Assurance

The Technical Assistance Contractor follows a formal subcontract analytical laboratory selection process that includes evaluating technical proposals and prequalification samples and auditing prequalification systems. Subcontract laboratories are contractually required to submit to annual systems audits and to analyze quarterly performance evaluation samples prepared specifically for the Technical Assistance Contractor.

In addition, Technical Assistance Contractor data management procedures require data package assessments at each subcontract laboratory twice yearly. These on-site validation activities ensure complete analysis documentation is maintained at the laboratory and provide a way to verify contract compliance.

To comply with HAZWRAP specifications (DOE, 1990b), each subcontract analytical laboratory submits a monthly progress report to the Technical Assistance Contractor. These reports describe changes in key staff members, quality assurance practices, analytical procedures, and instrumentation.

Analytical Data Validation

The Technical Assistance Contractor guidelines for subcontract laboratory data validation conform to or exceed HAZWRAP Level C data quality objectives (DOE, 1990b). Quality control requirements, unbroken chain of custody, and conformance with EPA-specified holding times also must be verified. Analytical results are stored in the Software Program for Environmental Analysis and Reporting, a Technical Assistance Contractor computer data base that can compare new data with historical data to identify potential anomalies. The Technical Assistance Contractor uses the precision and accuracy criteria specified for Level C data validation in the validation process for most general inorganic analyses. However, these quality control

CHAPTER 4 — QUALITY ASSURANCE PROGRAM FOR THE UMTRA PROJECT ENVIRONMENTAL MONITORING PROGRAM

Interlaboratory Performance Evaluation Programs

practices are not applicable to all analytes of interest on the UMTRA Project. The Technical Assistance Contractor data validation standard operating procedure provides specific data validation procedures covering all UMTRA analytes.

Subcontract analytical laboratories are contractually required to participate in EPA- and DOE-sponsored performance evaluation programs. Data from these programs are reported quarterly to the Technical Assistance Contractor. To determine the proficiency of the subcontract laboratories, Technical Assistance Contractor data management staff review these data, associated corrective actions, quarterly performance evaluation sample results, daily quality control sample results, and the monthly progress reports. Deficiencies are corrected, as appropriate.

Subcontract laboratories performing radiochemical analyses must participate in the DOE Environmental Measurements Laboratory intercomparison program, to conform with DOE Order 5400.1, *General Environmental Protection Program*. The DOE Environmental Measurements Laboratory intercomparison studies primarily address fission products and gross-alpha and -beta emissions in a variety of matrixes, including plant and animal tissue.

In addition, radiochemistry labs supporting the Technical Assistance Contractor must participate in the EPA Environmental Monitoring Systems Laboratory intercomparison program, which primarily addresses natural radionuclides and gross-alpha and -beta emissions in water samples.

Subcontract laboratories performing general inorganic analyses in support of Technical Assistance Contractor activities must participate in EPA water supply and water pollution studies, which address a range of analytes (for example, metals, nutrients, anions, total organic carbon, and organic compounds).

The Technical Assistance Contractor quarterly performance evaluation program is the only program covering all 49 parameters routinely measured in Technical Assistance Contractor samples. Chemists at the RUST Geotech analytical chemistry laboratory at the DOE Grand Junction Projects Office prepare and verify these samples. The matrix for Technical Assistance Contractor performance evaluation program samples is water because most samples are analyzed for Technical Assistance Contractor surface water and ground water activities.

CHAPTER 4 — QUALITY ASSURANCE PROGRAM FOR THE UMTRA PROJECT ENVIRONMENTAL MONITORING PROGRAM

Performance Evaluation Program Results

The summary of results presented in *Table 4-7* is limited to the quarterly Technical Assistance Contractor performance evaluation program because the programs acquire a large body of data, routinely addressing all measured parameters. The results discussed here were submitted to the Technical Assistance Contractor in the first quarter of 1994.

Table 4-7 Summary of the 1993 Technical Assistance Contractor quarterly performance evaluation program

Parameter	Number of labs under contract	Number of labs reporting	Outside of acceptance interval
Aluminum	6	6	0
Ammonium	6	6	1
Antimony	6	6	0
Arsenic	6	6	0
Barium	6	6	1
Beryllium	6	6	0
Boron	6	6	0
Bromide	6	6	1
Cadmium	6	6	0
Calcium	6	6	0
Chloride	6	6	0
Chromium	6	6	0
Cobalt	6	6	0
Copper	6	6	0
Cyanide	6	6	2
Fluoride	6	6	0
Gross α	5	5	1
Gross β	5	5	0
Iron	6	6	1
Lead	6	6	0
Lead-210	5	5	3
Magnesium	6	6	0
Manganese	6	6	0
Mercury	6	a	a
Molybdenum	6	6	1
Nickel	6	6	0

CHAPTER 4 — QUALITY ASSURANCE PROGRAM FOR THE UMTRA PROJECT ENVIRONMENTAL MONITORING PROGRAM

Table 4-7 Summary of the 1993 Technical Assistance Contractor quarterly performance evaluation program (Concluded)

Parameter	Number of labs under contract	Number of labs reporting	Outside of acceptance interval
Nitrate	6	6	1
Phosphate	6	6	2
Polonium-210	5	5	0
Potassium	6	6	1
Radium-226	5	5	4
Radium-228	5	5	0
Selenium	6	6	0
Silica	6	6	0
Silver	6	6	0
Sodium	6	6	0
Strontium	6	6	0
Sulfate	6	6	1
Sulfide	6	6	1
Thallium	6	6	0
Thorium-230	5	5	3
Tin	6	6	0
Total dissolved solids	6	6	0
Total Kjeldahl nitrogen	6	6	0
Total organic carbon/dissolved organic carbon	6	6	0
Uranium	7	7	0
Vanadium	6	6	0
Zinc	6	6	0
Total		276	24

^aPoor sample stability.

Data acceptance intervals for the Technical Assistance Contractor performance evaluation program are calculated to yield narrower acceptance ranges than are typically associated with other performance evaluation programs. Specifically, the intervals center on a known value and are calculated as the quadratic sum of the uncertainty in this

CHAPTER 4 — QUALITY ASSURANCE PROGRAM FOR THE UMTRA PROJECT ENVIRONMENTAL MONITORING PROGRAM

value and a concentration or activity-specific allowable analytical uncertainty. This practice allows the Technical Assistance Contractor to identify deficiencies quickly.

Corrective action reports may be requested for any of the following reasons:

- Large analytical error.
- Systematic bias indicated by both results when two samples are submitted.
- False negative result.
- Parameter outside the acceptance interval in two consecutive rounds.
- Parameter outside the acceptance interval in more than one performance evaluation program.
- Monthly progress reports describe a change in a problem area.
- Daily quality control sample results indicate a deficiency in a problem area.

Subcontract analytical laboratories may be suspended from participating in the chemical analysis program for several reasons, including poor performance in one or more of the performance evaluation programs.

Of the 24 values outside the acceptance interval (*Table 4-7*), 8 were only marginally outside the acceptance range and no other reasons existed to request corrective action reports. Sixteen values outside the acceptance interval resulted in requests for corrective action reports. One radiochemistry laboratory was suspended from the chemical analysis program pending receipt of adequate corrective action and successful analysis results for future performance evaluation samples. The relative percent differences for the lead-210 measurements outside the acceptance range were -13 percent, -17 percent, and -46 percent. The laboratory returning the -46 percent value was suspended. The relative percent differences for the radium-226 measurements outside the acceptance range were -11 percent, 21 percent, -98 percent, and 73 percent. A sample preparation error is believed to have caused the -98 percent result. The laboratory returning the 73-percent value was suspended. The relative percent differences for the thorium-230 measurements outside the acceptance range were 28 percent, 119 percent, and 251 percent. Raw data and corrective action reports have not been received from the laboratory returning the 119-percent

CHAPTER 4 — QUALITY ASSURANCE PROGRAM FOR THE UMTRA PROJECT ENVIRONMENTAL MONITORING PROGRAM

relative percent difference value; however, this laboratory's results in all previous submittals were accurate. The laboratory returning the 251 percent value was suspended.

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DOE (U.S. Department of Energy), 1990b. *Hazardous Waste Remedial Actions Program, Requirements for Quality Control of Analytical Data*, DOE/HWP-65/R1, prepared by the HAZWRAP Support Contractor Office and the K-25 Plant, Oak Ridge, Tennessee, for the U.S. Department of Energy.

DOE Orders

Order 5400.1, *General Environmental Protection Program*, November 9, 1988, U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Order 5700.6C, *Quality Assurance*, August 21, 1991, U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

United States Code

42 USC §300f *et seq.*, *Safe Drinking Water Act*, December 16, 1974.

CHAPTER 4 — QUALITY ASSURANCE PROGRAM FOR THE UMTRA PROJECT ENVIRONMENTAL MONITORING PROGRAM

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CHAPTER 5 ARIZONA SITES

ARIZONA SITES

This chapter provides detailed Uranium Mill Tailings Remedial Action (UMTRA) Project data on environmental monitoring activities conducted at the Monument Valley and Tuba City, Arizona, sites during 1993 and the first quarter of 1994.

Numerous documents describe the existing environmental and construction conditions at the UMTRA Project sites. These documents, including environmental impact statements, environmental assessments, and remedial action plans, are available at the U.S. Department of Energy (DOE) UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Monument Valley

The Monument Valley site is on Navajo Nation land in Cane Valley, approximately 13 miles east of Monument Valley Tribal Park. The site is undergoing remedial action. During 1993, air monitoring for both thorium-230 particulates and radon-222 and environmental gamma radiation monitoring were conducted. Only the data found to be statistically above background concentrations are reported here. In addition, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

Tuba City

The Tuba City site is in Coconino County on land currently under litigation between the Navajo Nation and the Hopi Tribe, approximately 6 miles east of Tuba City, Arizona. Surface remedial action at this site was completed in May 1990. Because surface remedial action is complete, air monitoring and environmental gamma radiation monitoring were not conducted in 1993. However, during 1993, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

CHAPTER 5 — ARIZONA

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**SITE DESCRIPTION
AND LOCATION**

The Monument Valley Uranium Mill Tailings Remedial Action (UMTRA) Project site is on the Navajo reservation in a remote area within Cane Valley in northeastern Arizona, in Apache County (*Figure 5-1*). Accessed by Indian Route 6440, the site is 17 miles south of the Mexican Hat UMTRA Project disposal site and about 4 miles south of the Arizona-Utah border.

The communities closest to the Monument Valley site are Dinnehotso (about 6 miles south), Mexican Hat, and Halchita (a Navajo community just south of the San Juan River). The closest towns are Blanding, Utah, approximately 40 miles northeast of Mexican Hat, and Kayenta, Arizona, approximately 45 miles southwest of Mexican Hat.

The site area is relatively remote and undeveloped, with no public housing or community services such as schools, sewage systems, and health care facilities. Population growth in this area is related primarily to coal, uranium mining development, and oil and gas exploration and development. An accurate population estimate for the site and surrounding area is unavailable; however, probably no more than 25 people live within 2 miles of the Monument Valley site.

The climate in the Monument Valley area is arid with large ranges in daily and seasonal temperatures. Winters are cold, with minimum temperatures below freezing prevailing from November through March; summers are hot, with temperatures as high as 100 degrees Fahrenheit (°F). The annual precipitation average of about 6 inches is fairly evenly distributed through the year. July through October typically receive slightly more precipitation than other periods due to seasonal thunderstorm activity in the Colorado Plateau region. Snowfall is normally light.

The only weather station near the site is at Mexican Hat, Utah. The Monument Valley site, south of Mexican Hat, can be expected to have a similar climate. However, since it is at a higher elevation, the Monument Valley site may have slightly lower temperatures and slightly greater precipitation than Mexican Hat.

Average wind speeds have been recorded at 9.2 miles per hour at Blanding, Utah, approximately 40 air miles northeast of Mexican Hat. The distribution of windblown tailings at the Monument Valley site indicates the wind blows predominantly from the southwest; however, the wind rose shows no predominant direction (*Figure 5-2*).

Figure 5-1
Monument Valley Site Location

ASER94/MON/SITELOC

Figure 5-2
Wind Rose

Ref: DOE, 1989.

ASER94/MON/WINDMON

SITE HISTORY AND OWNERSHIP

In 1942, Luke Yazzie, a Navajo, staked a claim on mineralized strata southeast of Yazzie Mesa. This claim was leased by the Vanadium Corporation of America from the Navajo Tribal Council and was mined for vanadium from 1942 to 1945. Uranium mining began in 1948. High-grade ores were shipped to a mill in Durango, Colorado, while the low-grade ores were either bypassed by selective mining or stockpiled in waste dumps.

In 1955, a mechanical upgrader mill was installed at the site to concentrate the lower-grade ores before shipment. Ore slimes recovered from the upgrader were shipped to other locations. All the uranium oxide produced from these ores was purchased by the U.S. Atomic Energy Commission (AEC).

A batch leach plant was constructed at the site in 1964 to upgrade the sand tailings rejected from the mechanical upgrader; the plant operated for 3 years. The uranium/vanadium product generated by this batch leach concentrator was sent to the Shiprock mill for processing and the

recovered uranium oxide was again purchased by the AEC. The bulk of the tailings from this plant were placed in a tailings pile east of the Monument Valley mill.

In 1966, Vanadium Corporation of America experimented with heap-leaching low-grade ores from mine dumps, producing an acidic, oxidizing leachate. This process continued intermittently until late 1967, when all milling activities ceased. Subsequently, Foote Minerals Corporation operated the plant until 1968, when the mill buildings were dismantled and control of the site and the tailings reverted to the Navajo Nation.

SITE CHARACTERIZATION AND CLEANUP

Remedial action at the Monument Valley site is designed to meet the U.S. Environmental Protection Agency (EPA) standards established in 40 CFR Part 192 for areas being excavated. Remedial action involves cleanup of the abandoned mill site and relocation of the residual radioactive materials to the Mexican Hat disposal cell (*Figure 5-1*). The relocation of residual radioactive materials began in 1992 and was completed in January 1994.

ENVIRONMENTAL COMPLIANCE STATUS

In accordance with U.S. Department of Energy (DOE) policy, the UMTRA Project at Monument Valley, Arizona, complies with federal and tribal environmental regulations. Remedial action activities are continuously evaluated for their environmental impact and to ensure they meet applicable regulatory requirements. In 1993, Monument Valley site activities were in compliance with the following environmental regulations: Resource Conservation and Recovery Act (RCRA) (42 USC §6901 *et seq.*), Clean Water Act (CWA) (33 USC §1251 *et seq.*), Clean Air Act (CAA) (42 USC §7401 *et seq.*), and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC §9601 *et seq.*) for reporting certain quantities of hazardous materials used or stored at the site; and community right-to-know, spill prevention control and countermeasures, U.S. Department of Transportation (DOT), and local regulations (conditional use and highway access permits).

Superfund Amendments and Reauthorization Act

Under the Superfund Amendments and Reauthorization Act (SARA) (PL 99-499), an amendment to CERCLA, the Monument Valley site will comply with Title III emergency planning and community right-to-know requirements. These requirements include notifying the appropriate authorities if spills of extremely hazardous materials occur. In 1993, the site met the requirements of SARA Title III, Section 311, because a site inventory had been developed for all materials stored on-site in excess of 10,000 pounds or in excess of the threshold planning quantities for extremely hazardous materials. The inventory included diesel fuel, oil, sulfuric acid, other automotive maintenance fluids, and uranium mill tailings, and was submitted to the State

Emergency Response Commission, the local emergency planning committee, and the fire department.

In 1993, the site met the requirements of SARA Title III, Section 312. Tier II documentation for the 1992 inventoried materials was developed and submitted to the State Emergency Response Commission, the local emergency planning committee, and the fire department on March 1, 1993.

The toxic release reporting requirements of SARA Title III, Section 313, do not apply to the Monument Valley site because it is not listed in Standard Industry Codes 20 to 39. However, no materials were released into the environment that fall under these reporting requirements in 1993.

Resource Conservation and Recovery Act

In October 1993, a 55-gallon drum filled with unknown substances and contaminated with residual radioactive material was discovered at the Monument Valley site. The contents of the drum were sampled, analyzed, and determined to be nonhazardous. The drum and its contents were deposited in the disposal cell. No RCRA activities were required at the Monument Valley site in 1993.

Clean Water Act

National Pollutant Discharge Elimination System

The federal EPA is reviewing a National Pollutant Discharge Elimination System (NPDES) permit application for the Monument Valley site. During 1993, the Monument Valley site had no wastewater discharges.

Spill Prevention Control and Countermeasures Plan

In 1993, earthen berms were designed and constructed around existing aboveground storage tanks and around oil drum storage areas. These secondary containment systems are designed to control spills. In addition, plans for berm inspection, spill detection, emergency spill response, and spill cleanup were developed for fuel and oil storage areas. During 1993, the site had no reportable spills.

Septic/Holding Tanks

During 1993, septic systems were constructed at the Monument Valley site following requirements of the Navajo Office of Environmental Health, which has regulatory jurisdiction.

Storm Water

A general storm water permit was submitted to the federal EPA in 1993. On August 10, 1993, as the result of an extremely heavy off-site rainfall, runoff cascaded through a channel across the site, breaching a Project-constructed berm and continuing through two catchment basins. An estimated 200,000 gallons of water ran onto and exited the site. The water was well below federal EPA radiological cleanup limits and no permit violations were issued.

As an extra precaution, an additional diversion berm was constructed at the site to divert possible flood waters that exceed a 10-year flood event from mountains west of the site.

Clean Air Act

The federal EPA determined that the Monument Valley site is not a major source of contamination. Because the major pollutant at the site is fugitive emissions from nonpoint sources, the Monument Valley site does not require an EPA permit. However, off-site visible fugitive dust emissions are strictly controlled, as required by the Navajo Nation EPA.

National Environmental Policy Act

In compliance with the National Environmental Policy Act (42 USC §4321 *et seq.*), public scoping meetings were held at Window Rock, Tuba City, Moenkopi, Mexican Hat, and Shiprock to gather information for the programmatic environmental impact statement (in preparation).

Hazardous Materials Transportation Act

All materials transported at the Monument Valley site were in full compliance with all applicable requirements of the Hazardous Materials Transportation Act (HMTA) (49 USC §1801 *et seq.*).

The DOE acquired a DOT exemption to transport tailings in bulk shipments. The exemption grants the use of special markings for haul trucks, shipping documentation, and training to address tailings hazards. Approximately 780,000 cubic yards of tailings were hauled from this site under DOT exemption E-10594 in 1993 and all requirements of the exemption met HMTA regulations.

Environmental Compliance Permits

All active permits applicable to environmental activities and under which the Monument Valley site operated from January 1, 1993, to April 1994, are listed in *Table 5-1*.

The Monument Valley site is under the jurisdiction of the Navajo Nation EPA. Because potential water discharges from the site would eventually flow into the San Juan River, Region IX of the federal EPA has regulatory authority for activities associated with the NPDES and storm water.

ENVIRONMENTAL MONITORING

The DOE implements a detailed environmental monitoring program for radiological and nonradiological materials at the Monument Valley site, including environmental gamma-dose equivalent and radionuclide/nonradionuclide concentrations in air, surface water, and ground water. This program monitors the amount of radioactive material and nonradiological hazardous constituents that may be released into the environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

Table 5-1 Active permits

Permit description	Submittal date	Preliminary approval date	Final approval date	Permit number	Expiration date
National Pollutant Discharge Elimination System permits (EPA)					
Process site wastewater	2/90	Pending	Pending	a	
Process site storm water(individual)	9/92	Pending	Pending		9/97
Process site storm water (general)	10/93	Pending	Pending	a	
Borrow permit (general fill) (BIA)	9/90	Pending	Pending	b	
Revocable use permit for trailer site (BIA)	11/88	Pending	Pending	b	

^aApplication accepted as storm water by the federal EPA Region IX. Submitted to establish legality.

^bPermit is overdue from agency.

BIA - Bureau of Indian Affairs.

Air Monitoring

Nonradiological Air Particulate Monitoring

Because the major pollutant at the site is fugitive emissions from nonpoint sources, a federal EPA permit is not needed and total suspended particulate monitoring was not conducted; however, off-site visible fugitive dust emissions are strictly controlled.

Radiological Air Particulate Monitoring

Radiological air particulate monitoring at the Monument Valley site was conducted at Stations 1 and 5 (*Figure 5-3*). Background measurements were not taken because airborne radioactivity levels at the site were very low.

Figure 5-4 shows thorium-230 concentrations statistically above background; these concentrations are estimated from gross alpha measurements. The estimated annual average thorium-230 concentration at all stations was well below the thorium-230 annual average guideline of 500×10^{-16} microcuries per milliliter ($\mu\text{Ci/mL}$) above background, indicating radioactive particulate releases from remedial action were not significant.

Figure 5-3
Environmental Air and Gamma Radiation Monitoring Stations, Processing Site

ASER94/MON/ENVMONLOCS

Radon Monitoring

Real-Time (Active) Radon Monitoring. Because activity in the tailings concentrations is low and because the Monument Valley site is in a very remote area, real-time radon monitoring was not required in 1993. However, passive environmental radon monitoring was conducted at the site.

Passive Radon Monitoring. Nine stations were established around the Monument Valley site. Five of these stations are near residences. Background monitoring was conducted at Station 9 (*Figure 5-3*).

The annual average background radon concentration measured at Station 9 was 0.5×10^{-9} $\mu\text{Ci/mL}$. Only two stations (7 and 8) were statistically different from background. Radon concentrations at both stations were much lower than the DOE guideline of 3×10^{-9} $\mu\text{Ci/mL}$ above background. Passive radon monitoring results for the stations statistically above background for the four quarters of 1993 at the Monument Valley site are presented in *Figure 5-5*. The elevated concentrations at the Monument Valley site are expected to return to background levels when remedial action is complete.

Figure 5-4
Environmental Airborne Radioactive Particulate
(Thorium-230) Concentrations

ASER94/MON/TAB1

Figure 5-5
Passive Radon Concentrations

ASER94/MON/TAB2

Air Monitoring
Conclusions

No significant releases from the site occurred during 1993. All measured concentrations of thorium-230 particulate and radon-222 were lower than the applicable guidelines.

Environmental Gamma
Radiation Monitoring

A network of nine thermoluminescent dosimeters measured exposure to penetrating gamma radiation in the environment around the Monument Valley site in 1993. Background dose was measured at Station 9, approximately 1.5 miles north of the site. Four dosimeters were placed around the site boundary at Stations 1, 6, 7, and 8 (*Figure 5-3*). The remaining five dosimeters were placed near residences.

Figure 5-6
Environmental Gamma Radiation Monitoring

The annual background dose equivalent from Station 9 was 109 ± 11 millirems (mrem). Of the locations for which annual dose equivalents are available, only Stations 7 and 8 were statistically different from background. *Figure 5-6* shows the cumulative results, statistically above background, for monitoring Stations 7 and 8 at the Monument Valley site for 1993.

None of the dose equivalents exceeded the DOE guideline of 100 mrem per year above background. After remedial action is complete, dose equivalents are expected to return to near-background levels.

Environmental Gamma
Radiation Monitoring
Conclusions

No stations recorded environmental gamma radiation levels greater than the applicable guideline, indicating no significant releases to the environment during 1993.

Surface Water Monitoring

Surface water features in the vicinity of the Monument Valley UMTRA site consist of Cane Valley Wash, several small drainage channels leading into the wash, and areas of ponded water locally referred to as the frog ponds. Cane Valley Wash is east of the tailings piles and flows from south to north. The frog ponds are east of the tailings piles and have been excavated into the wash. *Figure 5-7* shows the wash, frog ponds, springs, and surface water sampling locations.

Figure 5-7
Surface Water Sampling Locations, Processing Site

ASER94/MON/SWSAMPLOCSC

Surface water in the site area is not usually present during prolonged dry periods. Samples were taken in June and December (dry periods) by digging a shallow hole at each designated location and collecting water from the hole. Because this procedure included some soils in the water samples, the surface water samples that were not filtered are chemically representative of a soil-and-water combination; contaminant concentrations are higher than concentrations would be in water only. The June samples were not filtered before analysis. Two sets of samples were taken in December; one set was filtered to remove the soils before analysis and the other set was not filtered before analysis.

The following surface water locations were sampled at the site in June and December 1993 (*Figure 5-7*):

- 620 - a spring in a tributary to Cane Valley Wash, approximately 2 miles north of the tailings piles (June).
- 623 - Cane Valley Wash, east and slightly upstream from the tailings piles (June and December).
- 624 - Cane Valley Wash, east of the tailings piles (December).
- 627 - Cane Valley Wash, near well 651 and approximately 1 mile downstream from the tailings piles and frog ponds (June and December).

Analyses at each location included the primary contaminant indicator parameters of nitrate, sulfate, and uranium (*Table 5-2*). These contaminants were chosen as indicator parameters because they are by-products of the milling operation and usually have low concentrations in uncontaminated water.

The June results show that concentrations of the three chemicals did not exceed maximum concentration limits, even though these concentrations were influenced by the presence of soil in the water samples. The December results, however, show uranium exceeded the maximum concentration limit of 0.044 milligrams per liter (mg/L) at two locations, 624 and 627, in both the filtered and nonfiltered samples.

Surface Water Results and Conclusions

Analytical results for the June sampling event show that the concentrations of nitrate, uranium, and other constituents are below maximum concentration limits. Sulfate concentrations are typical of uncontaminated surface water for the area. Results from the December sampling event show that the maximum concentration limit for uranium was exceeded at two locations (624 and 627). These exceedances may result from natural uranium concentrations or from the former mill.

Table 5-2 Surface water quality results

Indicator parameter	Guideline	Monitoring well location			
		620	623	624	627
Nitrate	44 ^a				
June		<1.0	1.0	NM	<1.0
December		NM	<1.0	<1.0	<1.0
Sulfate	250 ^b				
June		84	55	NM	1120
December		NM	36	63	5990
Uranium	0.044 ^a				
June		0.028	<0.001	NM	0.043
December		NM	0.004	0.123	0.157

^aMaximum concentration limit.
^bSecondary Drinking Water Standard.
 NM - Not measured.

Notes: 1. Samples were taken in June and December 1993.
 2. Only analyses performed on unfiltered samples are reported here; concentrations are reported in milligrams per liter.
 3. < symbol indicates actual is less than the detection limit (number shown).

Ground Water Monitoring

Ground water was sampled on three occasions during 1993: late January/early February, late June/early July, and December. *Figure 5-8* shows monitoring well sample locations.

The area of the Monument Valley site contains three water-bearing zones (aquifers). From shallowest to deepest, they are the alluvium, the Shinarump Member, and the De Chelly Sandstone. Each aquifer flows northeast. *Figure 5-9* shows flow direction in the alluvium. Based on the extent of the plume and the length of time the mill was in operation, ground water flows at a rate of approximately 150 feet (ft) per year.

Ground water samples were analyzed for several constituents, including the primary ground water contaminant indicator parameters (nitrate, sulfate, and uranium) (*Table 5-3*). Nitrate, sulfate, and uranium are good ground water contaminant indicators because they are by-products of mill operations, travel at about the same rate as ground water flow, and concentrations usually are low in uncontaminated ground water. The wells are divided into three categories (upgradient, downgradient, and crossgradient). These categories reflect well locations relative to the former mill and tailings piles and to the direction of ground water flow.

Figure 5-8
Ground Water Monitoring Well Locations in the Alluvium, Shinarump, and De Chelly
Aquifers, Processing Site

ASER94/MON/LOCMONWELLS

Figure 5-9
Ground Water Table Contours in the Alluvial Aquifer, Processing Site

Table 5-3 Ground water quality results

Monitoring well location	Indicator parameter		
	Nitrate (MCL=44)	Sulfate (SDWS=250)	Uranium (MCL=0.044)
Upgradient			
601 - Jun	3	124	0.004
602 - Feb	4	126	0.004
Jun	2	125	0.004
603 - Jun	1	111	0.003
611 - Jun	1	73	0.008
613 - Jun	3	61	0.004
Dec	6	59	0.005
615 - Jun	<1	61	0.002
616 - Jun	6	346	0.006
Dec	6	136	0.006
617 - Jun	47	159	0.006
Dec	35	162	0.008
Downgradient			
606 - Jan	1160	990	0.013
Jun	1160	884	0.012
Dec	1120	805	0.012
614 - Feb	23	244	0.027
Jun	346	273	0.033
Dec	19	281	0.038
619 - Jun	32	129	0.133
Dec	20	73	0.135
650 - Dec	1	31	0.002
651 - Jul	2	113	0.002
652 - Feb	20	70	0.005
Jul	19	64	0.005
653 - Feb	75	1790	0.013
Jun	76	1650	0.011

Table 5-3 Ground water quality results (Concluded)

Monitoring well location	Indicator parameter		
	Nitrate (MCL=44)	Sulfate (SDWS=250)	Uranium (MCL=0.044)
655 - Feb	648	2470	0.028
Jun	598	2140	<0.001
656 - Feb	339	466	0.008
Jun	254	414	0.008
657 - Feb	19	138	0.068
Jun	19	122	0.076
Dec	19	122	0.080
660 - Feb	<1	24	<0.001
Jun	<1	28	0.026
662 - Feb	78	412	0.020
Jun	80	524	0.019
Dec	95	584	0.019
663 - Jun	a	46	<0.001
Dec	<1	45	<0.001
664 - Jun	<1	41	0.011
668 - Jun	2	36	0.003
669 - Jun	3	232	0.010
Crossgradient			
604 - Feb	<1	112	0.003
Jun	<1	108	0.002
605 - Feb	<1	1950	0.024
Jun	<1	2130	0.032
625 - Jun	<1	51	<0.001
Dec	<1	55	<0.001
654 - Feb	<1	48	0.001
Jun	<1	42	<0.001

^aAnalysis was not performed.

MCL—Maximum concentration limit.

SDWS—Secondary Drinking Water Standard.

- Notes: 1. Sampling results are reported in milligrams per liter.
 2. < symbol indicates actual is less than the detection limit (number shown).

Figure 5-10 shows the nitrate plume in the alluvial aquifer, which has the largest contaminant plume. Some nitrate contamination occurs in the Shinarump and De Chelly aquifers, but the plumes are smaller.

Ground Water Results

Wells 606 and 655 are in the most concentrated portion of the ground water contamination plume near the contaminant source. These wells show a gradual decrease in nitrate concentrations over time (*Figure 5-11*). Well 653 is at the leading edge of the plume and the increasing trend in contaminant concentrations shows the slow migration of the plume downgradient from the contaminant source. Wells 602 (upgradient) and 651 (downgradient) are far enough away from the plume that they are not contaminated (*Figure 5-12*). The lack of any trend demonstrates the relatively consistent quality of ground water outside the plume.

Ground Water Conclusions

Ground water within the site vicinity is affected by the former milling operations. The extent of contaminated ground water is shown by the nitrate plume in the uppermost (alluvial) aquifer (*Figure 5-10*). The nitrate plume moves northeast with the ground water, at a rate of approximately 150 ft per year.

Sampling results show that nitrate concentrations decrease near the tailings piles. Results from wells on the leading edge of the contamination, downgradient from the site, show a gradual increase in concentrations. This increase demonstrates the slow migration of the plume. Sampling results also show that nitrate and uranium exceeded maximum concentration limits within the most concentrated portion of the plume. Although sulfate has no maximum concentration limit, the site baseline risk assessment (in preparation) identifies a potential health concern from ingesting water from this area.

Figure 5-10**Nitrate Concentrations in the Alluvial Ground Water (1992), Processing Site**

Figure 5-11
Nitrate Concentrations Over Time in
Ground Water, Processing Site

ASER94/MON/PLUMEWELLS

Figure 5-12
Nitrate Concentrations Over Time in Upgradient
and Downgradient Wells, Processing Site

ASER94/MON/NITCON

SITE DESCRIPTION AND LOCATION

The Tuba City Uranium Mill Tailings Remedial Action (UMTRA) Project site lies at an elevation of approximately 5100 feet (ft) on alluvial and windblown deposits in the Southern Kaibito Plateau. The site is on a gently sloping terrace approximately 6000 feet northwest of Moenkopi Wash, an intermittent stream that drains west-southwest into the Little Colorado River. Surface drainage is to the southeast, toward Moenkopi Wash. The terrain north and west of the site is gently rolling, with active and partially stabilized windblown sand deposits and occasional outcrops of Navajo Sandstone. To the east and south, the terrain is more dissected because of erosion along the flank of Moenkopi Wash. Although mostly covered by dune deposits, the Navajo Sandstone appears to be close to the surface throughout the area.

The Tuba City site is on the Bennett-Freeze land, currently under dispute between the Navajo Nation and the Hopi Tribe. The site is 6 miles east of Tuba City (*Figure 5-13*), in Coconino County (population 96,591), Arizona. The 1990 populations of Tuba City/Moenkopi Village and the Tuba City Division were 924 and 27,436, respectively. In 1990, the population of the Hopi Reservation was 7360 (DOC, 1990).

The Tuba City site is arid. Very light precipitation, warm summers, cool winters, and occasionally strong, seasonal winds are characteristic of the area.

Due to the high elevation and low humidity at Tuba City, large daily temperature variations are typical. Normal daily highs range from 45 degrees Fahrenheit (°F) in January to 95°F in July. Normal daily lows range from 19°F in January to 61°F in July.

The average annual precipitation at Tuba City from 1941 to 1970 was approximately 6.2 inches. More than half of this amount, 3.8 inches, occurred as snow, sleet, or hail. The greatest monthly rainfall occurs in August, which is the peak of the late summer thunderstorm season. The driest month is June.

No wind data are available for the Tuba City area; however, the distribution of windblown tailings and formation of sand dunes in the area indicate the wind flows predominantly from the southwest.

SITE HISTORY AND OWNERSHIP

Rare Metals Corporation of America operated the uranium mill at the Tuba City site from 1956 to 1962. In 1962, Rare Metals merged with the El Paso Natural Gas Company, which ran the mill until 1966. During the 10 years of milling, about 800,000 tons of ore were processed. The mill was designed to process uranium ores using a sulfuric-acid leaching, sand-slime separation, and resin-in-pulp ion-exchange recovery system. However, in 1962, a high-lime content

Figure 5-13
Tuba City Site Location

ore became the primary feed source, and the mill was modified to use a carbonate leach process. Processing chemicals included iron metal, lime, ammonia gas, magnesia, tertiary amine, sulfuric and nitric acids, and kerosene. The tailings were placed as slurry in three contiguous piles at the site.

The Navajo Nation, the Hopi Tribe, and the U.S. Department of Energy (DOE) have entered into a cooperative agreement; the tribes will transfer custody of the disposal site to the DOE until the potential for adverse health effects abates and until ground water remediation is complete. The title to the residual radioactive material now located in the disposal cell automatically transfers from the tribes to the DOE. The transfer will be effective on the date the tribes receive the final Tuba City completion report.

SITE CHARACTERIZATION AND CLEANUP

Remedial action to stabilize the tailings in-place began in 1988. Relocated tailings from the adjacent subpiles, windblown and waterborne deposits, and other contaminated materials (including demolished buildings) were placed into the engineered disposal cell. Remedial action was completed in April 1990, with a total of 1,400,000 cubic yards of contaminated materials stabilized in the disposal cell. The cell covers 50 acres within the 145-acre disposal site.

ENVIRONMENTAL COMPLIANCE STATUS

With surface remedial action at the Tuba City site complete, the remaining surface-related compliance actions include U.S. Nuclear Regulatory Commission (NRC) licensing under the provisions of 10 CFR Part 40 for long-term surveillance and maintenance of the completed disposal site, including point-of-compliance ground water monitoring, as defined in the site long-term surveillance plan (DOE, 1992).

Under the UMTRA Ground Water Project, ground water, surface water, and sediment samples are analyzed to evaluate the ground water contamination resulting from processing site activities. In addition, sample results are evaluated for compliance with proposed U.S. Environmental Protection Agency (EPA) ground water standards.

In compliance with the National Environmental Policy Act (42 USC §4321 *et seq.*), public scoping meetings were held to gather information for the ground water programmatic environmental impact statement (in preparation) at Window Rock, Tuba City, and Moenkopi, Arizona; Mexican Hat, Utah; and Shiprock, New Mexico.

ENVIRONMENTAL MONITORING

At the Tuba City site, the DOE conducts an environmental monitoring program for radiological and nonradiological materials in surface water and ground water. This program monitors quantities of radioactive material and nonradiological hazardous constituents that may be

released into the environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

With the surface remedial action at the Tuba City site complete, air and environmental gamma radiation monitoring data were not collected for the UMTRA Project environmental monitoring program in 1993.

Surface Water Monitoring Results and Conclusions

In 1993, surface water samples were collected and analyzed from Moenkopi Wash at locations upstream and downstream of the site and at a ground water seep between the disposal cell and Moenkopi Wash (*Figure 5-14*). *Table 5-4* presents the surface water quality data for samples collected in April 1993.

Table 5-4 Surface water quality results

Indicator parameter ^a	Guideline	Monitoring well location		
		778 (upstream)	759 (downstream)	780 (seep downgradient of cell)
Cadmium	0.01 ^b	<0.001	0.007	<0.001
Calcium	None	88	92	12
Magnesium	None	27	29	4
Molybdenum	0.05 ^b	0.01	0.02	<0.01
Selenium	0.05 ^b	<0.005	<0.005	<0.005
Strontium	None	1.32	1.41	0.49
Uranium	0.044 ^c	0.005	0.005	0.002

^aSurface water samples were collected April 1993. Results are reported in milligrams per liter.
^bMaximum concentration limit.
^cThe maximum concentration limit (0.044) is the mass equivalent of 30 picocuries per liter, assuming uranium-234 and uranium-238 are in equilibrium.

Note: < symbol indicates actual is less than the detection limit (number shown).

Surface water data indicate that Moenkopi Wash and the ground water seep are not affected by tailings seepage.

Ground Water Monitoring

The ground water monitoring network consists of 14 wells screened in the Navajo Sandstone aquifer (*Figure 5-15*). Background ground water quality was established using data from monitoring wells 901, 910, and 917. Ground water quality in the contamination zone was established using data from monitoring wells 903, 906, 908, 909, and

Figure 5-14
Surface Water Sampling Locations, Disposal Site

ASER94/TUB/SWMONLOCS

Figure 5-15
Ground Water Monitoring Well Locations and Potentiometric Surface of
Navajo Sandstone Aquifer, Disposal Site

ASER94/TUB/POTENTIO

912. Downgradient ground water quality was established using data from monitoring wells 904, 913, 914, 915, 920, and 921.

Ground water elevations were measured and samples were collected from the 14 monitoring wells at the Tuba City site during one sampling round in August 1993. *Figure 5-15* shows the potentiometric surface of the Navajo Sandstone aquifer for August 1993. The next water quality sampling round is scheduled for August 1994.

The parameters that were analyzed reflect the hazardous constituents in ground water that are related to uranium processing activities at this site. Chloride, nitrate, sulfate, and uranium are four major contaminants chosen as indicator parameters. These indicator parameters are contaminants derived from the processing activities and tailings piles that have migrated into ground water in the uppermost aquifer during the past 35 years.

Ground Water Results

Results from the 1993 sampling round showed that concentrations of molybdenum, nitrate, selenium, and uranium exceeded maximum concentration limits in Navajo Sandstone aquifer ground water beneath the site. Chloride and sulfate concentrations in ground water exceeded Secondary Drinking Water Standards. Ground water quality data for a background monitoring well, a monitoring well screened in the plume, and a monitoring well downgradient of the plume are presented in *Table 5-5*. The extent of nitrate-contaminated ground water at the site is shown in *Figure 5-16*. *Figure 5-17* shows nitrate concentration trends in ground water for the years 1988 to 1993. No ground water sampling was conducted in the first quarter of 1994.

Table 5-5 Ground water quality results

Indicator parameter ^a	Guideline	Monitoring well location		
		901 (background)	906 (contaminated area)	904 (downgradient)
Chloride	250 ^b	11	353	79
Molybdenum	0.1 ^c	<0.01	0.8	<0.01
Nitrate (as NO ₃)	44 ^c	13	1310	6
Selenium	0.01 ^c	<0.005	0.011	0.009
Sulfate	250 ^b	18	3640	68
Uranium	0.044 ^c	0.001	1.75	0.003

^aGround water samples were collected August 1993. Results are reported in milligrams per liter.
^bSecondary Drinking Water Standard.
^cMaximum concentration limit.

Note: < symbol indicates actual is less than the detection limit (number shown).

Figure 5-16
Nitrate Concentrations in Ground Water, Disposal Site

ASER94/TUB/NITCONTAM

Note: Data collected August 1993.

Figure 5-17
Nitrate Concentrations Over Time in
Ground Water (1988-1993), Disposal Site

ASER94/TUB/NITCON

Ground Water Conclusions

Ground water near the Tuba City disposal cell continues to be contaminated as a result of the former uranium processing activities. Ground water quality conditions immediately downgradient of the disposal cell (in the vicinity of monitoring well 906) show a significant increase in chloride, nitrate, sulfate, and uranium concentrations. This trend may be caused by the possible release of tailings pore fluids into the aquifer during disposal cell construction. However, the concentrations pose no risk to public health and the environment because ground water is not being used for domestic or industrial purposes.

REFERENCES

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- DOE (U.S. Department of Energy), 1992. *Long-Term Surveillance Plan for the Tuba City, Arizona, Disposal Site*, final, UMTRA-DOE/AL-350218.0000, U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Code of Federal Regulations	10 CFR Part 40, <i>Domestic Licensing of Source Material</i> , U.S. Nuclear Regulatory Commission (1994).
	40 CFR Part 192, <i>Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings</i> , U.S. Environmental Protection Agency (1994).
Public Law	PL 99-499, <i>Superfund Amendments and Reauthorization Act</i> , amendment to CERCLA, October 17, 1986.
United States Code	33 USC §1251 <i>et seq.</i> , <i>Clean Water Act</i> , October 18, 1972.
	42 USC §4321 <i>et seq.</i> , <i>National Environmental Policy Act</i> , January 1, 1970.
	42 USC §6901 <i>et seq.</i> , <i>Resource Conservation and Recovery Act</i> , October 21, 1976.
	42 USC §7401 <i>et seq.</i> , <i>Clean Air Act</i> , December 17, 1963.
	42 USC §9601 <i>et seq.</i> , <i>Comprehensive Environmental Response, Compensation, and Liability Act</i> , December 11, 1980.
	49 USC §1801 <i>et seq.</i> , <i>Hazardous Materials Transportation Act</i> , January 3, 1975.

CHAPTER 6

COLORADO SITES

PROJECT
FUNDRAISING

COLORADO SITES

This chapter provides detailed Uranium Mill Tailings Remedial Action (UMTRA) Project data on environmental monitoring activities conducted at the Durango, Grand Junction, Gunnison, and Rifle, Colorado, sites during 1993 and the first quarter of 1994. The Maybell, Naturita, and Slick Rock, Colorado, sites were not sampled in 1993. There are nine uranium mill tailings piles at seven UMTRA sites in the state of Colorado.

Numerous documents describe the existing site environmental and construction details for surface remediation at the UMTRA Project sites. These documents, including environmental impact statements, environmental assessments, and remedial action plans, are available at the U.S. Department of Energy (DOE) UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Durango

The Durango site is in La Plata County in southwestern Colorado. Site remediation was completed in May 1991. Because surface remedial action is complete, air monitoring and environmental gamma radiation monitoring were not conducted in 1993. However, during 1993, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

Grand Junction

The Grand Junction site is in Mesa County in northwestern Colorado. Site remedial action is nearing completion. During 1993, air was monitored for total suspended particulates, thorium-230 particulates, and radon-222. Environmental gamma radiation monitoring was conducted as well. Only the data found to be statistically above background concentrations are reported here. In addition, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

Gunnison

The Gunnison site is in Gunnison County in western Colorado. The site is undergoing remedial action. During 1993, air was monitored for total suspended particulates, thorium-230 particulates, and radon-222. Environmental gamma radiation monitoring was conducted as well. Only the data found to be statistically above background concentrations are reported here. In addition, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here. In 1993, a wetlands study was initiated for a wetlands mitigation and monitoring plan in support of U.S. Army Corps of Engineers Section 404 Permit compliance activities.

CHAPTER 6 — COLORADO

Maybell

The Maybell site is in Moffat County in northwestern Colorado. Site remedial action is scheduled to begin in 1995. An ecological survey of threatened and endangered species was conducted in 1993 to comply with the Endangered Species Act (16 USC §1531 *et seq.*). Because remediation at the Maybell site is in the planning stage, no other environmental sampling was conducted in 1993 and this site is not discussed in this report.

Naturita

The Naturita site is in Montrose County in western Colorado. Site demolition is scheduled to begin during the summer of 1994. Because remediation at the Naturita site is in the planning stage, environmental sampling was not conducted in 1993. However, surveys of threatened and endangered species were conducted during June 1993, when a field team surveyed the San Miguel River for the southwestern willow flycatcher near the processing site. Environmental sampling is expected to begin before site remedial action begins. This site is not discussed in this report.

Rifle

The two Rifle sites are in Garfield County in northwestern Colorado. The New Rifle site is undergoing remedial action. Remedial action at the Old Rifle site has not begun. During 1993, air was monitored for total suspended particulates, thorium-230 particulates, and radon-222. Environmental gamma radiation monitoring was conducted at the New and Old Rifle sites. Only the data found to be statistically above background concentrations are reported here. In addition, surface water and ground water were monitored for radiological and nonradiological constituents at both the New and Old Rifle sites. Only the constituents defined as indicator parameters for these sites are discussed here.

Slick Rock

The two Slick Rock sites are in San Miguel County in southwestern Colorado. Site remedial action is scheduled to begin in April 1995. The regular surface water and ground water environmental sampling was conducted in late 1992. The 1993 annual environmental sampling event subsequently was rescheduled for early 1994 to support the site baseline risk assessment and to accommodate other UMTRA Project sampling needs. Results from the 1994 environmental sampling event will be published in the next annual site environmental report. Surveys of threatened and endangered species were conducted during June 1993, when a field team surveyed the Dolores River for the Southwestern willow flycatcher near the processing sites.

**SITE DESCRIPTION
AND LOCATION**

The Durango Uranium Mill Tailings Remedial Action (UMTRA) Project site includes the former processing site (the former mill/tailings pile site and the former raffinate pond area) and the Bodo Canyon disposal site.

The mill/tailings site and raffinate pond area are on the west bank of the Animas River, immediately southwest of the intersection of U.S. Highways 160 and 550 southwest of Durango, in La Plata County, Colorado. The disposal site is approximately 1.5 miles southwest, in a mountain valley near Bodo Canyon (*Figure 6-1*). The mill/tailings site encompasses approximately 40 acres. It is on a bedrock-supported river terrace between Smelter Mountain to the west, the Animas River to the east, and Lightner Creek to the north.

Covering approximately 17 acres, the raffinate pond area occupies part of the river terrace. The northern edge of this area is approximately 2000 feet (ft) south of the southern end of the mill/tailings site. The two areas are geologically and hydrologically separated. The Animas River borders the northeastern half of the site, and U.S. Highway 160/550 runs along the southeastern half. A small, intermittent creek (South Creek) forms the southern boundary of the raffinate pond area.

The Bodo Canyon disposal cell is in a southwest-to-northeast trending valley. The valley is bordered on both its northern and southern flanks by bedrock-supported ridges. Eastward-flowing arroyos to the north and south of the two flanking ridges are dry during much of the year.

The 1990 census reported a county population of 32,284. The population of the city of Durango is 12,430 (DOC, 1990).

Southwestern Colorado is climatically classified as a midlatitude steppe characterized by warm summers, cool springs and autumns, and moderately cold winters. The average annual temperature recorded at the National Weather Service Station in Durango is 46.8 degrees Fahrenheit (°F). Temperatures usually reach or exceed 90°F about 18 days each year, and are below 0°F about 10 days each year. Annual average precipitation is about 18 inches.

**SITE HISTORY AND
OWNERSHIP**

A lead smelter located near the south end of the mill/tailings site operated from 1880 to 1930. Slag from the smelter operation still exists in the southeast corner of the site along the Animas River.

In 1942, U.S. Vanadium Corporation leased the property and constructed a uranium processing mill on the site. The mill operated until 1946, when the mill was shut down. In 1949, Vanadium Corporation of America leased and subsequently purchased the processing site. The Vanadium Corporation of America operated the mill and sold uranium to the U.S. Atomic Energy Commission until

Figure 6-1
Durango Processing and Disposal Site Locations, La Plata County

NOT TO SCALE

March 1963, when the mill shut down permanently. Ranchers Exploration and Development Corporation purchased the mill in 1977. Hecla Mining Company acquired Ranchers Exploration and Development Corporation in July 1984.

Between 1942 and 1963, the uranium mill processed approximately 1.6 million tons of ore. From 1942 to 1959, the ore was salt-roasted, using sodium chloride, then quenched in sodium carbonate. The tailings were acid-leached with sulfuric acid and oxidizers. The acid-leach liquor was treated by solvent extraction, using kerosene and amines to recover vanadium and uranium. The principal wastes from the process included vanadium precipitation liquor, raffinate from the organic solvent extraction process, overflow from alkaline leach tanks, iron and aluminum sludge, and acid leach tails. Tailings were disposed of in two piles northwest of the mill. Until 1959, waste liquors were discharged directly into the Animas River or Lightner Creek without treatment.

After 1959, raffinate from the solvent extraction process flowed into a series of ditches and a system of 10 ponds at the raffinate pond area south of the mill site. The ponds were designed to dispose of the raffinate through evaporation and seepage, with no direct discharge to the river.

The former lead smelting and uranium milling operations may have added the following constituents to the soils, bedrock, and ground water at the mill/tailings site: arsenic, cadmium, chloride, cobalt, copper, lead, manganese, mercury, molybdenum, net gross alpha, nickel, nitrate, radium-226 and radium-228, selenium, silver, sodium, sulfate, thallium, uranium, vanadium, and zinc. Many of these constituents also were pumped to the raffinate ponds where they seeped into the soils, bedrock, and ground water.

The land on which the disposal site is located consists of two parcels: Tracts 101 and 102. The parcels were deeded to the Colorado Department of Public Health and Environment (CDPHE) on August 4, 1987, and November 6, 1992, respectively. On October 20, 1993, the state of Colorado forwarded draft deeds and supporting documentation for transferring the site to the federal government.

The Bodo Canyon site was used as pasture land and managed by the U.S. Department of the Interior, Bureau of Land Management. No mining, milling, or other industrial activities occurred in the valley before the disposal cell was established.

**SITE
CHARACTERIZATION
AND CLEANUP**

The U.S. Department of Energy (DOE) initiated remedial action to relocate the tailing piles and the contaminated soils from the mill/tailings site and raffinate pond area to the Bodo Canyon disposal site in March 1987. Relocation was completed in the fall of 1990.

At the Durango site, the residual radioactive materials included tailings, subpile soils, surficial materials from the mill yard, windblown materials, soils from vicinity properties, and soil from the raffinate pond area. In the disposal cell, materials with relatively low concentrations of radium-226 were placed above (on top of) materials with higher concentrations. This design provides additional shielding from both gamma radiation and radon.

After the residual radioactive material was removed from the Durango site, the site was backfilled with approximately 230,000 cubic yards of uncontaminated soil, contoured for drainage, and reseeded with native vegetation. The haul road between the processing site and the disposal site was scanned during and after remedial action to ensure the roadway had not become contaminated. The remaining lead smelter stack was demolished and hauled to the disposal cell for burial. Contaminated building foundations, rubble, and debris were removed and buried at the disposal site. River bank areas susceptible to erosion were lined with riprap (rock).

Supplemental standards were applied to three areas at the processing site (40 CFR Part 192): two locations along the banks of the Animas River (where removing the tailings would cause more environmental harm than leaving them in place) and one location on the face of Smelter Mountain. Safety concerns associated with removing the small area of tailings on Smelter Mountain outweighed the health risks associated with leaving the material in place.

**ENVIRONMENTAL
COMPLIANCE
STATUS**

With surface remedial action at the Durango site complete, the remaining surface-related compliance issues are U.S. Nuclear Regulatory Commission (NRC) licensing (10 CFR Part 40) and continued surveillance and maintenance of the completed disposal site, including point-of-compliance ground water monitoring defined in the site long-term surveillance plan (in preparation). Under the UMTRA Ground Water Project, ground water, surface water, and sediment samples are collected and analyzed to evaluate ground water contamination from the former uranium processing activities. The CDPHE, Water Quality Control Division, has regulatory authority over all Clean Water Act (33 USC §1251 *et seq.*) activities in Colorado.

In compliance with the National Environmental Policy Act (42 USC §4321 *et seq.*), a public scoping meeting was held in Durango to gather information for the ground water programmatic environmental impact statement (in preparation).

**ENVIRONMENTAL
MONITORING**

The DOE conducts a detailed environmental monitoring program for radiological and nonradiological materials at the Durango site, including radionuclide and nonradionuclide concentrations in surface water and ground water. This program monitors quantities of radioactive material and nonradiological hazardous constituents released into the environment, demonstrates compliance with applicable guidelines, and indicates the efficiency of environmental protection measures.

With surface remedial action at the Durango site complete, air and environmental gamma radiation monitoring data were not collected for the UMTRA environmental monitoring program in 1993.

Surface Water Monitoring

In November 1993, surface water and sediment samples were collected from eight locations along Lightner Creek, South Creek, and the Animas River, adjacent to the former processing site (*Figure 6-2*). The samples were collected in November because that is the time of lowest flow in Lightner Creek and the Animas River, making contaminant discharge into surface water noticeable. Samples were collected from Lightner Creek upstream of the site (650) and near the confluence with the Animas River (651); along the Animas River upstream of the confluence with Lightner Creek (652), upstream (690) and downstream (691) of the former mill/tailings site; and upstream (657) and downstream (654) of the former raffinate ponds. Samples also were collected from South Creek near the southwest corner of the site (653) to evaluate how infiltrating water from this creek could affect the background ground water quality. Samples taken downstream of the site were compared to upstream background samples to identify water quality changes that could result from the former uranium milling activities. Surface water and sediment samples were not collected at the Bodo Canyon disposal cell.

Samples from all locations were analyzed for sulfate, magnesium, calcium, nitrate, arsenic, cadmium, iron, lead, manganese, mercury, molybdenum, selenium, zinc, uranium, and total dissolved solids. Total dissolved solids, sulfate, and uranium were selected as probable indicators of contamination (*Table 6-1*).

**Surface Water Results
and Conclusions**

Surface water and sediment samples showed no consequences of the contaminated ground water that discharges to Lightner Creek and the Animas River, except a possible slight increase in sulfate concentration in the sediments downstream of the raffinate pond area. Elevated selenium and sulfate concentrations in the surface water and sediment samples from South Creek may be from the toe drain at the Bodo Canyon disposal cell.

Figure 6-2
Surface Water and Sediment Sampling Locations, Processing Site

ASER94/DUR/SURF&SEDLOCS

Table 6-1 Surface water and sediment quality results, processing site

Indicator parameter			Sampling location					
			Lightner Creek		Animas River (tailings/mill site vicinity)		Animas River (raffinate pond vicinity)	
			650 (up- gradient)	651 (down- gradient)	690 (up- gradient)	691 (down- gradient)	657 (up- gradient)	654 (down- gradient)
Total dissolved solids	Water	500 ^a	448	450	439	424	419	411
Sulfate	Water	250 ^a	157	154	153	152	148	168
	Sediment	NA	61.3	69.6	69.5	59.0	53.7	196
Uranium	Water	0.044 ^b	<0.001	<0.001	0.002	0.002	0.001	<0.001
	Sediment	NA	1.5	1.4	1.5	1.2	1.7	1.8

^aSecondary Drinking Water Standard.
^bMaximum concentration limit.
NA - None available.

Note: 1. Water concentrations are reported in milligrams per liter. Sediment concentrations are reported in milligrams per kilogram. Concentrations are averaged if two samples were collected (November 1993).
2. < symbol indicates actual is less than the detection limit (number shown).

Ground Water Monitoring

Processing Site

The Durango processing site consists of the former mill/tailings site and the former raffinate pond area (*Figure 6-3*). Ground water at the former mill/tailings site moves toward Lightner Creek and the Animas River as a thin (less than 3-ft-thick) layer through the alluvium on top of the very impermeable Mancos Shale. The low permeability of the shale limits downward ground water movement. At the former raffinate pond area, ground water moves through the relatively permeable sandstone and the overlying alluvium toward the Animas River.

During 1993, samples were collected from background wells 599, 600, 607, and 629, and from wells 598, 602, 628, 612, 617, and 622 downgradient of the sources of contamination at the former mill/tailings site and raffinate pond area (*Figure 6-3*). Monitoring well 602 was fitted with a packer to allow sample collection 50 ft below land surface, and wells 628 and 629 were installed. Three monitoring wells previously installed by the U.S. Bureau of Reclamation also were sampled.

Figure 6-3
Ground Water Monitoring Well Locations, Processing Site

ASER94/DUR/GWSAMPLOCS

Monitoring wells and piezometers, including a nested pair, were used to measure ground water elevations (*Figure 6-4*). Benchmarks established over Lightner Creek and the Animas River facilitated measuring surface water elevations to evaluate ground water and surface water interactions.

Ground Water Results

The ground water samples from the processing site were analyzed for sulfate, magnesium, calcium, nitrate, arsenic, cadmium, iron, lead, manganese, mercury, molybdenum, selenium, zinc, uranium, and total dissolved solids. Total dissolved solids, sulfate, and uranium are considered indicator parameters of ground water contamination caused by the former uranium milling operations. *Table 6-2* gives the water quality data on these three indicator parameters from background wells (607 and 629) and plume wells (617 and 628).

Ground Water Conclusions

There are insufficient water level measuring points to permit preparation of a ground water contour map at the former mill/tailings portion of the processing site. Prior to surface remediation at the raffinate pond area, the U.S. Bureau of Reclamation prepared a water table contour map (*Figure 6-4*). Current ground water conditions are expected to be similar to conditions at that time.

Ground water samples collected in previous years from the wells downgradient of the sources of contamination at the processing site show the ground water is contaminated by the former uranium milling activities. Hydrogeologic information on the aquifer characteristics, however, indicates the amount of ground water discharging to Lightner Creek and the Animas River is relatively small compared to the flow in those streams.

Analytical data also show constituent concentrations at the former mill/tailings site remain fairly constant, indicating little ground water movement. However, at the raffinate pond area sulfate and uranium concentration levels have decreased over time, suggesting ground water moving beneath the site may be naturally flushing these contaminants (*Figures 6-5 and 6-6*). It should be noted that total dissolved solids and sulfate concentrations in the natural, unimpacted ground water upgradient of the site exceed the U.S. Environmental Protection Agency (EPA) Secondary Drinking Water Standard (*Table 6-2*).

Disposal Site

The disposal cell contains the tailings, building debris, and contaminated soils from the processing site vicinity properties. The cell is designed to limit the amount of precipitation that could infiltrate and contaminate ground water.

Ground water in the alluvium beneath the disposal cell moves northeast; ground water in the sedimentary rocks moves southeast and northeast. Before the disposal cell was constructed, the Bodo Canyon

Figure 6-4

Ground Water Table Contours of the Raffinate Pond Area, Processing Site

Note: Conditions before surface remediation began.
U.S. Bureau of Reclamation, April 1990.

ASER94/DUR/GWCONTOURMAP

Table 6-2 Ground water quality results, processing site

Indicator parameter	Guideline	Location				
		Mill/tailings site		Raffinate pond area		
		629 (background)	617 (downgradient)	607 (upgradient)	602 (downgradient)	628 (downgradient)
Total dissolved solids	500 ^a	3710	3890	1420	3530 (4500)	12,900
Sulfate	250 ^a	2020	2120	628	6290 (6820)	7560
Uranium	0.044 ^b	0.008	0.272	0.003	0.076 (0.065)	0.367

^aSecondary Drinking Water Standard.
^bMaximum concentration limit.

Notes: 1. Analytical results for samples collected in November 1993. Concentrations are reported in micrograms per liter.
2. Numbers in parentheses are 1992 analytical results from well 602 before installation of the packer and isolation of the deep screen section.

site was used only as pasture. Therefore, all the monitoring wells originally were background wells.

Monitoring wells were sampled twice during 1993 (once in April and once in November) to detect changes in ground water quality that may indicate contaminants are moving from the disposal cell. Ground water elevations also were measured in April and November, before sampling, to monitor how well the cell cover reduces seepage into the ground water.

Ground water samples were collected from upgradient alluvial monitoring well 623 and upgradient bedrock wells 605 and 625 (*Figure 6-7*). Samples also were collected from downgradient alluvial wells 606, 608, 614, 618, and 620, and downgradient bedrock monitoring wells 607, 611, 612, 616, and 621. Wells 605, 607, 611, 612, and 621 are point-of-compliance wells.

Ground Water Results

These samples were analyzed for sulfate, magnesium, calcium, nitrate, arsenic, cadmium, iron, lead, manganese, mercury, molybdenum, selenium, zinc, uranium, and total dissolved solids. Total dissolved solids, sulfate, and uranium are considered indicator parameters of ground water contamination. *Table 6-3* lists the water quality data on these three parameters from upgradient wells 623 in the alluvium and 605 in the bedrock, and downgradient well 606 in the alluvium and 612 and 621 in the bedrock for the November 1993 sampling event.

Figure 6-5
Sulfate Concentrations Over Time,
Raffinate Pond Area, Processing Site

ASER94/DUR/SULOTRAFF

Figure 6-6
Uranium Concentrations Over Time,
Raffinate Pond Area, Processing Site

ASER94/DUR/URNOTRAFF

Figure 6-7
Ground Water Monitor Well Locations, Disposal Cell

ASER94/DUR/LOCSMONWELLS

Table 6-3 Ground water quality results, disposal cell

Indicator parameter	Guideline	Monitoring location				
		Alluvium		Bedrock		
		623 (upgradient)	606 (downgradient)	605 (upgradient)	612 (downgradient)	621 (downgradient)
Total dissolved solids	500 ^a	1980	1220	2960	2730	5090
Sulfate	250 ^a	1060	568	1350	607	3330
Uranium	0.044 ^b	0.002	0.002	<0.001	0.005	<0.001

^aSecondary Drinking Water Standard.
^bMaximum concentration limit.

Note: 1. November 1993 sampling event. Concentrations are reported in milligrams per liter.
 2. < symbol indicates actual is less than the detection limit (number shown).

Historic trends in concentrations versus time for sulfate and uranium in the upgradient and downgradient alluvial and bedrock wells (*Figures 6-8 and 6-9*) show that concentrations do not increase downgradient of the disposal cell.

There are insufficient water level measuring points to permit preparation of a ground water contour map. However, prior to surface remediation at the raffinate pond area, the U.S. Bureau of Reclamation prepared a water table contour map. Current ground water conditions are expected to be similar to conditions at that time. Ground water elevations from upgradient and downgradient alluvial wells 623 and 606, respectively, are plotted in *Figure 6-10*. Although these water level measurements in upgradient and downgradient alluvial wells do not indicate lowered water levels in the disposal cell, they do indicate water level fluctuations in downgradient wells are reduced since the disposal cell was constructed.

Ground Water Conclusions

The samples collected in April and November 1993 confirm earlier findings that trends cannot be detected to indicate increasing contamination from the disposal cell. Therefore, the disposal cell appears to provide the level of ground water protection for which it was designed.

The reduction in water level fluctuations in the downgradient alluvial well compared to the upgradient alluvial well indicates the cell cover is reducing infiltration from rain and snow.

Figure 6-8
Sulfate Concentrations Over Time, Alluvial Wells,
Disposal Site

ASER94/DUR/SULOTDIS

Figure 6-9
Uranium Concentrations Over Time, Alluvial Wells,
Disposal Site

ASER94/DUR/URNOTDIS

Figure 6-10
Ground Water Elevations, Alluvial Wells,
Disposal Site

ASER94/DUR/GWELEVDIS

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SITE DESCRIPTION AND LOCATION

The Grand Junction Uranium Mill Tailings Remedial Action (UMTRA) Project processing site is in Mesa County, Colorado, immediately south and east of the Grand Junction city limits (a portion of the site lies within the city limits). The site lies in the floodplain along the north side of the Colorado River about 0.75 mile upstream from the confluence of the Colorado and Gunnison Rivers (*Figure 6-11*). The site is in the Grand Valley, a major structural feature on the northeastern flank of the Uncompahgre Uplift.

The Cheney Reservoir disposal cell is approximately 18 miles south of Grand Junction, 2 miles due east of State Highway 50. The site sits on terraced deposits below the Grand Mesa, approximately 6 miles due east of the Gunnison River (*Figure 6-11*).

The 1990 populations of Mesa County and Grand Junction were 93,145 and 29,034, respectively (DOC, 1990).

Summer days with maximum temperatures near 90 degrees Fahrenheit (°F) and minimum temperatures near 60°F are common. Monthly average temperatures range from 26.6°F in January to 78.7°F in July. Summer rains occur mainly as scattered intense showers from thunderstorms that develop over the nearby mountains. Winter snows are fairly frequent; however, they are mostly light and the snow melts quickly. The average annual precipitation for Grand Junction is 8.4 inches. Snowfall at Grand Junction averages 26.5 inches.

The prevailing winds are from the east-southeast and average 8 miles per hour (*Figure 6-12*). The distribution is constant throughout the year because of the dominant, valley-induced upslope and downslope flows.

SITE HISTORY AND OWNERSHIP

The Climax Uranium Company opened the mill in Grand Junction in 1951. It was designed and built for uranium production, with by-product vanadium production. The mill's processing capacity was 330 tons of ore per day in 1951, but increased to 500 tons per day in 1955. A solvent-extraction circuit was added in 1956. The mill process involved ore neutralization, sand/slime separation, and treatments for sand and slime. An acid-leaching and solvent extraction process recovered uranium from the sand. The slimes were salt-roasted, water-leached to remove vanadium, and acid-leached with a solvent-extraction step to extract uranium and the remaining vanadium.

Uranium and vanadium oxide were sold under contract to the U.S. Atomic Energy Commission from 1951 to 1966. In 1960, the Climax Uranium Company was incorporated into American Metals Climax, Inc., which operated the mill until February 1970.

Figure 6-11
Grand Junction Site Location

Figure 6-12
Wind Rose

Ref: Grand Junction Airport.
Cumulative data 1948 through 1956.

ASER94/GRJ/WINDGRJ

Approximately 4.6 million dry tons of tailings were produced at the Grand Junction mill. Climax released approximately 500,000 cubic yards of tailings to private individuals and contractors for use as construction fill material from 1951 to 1966.

The mill was dismantled and the tailings pile was stabilized in late 1970 to early 1971. Contaminated materials remediated from vicinity properties in the Grand Junction area were stored in the evaporation ponds east of the tailings pile.

The state of Colorado owns the Grand Junction site. The U.S. Department of Energy (DOE) owns the Cheney Reservoir disposal site.

SITE CHARACTERIZATION AND CLEANUP

Remedial action for the Grand Junction site entailed excavating all residual radioactive materials at the site. The materials were transported by train to the Cotter transfer site, which is near Whitewater, a community 10 miles southeast of Grand Junction. At the Cotter transfer site, the tailings containers were transferred from the train to trucks. Trucks transported the tailings containers on a specially constructed haul road to the Cheney Reservoir disposal site. Train transport activities at the Grand Junction mill tailings site were

completed in September 1993. Currently, all vicinity property material is transported by truck.

At Cheney, the residual radioactive materials in the containers (tailings, asbestos, and other materials) were placed in a single disposal cell. Frost barrier bedding material, a radon barrier, and rock layers on the sideslopes protect the pile from erosion.

Phase I remedial action, which involved fencing, constructing retention ponds, and preparing the wastewater treatment plant foundation at the process site, was completed in 1989.

Phase II construction began in 1990 and included constructing the disposal cell and assembling the wastewater treatment plant. Tailings movement started in the spring of 1991. Remedial action at the Grand Junction site is expected to be completed in early 1994.

ENVIRONMENTAL COMPLIANCE STATUS

In accordance with DOE policy, the UMTRA Project at Grand Junction complies with federal and state environmental regulations. Remedial action activities are continuously evaluated for their environmental impact and to ensure that they meet applicable regulatory requirements. In 1993, Grand Junction site environmental activities included compliance with the Clean Water Act (CWA) (33 USC §1251 *et seq.*); the Clean Air Act (CAA) (42 USC §7401 *et seq.*); the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC §9601 *et seq.*); community right-to-know regulations; Spill Prevention Control and Countermeasures Plan regulations; and transportation regulations. Local regulations required permits for conditional use, highway access, and noise pollution.

Superfund Amendments and Reauthorization Act

Under the Superfund Amendments and Reauthorization Act (SARA) (Public Law 99-499), an amendment to CERCLA, the Grand Junction site must comply with Title III emergency planning and community right-to-know requirements. These requirements include notifications for threshold planning quantities of hazardous materials and notifications for spills of reportable quantities of extremely hazardous materials.

In 1993, the site was inventoried for all materials stored on-site in excess of 10,000 pounds or in excess of the threshold planning quantities for hazardous materials. The inventory included diesel fuel, oil, sulfuric acid, automotive maintenance fluids, and uranium mill tailings. It was submitted to the State Emergency Response Commission, the local emergency planning committee, and the local fire department.

Clean Water Act

The Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Division, has regulatory authority over all CWA activities in Colorado.

National Pollutant Discharge Elimination System

Operating under the Colorado Discharge Permit System, discharge permits issued to the Grand Junction site by the CDPHE, include wastewater and storm water permits. Wastewater discharge permits were issued for the retention basins at the processing site and the disposal site. The disposal site wastewater permit (No. CO-0042391) and the disposal site storm water permit (No. COR-30192) will be renewed as one permit in 1995. The three discharge points (outfalls) for effluent water identified in the processing site wastewater permit (No. CO-0042536) are not discharging. A report was sent to the CDPHE to terminate this permit in the spring of 1994. All effluent generated at the processing site was treated by a wastewater treatment plant and was discharged to the sewer system under permit (No. 017) issued by the city of Grand Junction. During 1993, wastewater was discharged routinely into this local treatment facility. No other wastewater discharges occurred at the processing site or the disposal site. Discharge parameters were not exceeded in 1993.

Spill Prevention Control and Countermeasures Plan

In 1990, the earthen berms were designed and constructed around existing aboveground storage tanks and around drum storage areas at Grand Junction. These secondary containment systems provide adequate spill control. In addition, plans for inspecting berms, detecting spills, emergency spill response, and spill cleanup were developed for fuel, oil, and other storage areas. Revisions were made as needed. During 1993, no reportable spills occurred at the site.

Septic/Holding Tanks

The Grand Junction processing site uses the local, publicly owned treatment works to dispose of all sanitary sewage. A septic tank at the processing site and the disposal site hold grey water from sanitary facilities.

Clean Air Act*Total Suspended Particulates*

The CDPHE, Air Pollution Control Division, has the regulatory authority to enforce CAA requirements. The state has adopted federal total suspended particulate standards, including a 24-hour limit of 150 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) and an annual limit of 60 $\mu\text{g}/\text{m}^3$ geometric mean. The Grand Junction site complies with all CAA monitoring requirements for fugitive dust. No exceedances or violations occurred during 1993.

The state health department is extensively involved with site total suspended particulate monitoring activities and granted initial approval to the monitoring program in 1988; the Grand Junction program operates under an air emission permit from this department, and two

total suspended particulate monitoring stations operate under an approved protocol that meets department requirements. Total suspended particulate monitoring occurs every three days; quarterly reports are submitted to the CDPHE, Air Pollution Control Division.

The Grand Junction site recorded a total suspended particulate reading higher than the threshold limit of $150 \mu\text{g}/\text{m}^3$ on June 24 and September 1, 1993. The exceedances were caused by off-site activities (a farmer was plowing a dry, nonirrigated field near the monitoring station). The CDPHE, Air Pollution Control Division, audited total suspended particulate stations in 1993, and a calculation discrepancy was corrected immediately.

National Environmental Policy Act

In compliance with the National Environmental Policy Act (42 USC §4321 *et seq.*), a scoping meeting was held in Grand Junction to gather information for the ground water programmatic environmental impact statement (in preparation).

Hazardous Materials Transportation Act

All materials transported at the Grand Junction Site were in full compliance with all requirements of the Hazardous Materials Transportation Act (HMTA) (49 USC §1801 *et seq.*).

The DOE acquired an exemption from the U.S. Department of Transportation to transport the tailings in bulk shipments. The exemption grants the use of special markings for haul trucks, shipping documentation, and training to address the hazards of tailings. Approximately 430,000 cubic yards of residual radioactive materials were hauled from the site under exemption E-10594 in 1993, and all requirements of the exemption were in compliance.

Noise Control

Noise control is regulated under "Noise Abatement-Colorado Revised Statutes," with specific requirements for the Grand Junction, Colorado, site, contained in Mesa County Conditional Use Permit MCM 88-30. The Grand Junction site developed and implemented the Site-Specific Community Noise Minimization Plan on January 7, 1992, to ensure compliance with conditional use permits and to institute engineering and administrative controls, as necessary, to reduce Project-related noise impacts to residential areas bordering the site.

Noise level monitoring was conducted at three fixed monitoring stations during at least one 24-hour period per week during normal operating hours. Additionally, monitoring was conducted when site conditions changed or complaints from the public were received.

Monthly noise control reports are prepared and submitted to Mesa County. For further information regarding noise data, contact Mesa County or the DOE UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Environmental Permits

The Grand Junction site obtained and operated under all required permits in 1993. *Table 6-4* lists all active permits for the site from January 1, 1993, to April 1994. Noncompliance notices were not issued in 1993.

**ENVIRONMENTAL
MONITORING**

The DOE conducts a detailed environmental monitoring program for radiological and nonradiological materials at the Grand Junction site, including environmental gamma-dose equivalent and radionuclide and nonradionuclide concentrations in air, surface water, and ground water. This program monitors quantities of radioactive material and nonradiological hazardous constituents released into the environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

Air Monitoring*Nonradiological Air
Particulate Monitoring*

The total suspended particulate monitoring system at the Grand Junction processing site consists of two monitors, TSP-1 and TSP-2 (*Figure 6-13*). *Figure 6-14* presents monitoring data. Total suspended particulate monitoring is not required at the Cotter transfer site or the Cheney Reservoir disposal site.

*Radiological Air
Particulate Monitoring*

Radiological air particulate monitoring at the processing site was conducted at Stations 1, 2, 3, 5, and 7, which were collocated with active radon gas monitoring stations (*Figure 6-13*). Station 4 was established to give additional information for residential locations east and south of the site. Station 27 was established to monitor the north side of the processing site. Only Station 14 (*Figure 6-15*) monitored the Cotter transfer site. Stations 20 and 25 (*Figure 6-16*) monitored the Cheney Reservoir disposal site.

Figure 6-17 summarizes site thorium-230 concentrations estimated from gross alpha measurements for the stations statistically above background. Background concentrations were measured at Station 7. The annual average concentration was statistically different from background only at Station 2. The estimated annual average thorium-230 concentration at all stations was well below the thorium-230 average annual guideline of 500×10^{-16} microcuries per milliliter ($\mu\text{Ci/mL}$) above background.

Radon Monitoring

Real-Time Radon Monitoring. *Figures 6-13 and 6-16* show the locations of real-time radon monitoring stations. Station 2 provides a conservative estimate of radon concentrations at the tailings pile boundary because it is immediately downwind of the tailings pile; Stations 1 and 5 monitor downwind community concentrations and concentrations at a residential area across the Colorado River, respectively. Station 3 provides radon concentration information near the vicinity property contaminated-material storage area, and

Table 6-4 Active Permits

Permit description	Submittal date	Preliminary approval date	Final approval date	Permit number	Expiration date
Dredge and fill permits (U.S. Army Corps of Engineers)					
Process site	07/88	10/88	01/89	9978	12/95
Kannah Creek ^a	12/89	11/89	02/90	9978	12/95
Colorado Discharge Permit System					
Process site wastewater ^b	04/89	12/89	05/90	CO-0042536	02/95
Disposal site wastewater	04/89	Final received ^c	03/91	CO-0042391	12/95
Process site storm water (general)	09/92	Final received ^c	10/92	COR-30263	03/95
Disposal site storm water (general)	09/92	Final received ^c	08/92	COR-30192	03/95
Cotter site storm water (general)	09/92	Final received ^c	10/92	COR-30262	03/95
Air emission notices					
Process site	08/88	10/90	07/93	88ME250	NA
Disposal site	08/88	10/90	07/93	88ME247	NA
Disposal site screening plt. plant ^d	07/91	09/91	NA	91ME598	NA
Surface water rights - Cheney ^e	08/88	Final received ^c	12/88	92CW144 88CW97	04/99 12/92
County floodplain (Mesa County)					
Process site ^f	07/88	Final received ^c	09/88	F2-88	11/94
Floodplain permit repository (city of Grand Junction) ^g	07/88	Final received ^c	03/90	13-90	NA
Ground water discharge permit (city of Grand Junction) ^h	05/91	Final received ^c	05/91	017	05/95
Conditional use permits					
Mesa County truck/train	01/88	Final received ^c	03/89	MCM88-30	04/93
Amendment for Cheney vicinity property	05/93	Final received ^c	08/93	88-30(D)	09/96

^aTwo included as amendment to permit number 9978.
^bLetter requesting termination of permit sent to CDPHE March 24, 1994.
^cNot applicable in 1993.
^dLetter requesting termination sent to CDPHE November 18, 1993.
^eWas 88CW97, given conditional status.
^fExpiration date extended.
^gIssued to DOE Idaho, then MK-Ferguson; stays with property.
^hWastewater discharge to city sewage. Termination request to city January 25, 1994.

NA - Not applicable; permit is pending.

Figure 6-13
Environmental Air and Gamma Radiation Monitoring Stations, Processing Site

ASER94/GRJ/BASE-ENVMONLOCS

Figure 6-14
Total Suspended Particulates, Processing Site

Figure 6-15
Environmental Air and Gamma Radiation Monitoring Stations,
Cotter Transfer Site Rail Facility

ASER94/GR/J/COTTRANSITE

Figure 6-16
Environmental Air and Gamma Radiation Monitoring Stations,
Cheney Disposal Site

ASER94/GRJ/DISSIFAC

Figure 6-17
Environmental Airborne Radioactive Particulate
(Thorium-230) Concentrations

ASER94/GRJ/TAB1

background radon concentrations were measured at Station 7, located 3 miles upwind (south) of the site (*Figure 6-13*). One station (Station 20) was established at the northwest boundary of the Cheney Reservoir disposal site (*Figure 6-16*).

Figure 6-18 presents the quarterly average radon concentrations for all locations statistically above background at the Grand Junction site for 1993. The annual average background radon concentration measured at Station 7 was 0.5×10^{-9} µCi/mL. Although radon concentrations were greater than background levels at Stations 2, 3, and 20, they were much lower than the DOE guideline of 3×10^{-9} µCi/mL above background. The elevated concentrations at the Grand Junction site should return to background levels when remedial action is complete.

Passive-Radon Monitoring. Thirteen stations around the processing site perimeter monitor passive radon (Stations 1 through 5, 8 through 13, and 27). Of the 12 stations, 6 are downwind from contaminated areas (Stations 2, 9, 10, 11, 12, and 27). Four stations (Stations 1, 3, 4, and 5) monitor residential areas in the community, and Station 2 is immediately downwind from the site. Background monitoring was performed again at Station 7, upwind of the site. Stations 14 through

Figure 6-18
Real-Time Radon Concentrations

ASER94/GRJ/TAB2

19 were established around the perimeter of the Cotter transfer site. Stations 20 through 26 were established around the Cheney Reservoir disposal site boundary. *Figures 6-13, 6-15, and 6-16* show locations of passive radon detectors at the processing site, Cotter transfer site, and Cheney Reservoir disposal site, respectively.

Figure 6-19 presents the passive-radon monitoring results for stations statistically different from background for the four quarters of 1993 at the Grand Junction site. The annual average background radon concentration measured at Station 7 was 0.6×10^{-9} µCi/mL. Although several annual average concentrations were greater than background, they were all much lower than the DOE guideline. The elevated concentrations at the Grand Junction site should return to background levels when remedial action is complete.

Air Monitoring Conclusions

With the exception of one exceedance caused by an off-site activity, all measured total suspended particulate results were below the applicable guidelines. Likewise, all measured concentrations of thorium-230 particulates and radon-222 were less than the applicable guidelines. No significant releases occurred from the site during 1993.

Figure 6-19
Passive Radon Concentrations

^a No monitoring was required at Station 3 during Quarter 4; remedial action was completed in Quarter 3.

ASER94/GRJ/TAB3

**Environmental Gamma
Radiation Monitoring**

A network of thermoluminescent dosimeters was used to measure exposure from environmental gamma radiation in the environment around the Grand Junction site. Monitors were placed around the site perimeter as well as in key locations in the city of Grand Junction.

Eighteen dosimetry monitoring stations were active in 1993. The processing site was monitored by eight environmental dosimeters (Stations 2B, 27C, 9D, 3E, 8F, G, H, and I) on the site boundary (*Figure 6-13*). Stations 2B and I also monitor dosimetry results for residential areas immediately west of the site. Station 1A provides dosimetry information for the downwind portion of the city of Grand Junction. Background dose is measured at Station 7J, which is 3 miles south (upwind) of the processing site. Four environmental dosimeters (Stations 14, 15, 16, and 17) were placed on the transfer site boundary (*Figure 6-15*). Four environmental dosimeters (Stations 20, 22, 24, and 25) were placed on the Cheney Reservoir disposal site boundary (*Figure 6-16*).

The annual background dose equivalent was 134.0 ± 17.4 millirems (mrem) at Station 7J. Of the perimeter locations for which annual dose equivalents are available, only Station 9D was statistically different from background. *Figure 6-20* presents the results of the environmental dosimetry monitoring for Station 9D at Grand Junction for 1993.

The dose equivalents measured at Station 9D for the third and fourth quarters were much lower than the dose equivalents measured during the first half of the year. Station 9D third- and fourth-quarter measurements were not statistically different from background measurements, indicating the source of elevated radiation exposure had been removed by remedial action. None of the measured dose equivalents exceeded the DOE guideline (100 mrem above background).

**Environmental Gamma
Radiation Monitoring
Conclusions**

No stations recorded environmental gamma radiation levels greater than the applicable guidelines, indicating no significant releases to the environment.

Surface Water Monitoring

Surface water monitoring of the Colorado River for radiological contaminants was conducted upstream and downstream to assess the potential environmental impacts of site remedial action activities. *Table 6-5* gives the radiological results of the surface water analysis.

Downstream water monitoring results were statistically indistinguishable from upstream results. In all cases, the results were well below DOE guidelines for water concentrations.

Figure 6-20
Environmental Gamma Radiation Monitoring

ASER94/GRJ/TAB4

Surface water and sediment samples were also collected in support of the Grand Junction baseline risk assessment from five locations along the Colorado River (locations 423, 424, 425, 427, and 428) in September 1993 (*Figure 6-21*) to assess the impacts of contaminated ground water. These surface water and sediment samples were analyzed for the following parameters: molybdenum, selenium, strontium, sulfate and uranium. *Table 6-6* lists the results of surface water and sediment analyses for primary indicator parameters at the processing site.

Surface Water Results and Conclusions

Only activities of net gross alpha have historically exceeded the U.S. Environmental Protection Agency (EPA) maximum concentration limit for ground water by up to a factor of 2 over time, both upstream and downstream, and during different stages of river flow. The source of the elevated net gross alpha concentrations is not the former uranium processing activities. None of the hazardous constituents exceeded background or maximum concentration limits in surface water, including sulfate and uranium (the primary indicator parameters).

The indicator parameters for ground water at the Grand Junction processing site are not above background or the maximum concentration limits in surface water. Water quality in the river

Table 6-5 Radiological surface water results

Location	Radionuclide	Quarter				Annual average	Limit ^a
		1	2	3	4		
Upstream of site	Radium-226	1.2	0.9	0.4	0.1	0.65 ± 0.50	100
	Thorium-230	0.0	2.1	1.5	0.6	1.05 ± 0.94	300
Downstream of site	Radium-226	0.8	2.1	0.6	0.1	0.90 ± 0.85	100
	Thorium-230	0.0	2.7	1.6	0.4	1.18 ± 1.23	300

^aGuidelines are from DOE Order 5400.5, *Radiation Protection of the Public and the Environment*.

Note: Results are reported in 1×10^{-9} microcuries per milliliter. All errors reported as twice the standard error of the mean.

appears to be relatively consistent both upstream and downstream of the site.

Surface water was not monitored at the Cheney Reservoir disposal site during 1993.

Ground Water Monitoring

Processing Site

Ground water is monitored during remedial action to assess the effects of remedial activities on ground water flow and ground water quality. In 1993, samples were collected from the processing site monitoring locations shown in *Figure 6-22*. Ground water occurs under unconfined conditions in the alluvium and generally flows south and southwest toward the Colorado River (*Figure 6-23*).

Ground water in the alluvium (uppermost aquifer) is affected by uranium processing activities. The contamination extends approximately 3300 feet (ft) downgradient from the site (*Figure 6-24*). Uranium is sampled and analyzed to measure the extent of the contamination because it is the most prevalent and mobile hazardous constituent that exceeds the maximum concentration limit. To evaluate the need for ground water remediation, ground water quality data are compared to background levels and the proposed EPA maximum concentration limits.

Ground water elevations were measured and samples were collected during three sampling rounds in 1993. Ten wells were sampled during the first sampling round in February and six wells were sampled in both June and December. All wells currently monitored at the processing site (*Figure 6-22*) are screened in the alluvium. These include two monitoring wells (745 and 746) to collect background

Figure 6-21
Surface Water and Sediment Sampling Locations Near the Processing Site

ASER94/GRJ/SURF&SEDLOCS

Table 6-6 Surface water quality results, processing site

Indicator parameter	Guideline	Colorado River locations				
		423 (upgradient)	424 (cross-gradient)	425 (cross-gradient)	428 (cross-gradient)	427 (cross-gradient)
Sulfate	250 ^a					
Water		164	182	196	148	186
Sediment		105	273	500	158	56
Uranium	0.044 ^b					
Water		0.003	<0.001	0.004	<0.001	0.005
Sediment		1.5	1.2	2.0	1.2	4.9

^aSecondary Drinking Water Standard.
^bMaximum concentration limit.

Notes: 1. Sediment concentrations are reported in milligrams per kilogram.
2. Samples were collected in September 1993.
3. < symbol indicates the value is less than the detection limit (number shown).

ground water quality data and four monitoring wells (590, 736, 740, and 742) to collect crossgradient and downgradient ground water quality data. Static ground water elevations were measured in several other monitoring wells not currently sampled for ground water quality.

Ground Water Results

Water samples are analyzed for the following parameters: molybdenum, selenium, strontium, uranium, sulfate, ammonium, nitrate, radium-226 and radium-228, gross alpha, and total dissolved solids. *Table 6-7* lists the results of 1993 ground water analyses for indicator parameters at the processing site. Sampling was not conducted in the first quarter of 1994.

Figure 6-25 illustrates uranium concentration variations in background, contaminated, and downgradient ground water. The fluctuating uranium concentrations in on-site and downgradient wells indicate a slight increase in uranium concentration since 1988. This apparent increase may be due to a combination of seasonal and contaminant migration-related factors. This trend illustrates that contaminants within ground water move downgradient toward the Colorado River, which may be the ultimate point of discharge for local ground water.

Ground Water Conclusions

Ground water elevation data show ground water flow direction and gradient remained relatively stable during 1993.

Figure 6-22
Ground Water Monitoring Well Locations, Processing Site

ASER94/GRJ/PROCSITEMONWELL

Figure 6-23
Ground Water Table Contours of the Alluvium, Processing Site

Figure 6-24
Uranium Concentrations in the Alluvial Aquifer, Processing Site

Note: Data collected February 1993.

ASER94/GRJ/URNPLUMEMAP

Table 6-7 Ground water quality results, processing site

Indicator parameter	Guideline	Monitoring well location		
		745 (background)	740 (plume)	736 (downgradient)
Total dissolved solids	500 ^a			
02/93		3550	7350	8030
06/93		3130	8010	7690
12/93		4950	7540	7950
Sulfate	250 ^a			
02/93		1790	3790	4020
06/93		1540	4220	3920
12/93		2590	3880	3720
Uranium	0.044 ^b			
02/93		0.030	0.20	0.150
06/93		0.029	0.190	0.135
12/93		0.024	0.153	0.111

^aSecondary Drinking Water Standard.
^bMaximum concentration limit.

Note: Results are reported in milligrams per liter.

Background ground water quality in the alluvium shows uranium, molybdenum, and selenium concentrations and net gross alpha activities are above the maximum concentration limits. Concentrations of total dissolved solids are elevated, with a marked decline in ground water quality away from the Colorado River. The variability in ground water quality probably comes from multiple contaminant and recharge sources, including irrigation canal leakage and deep field percolation, the Colorado River, and dissolution of salts from the underlying sedimentary rocks.

Water quality results indicate long-term historical fluctuation within a relatively broad range. Comparing analytical results of ground water samples collected during 1993 with existing water quality data indicates ground water quality at or downgradient of the processing site has not changed significantly.

Results of water quality sampling and ground water elevation measurements indicate no trends in ground water flow conditions or

Figure 6-25
Uranium Concentrations Over Time in the
Alluvial Aquifer, Processing Site

ASER94/GRJ/URNCON

ground water quality that could affect human health or the environment.

The current risk to human health or the environment is limited because water used for domestic and most other purposes is obtained from the Grand Mesa Reservoir, approximately 25 miles upgradient from the processing site. Ground water use in the vicinity of the Grand Junction processing site is not expected to change in the near future. However, if shallow ground water in the site vicinity were used, risk to human health would increase. In the future, the DOE will periodically survey water use in the vicinity of the former processing site.

Cheney Reservoir Disposal Site

Ground water was not monitored at the Cheney Reservoir disposal site during 1993. However, after disposal operations at the Cheney site are complete, ground water will be monitored to evaluate the potential impact of the disposal cell on transient ground water in adjacent paleochannels.

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SITE DESCRIPTION AND LOCATION

The Gunnison Uranium Mill Tailings Remedial Action (UMTRA) Project processing site is in a valley formed by the Gunnison River, approximately 10 miles downstream from the confluence of the Taylor and East rivers. The former Gunnison processing site is approximately between the Gunnison River and Tomichi Creek (*Figure 6-26*), which enters the Gunnison River near the site. The processing site is approximately 7640 feet (ft) above mean sea level (MSL). The processing site borders the city limits of Gunnison (population 4636), in Gunnison County (population 10,273), Colorado (DOC, 1990). The Gunnison County Airport borders the site on the north and east. Residual radioactive materials from the former processing site are being relocated to a disposal cell 8 miles to the east.

Between 1941 and 1970, the annual average rainfall in the Gunnison area was 11 inches. The annual average snowfall from 1951 to 1973 was 58 inches.

The local topography (mountains and valleys) influences winds in the upper Gunnison River Basin. However, the development of strong wind patterns, typical of mountain-valley settings, is somewhat weakened by the relatively small size of the airshed. Wind flow is predominantly from the north with an average speed of 7 miles per hour (*Figure 6-27*).

SITE HISTORY AND OWNERSHIP

Gunnison Mining Company operated the processing site from February 1958 to December 1961. Kermac Nuclear Fuels Corporation operated the processing site from December 1961 until its closure in April 1962. The processing site was acquired and is currently owned by the state of Colorado. Ore was trucked to the mill site from mines in the Cochetopa Pass area, about 25 miles southeast of Gunnison.

The processing site had a capacity of 200 tons of ore per day. The ore was ground and then leached with sulfuric acid and sodium chlorate. A sodium carbonate solution was used to extract the uranium from the solvent. The washed solids were sent to the tailings pile. During its 4 years of operation, the mill processed about 540,000 tons of ore to produce 800 tons of uranium concentrate (yellow cake).

The tailings were deposited originally in a rectangular pond confined by four dikes built of gravelly, sandy material scraped from the ground surface. The total surface area of the tailings pile was approximately 32 acres; the tailings are a maximum of 18 ft thick.

The tailings materials are primarily sands and fine sands with some clay and sandy clay slimes.

Figure 6-26
Gunnison Site Location

Figure 6-27
Wind Rose

Ref: Gunnison County Airport.
Cumulative data 1973 through 1977.

ASER94/GUN/WINDGUN

SITE CHARACTERIZATION AND CLEANUP

Remedial action involves demolition of the mill buildings (Phase I) and excavation and construction of the disposal cell, excavation of residual radioactive materials from the processing site and transportation to the disposal cell, and restoration of all areas disturbed by the remedial action activity (Phase II). Phase I remedial action was completed in 1992. Phase II remedial activities began in June 1992 and excavation of the disposal cell and tailings haul began in June 1993. By the end of construction in 1993, approximately 20 percent of the total volume of 850,000 cubic yards of residual radioactive materials was relocated to the disposal cell.

Before tailings placement, the disposal cell was excavated. The disposal cell will consist of an earthen embankment containing the residual radioactive materials and a multilayer cover. A layer of low-permeability clay mixed with bentonite will be placed over the tailings to limit radon emissions and reduce water infiltration. The clay layer will be covered by a layer of coarse sand for lateral water drainage. A thick layer of soil will be placed over the sand layer to prevent frost on the radon barrier. A rock layer will be placed on the top and sideslopes to prevent erosion. By using only natural materials in the disposal cell, the longevity requirement of disposal will be achieved at the Gunnison site.

**ENVIRONMENTAL
COMPLIANCE
STATUS**

In accordance with U.S. Department of Energy (DOE) policy, the UMTRA Project at Gunnison, Colorado, complies with federal and state environmental regulations. Remedial action activities are continuously evaluated for their environmental impact and to ensure they meet applicable regulatory requirements. Gunnison site environmental activities include compliance with the Clean Water Act (CWA) (33 USC §1251 *et seq.*) for monitoring and discharging liquid effluents to surface waters; the Clean Air Act (CAA) (42 USC §7401 *et seq.*) for monitoring fugitive dust and radon gas emissions; the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC §9601 *et seq.*) for reporting certain quantities of hazardous materials used or stored at the site; community right-to-know regulations; Spill Prevention Control and Countermeasures Plan regulations; U.S. Department of Transportation regulations; and local (conditional use, highway access, and noise) regulations in 1993.

**Superfund Amendments
and Reauthorization Act**

Under the Superfund Amendments and Reauthorization Act (SARA) (Public Law 99-499), an amendment to CERCLA, the Gunnison site must comply with the Title III emergency planning and community right-to-know requirements. These requirements include notifications for threshold planning quantities of hazardous materials and for spills of reportable quantities of extremely hazardous materials.

To comply with requirements of SARA, Title III, Section 311, an inventory was developed for all materials stored on the site in excess of 10,000 pounds or in excess of the threshold planning quantities for extremely hazardous materials. The inventory included diesel fuel, oil, sulfuric acid, automotive maintenance fluids, and uranium mill tailings. Notifications included the State Emergency Response Commission, the local emergency planning committee, and the local fire department.

Compliance with SARA, Title III, Section 312, was achieved by developing Tier II reporting forms for the 1992 inventoried materials and submitting them to the State Emergency Response Commission, local emergency planning committee, and local fire department by March 1, 1993.

The toxic release reporting requirements of SARA Title III, Section 313, do not apply to the Gunnison site because it is not listed in the manufacturing Standard Industrial Classification Codes 20 to 39. No materials were released into the environment that would fall under these reporting requirements.

**Resource Conservation
and Recovery Act**

In 1993, eight drums containing diesel fuel, tank rinsate, fiberglass, and tar contaminated with residual radioactive materials were deposited in the disposal cell in accordance with UMTRA Project guidelines and

with concurrence from the Colorado Department of Public Health and Environment (CDPHE).

Clean Water Act

The CDPHE, Water Quality Control Division, has authority over all CWA activities in Colorado.

National Pollutant Discharge Elimination System

Under the Colorado Discharge Permit System, the CDPHE issued discharge permits to the Gunnison site, including wastewater and storm water permits. Wastewater discharge permits were issued for the retention basins at the processing site (No. CO-0042889) and the disposal site (No. CO-0043401). An amendment was granted to the processing site permit in May 1993. The CDPHE issued the disposal site permit in July 1993 and a general storm water permit in August 1993. Storm water permits have been issued for the processing site, disposal site, and the haul road. No discharges occurred during 1993 at the disposal site or the processing site.

Spill Prevention Control and Countermeasures Plan

In 1993, a plan was implemented to store oil and diesel fuel on-site. Secondary containment included earthen berms to control spills and posting and safety devices. During 1993, the site had no reportable spills.

Septic/Holding Tanks

Septic systems had been installed to meet local codes at the processing site and disposal site; their use continued during the 1993 construction season.

Clean Air Act

The CDPHE, Air Pollution Control Division, has regulatory authority for CAA requirements. The CDPHE has adopted the federal standards for total suspended particulate levels, including a 24-hour limit of 150 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) and an annual limit of 60 $\mu\text{g}/\text{m}^3$ geometric mean. Although total suspended particulate monitoring is not required at the Gunnison site, the DOE has agreed to conduct modified total suspended particulate monitoring for fugitive dust. Fugitive dust did not exceed guidelines during 1993 at the Gunnison site.

National Environmental Policy Act

In compliance with the National Environmental Policy Act (42 USC §4321 *et seq.*), a public scoping meeting was held in Gunnison to gather information for the programmatic environmental impact statement (in preparation).

Hazardous Materials Transportation Act

All materials transported at the Gunnison site were in full compliance with all requirements of the Hazardous Materials Transportation Act (HMTA) (49 USC §1801 *et seq.*).

To transport the tailings in bulk shipments, the DOE acquired an exemption from the Department of Transportation. The exemption grants the use of special markings for haul trucks, shipping

documentation, and training to address tailings hazards. The approximately 88,000 cubic yards of residual radioactive materials hauled from the site under exemption E-10594 in 1993 complied with all requirements of the exemption.

Environmental Permits

The Gunnison site obtained and operated under all required permits in 1993. *Table 6-8* lists all active permits for the Gunnison site from January 1993 to December 1993.

ENVIRONMENTAL MONITORING

The DOE conducts a detailed environmental monitoring program for radiological and nonradiological materials at the Gunnison site, including environmental gamma radiation and radionuclide and nonradionuclide concentrations in air, surface water, and ground water. This program monitors radioactive material and nonradiological hazardous constituents released into the environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

Air Monitoring

Nonradiological Air Particulate Monitoring

Total suspended particulate monitoring under air emission permits for the processing site haul road, haul road development, disposal site, rock borrow area, and soil borrow area were in effect throughout 1993. The permits did not require total suspended particulate air monitoring, but at the request of the CDPHE, Air Pollution Control Division, monitoring was conducted during tailings haul activities in 1993 (*Figures 6-28 and 6-29*). The total suspended particulate monitoring system at the Gunnison processing site consists of two monitors.

Dust-suppressive water sprays control visible and off-site fugitive dust emissions during the Gunnison remedial action activities, as required in the air emissions permit.

Radiological Air Particulate Monitoring

Radiological air particulate monitoring at the Gunnison processing site was conducted at Stations 1 through 6, which were collocated with active radon monitoring stations (*Figure 6-28*). Because of the extremely cold weather in Gunnison, Stations 1 through 5 could not begin monitoring until April 9, 1993. Station 6 became operational on April 14, 1993. Stations 7 and 9 were established on May 18, 1993, when the disposal site became accessible (*Figure 6-30*). Background measurements were conducted at Station 5, approximately 1.5 miles west of the processing site. All stations were discontinued on November 22, 1993, 1 month after remedial action ceased for the winter.

Figure 6-31 summarizes site thorium-230 concentrations estimated from gross alpha measurements for Station 7. The annual average concentration at Station 7 was statistically different from the

Table 6-8 Active permits

Permit description	Submittal date	Preliminary approval date	Final approval date	Permit number	Expiration date
Dredge and fill permit (U.S. Army Corps of Engineers)	12/91	Final received ^a	07/92	9200371	06/95
Colorado Discharge Permit System					
Process site wastewater	07/90	Final received ^a	06/92	CO-0042889	04/97
Disposal site wastewater	11/92	Final received ^a	07/93	CO-0043401	05/98
Process site storm water	09/92	Pending	Pending	COR-30193	03/95
Disposal site storm water	09/92	Final received ^a	10/92	COR-30264	03/95
Chance Gulch storm water	06/93	Final received ^a	08/93	COG-500259	09/97
Haul Road storm water	09/92	Final received ^a	10/92	COR-30265	03/95
Process site wastewater Amendment No. 1	08/92	Final received ^a	05/93	CO-0042889	04/97
Air emission notice/permits, CDPHE					
Process/haul route - earth moving ^b	12/91	05/92	Pending	90GU472F-1	NA
Process - demolition ^c	08/91	10/91	Pending	91GU657	NA
Disposal site - earth moving ^a	11/90	05/92	Pending	90GU472F-2	NA
Chance Gulch rock borrow site	12/91	02/92	Pending	91GU249F	NA
Sixmile Lane radon barrier borrow site	12/91	03/92	Pending	91GU953F	03/95
Land development - haul road ^b	01/91	03/91	Pending	91GU022L	NA
Tenderfoot Mountain					
Water rights, Colorado Division of Water Rights					
Surface Water - disposal site	05/92	09/92	10/92	92CW40	10/98
Water storage rights - disposal site	05/92	09/92	10/92	92CW41	10/98
Free use permits, Bureau of Land Management					
Sixmile Lane radon barrier borrow site	02/92	Final received ^a	07/92	COC53788	6/2002

Table 6-8 Active permits (Concluded)

Permit description	Submittal date	Preliminary approval date	Final approval date	Permit number	Expiration date
Certificate of designation solid waste disposal (county)	—	Final received ^a	06/92	G-09-03260	6/2002
Chance Gulch rock borrow site	03/92	Final received ^a	07/92	COC53787	NA
Gunnison County Land Use Change Permit	04/92	NA	05/92	27	NA

^aNot applicable in 1993.
^bReceived revisions dated January 15, 1993.
^cActivity complete - requested deactivation September 2, 1993.
^dReceived revision dated January 15, 1993.

NA - Not applicable.

background average. The estimated annual average thorium-230 concentrations at all stations were well below the thorium-230 average annual guideline of 500×10^{-16} microcuries per milliliter ($\mu\text{Ci/mL}$) above background.

Radon Monitoring

Real-Time Radon Monitoring. Stations 1 through 5 became operational on April 9, 1993, and Station 6 began monitoring on April 14, 1993. Background radon concentrations were measured at Station 5, located 1.5 miles west of the site. **Figures 6-28 and 6-30** show the locations of the real-time radon monitoring stations.

Figure 6-32 presents the quarterly 1993 average radon concentrations for all locations statistically above background at the Gunnison site. The annual average background radon concentration measured at Station 5 was $0.51 \times 10^{-9} \mu\text{Ci/mL}$. Although the annual average radon concentrations at Stations 1 and 2 were statistically different from background, all of the annual average radon concentrations were much lower than the DOE guideline of $3 \times 10^{-9} \mu\text{Ci/mL}$ above background. The elevated concentrations at the Gunnison site should return to background levels when remedial action is complete.

Passive Radon Monitoring. Five stations were established around the processing site perimeter (Stations 1 through 4 and 6). Background monitoring was conducted at Station 5 upwind of the site. Stations 7 through 9 were established in the second quarter of 1993 around the perimeter of the disposal site. **Figures 6-28 and 6-30** provide locations of passive radon detectors at the Gunnison site.

Figure 6-28
Environmental Air and Gamma Radiation Monitoring Stations,
Processing Site

Figure 6-29
Total Suspended Particulates, Processing Site

Figure 6-30
Environmental Air and Gamma Radiation Monitoring Stations, Disposal Site

ASER94/GUN/DISMONSTATIONS

Figure 6-31
Environmental Airborne Radioactive Particulate
(Thorium-230) Concentrations

ASER94/GUN/TAB1

Figure 6-33 provides the quarterly passive radon monitoring results for 1993 at the Gunnison site for stations statistically above background. The annual average background radon concentration measured at Station 5 was 0.6×10^{-9} µCi/mL. Although the annual average concentrations at Stations 1, 2, 7, and 8 were statistically different from the background concentration, all of the annual average radon concentrations were lower than the DOE guideline. The elevated concentrations at the Gunnison site should return to background levels when remedial action is complete.

Air Monitoring Conclusions

All total suspended particulate results were below applicable guidelines. All measured concentrations of thorium-230 particulates and radon-222 were lower than the applicable guidelines. No significant releases occurred at either the processing or disposal site during 1993.

Environmental Gamma Radiation Monitoring

A network of thermoluminescent dosimeters measured exposure from environmental gamma radiation in the environment around the Gunnison processing site. Monitors were placed at the perimeters of the processing site and the disposal site (*Figures 6-28 and 6-30*).

Figure 6-32
Real-Time Radon Concentrations

ASER94/GUN/TAB2

^aStations 1 and 2 established during Quarter 2.

Nine dosimetry monitoring stations were active in 1993. Five environmental dosimeters placed on the site boundary (Stations 1 through 4 and 6) monitored the processing site. Background dose was measured at Station 5, which is 1.5 miles west of the processing site. Three environmental dosimeters were placed on the disposal site boundary, starting during the second quarter (Stations 7 through 9).

Figure 6-34 presents the results of the environmental dosimetry monitoring for Station 2 at the Gunnison site for 1993. The annual background dose equivalent was 135.0 ± 11 millirems (mrem) at Station 5. Of the locations for which annual dose equivalents were available, only Station 2 was statistically different from background. None of the monitoring stations at the disposal site were significantly different from background. The elevated dose equivalent at Station 2 did not exceed the DOE guideline (100 mrem above background). After remedial action, dose equivalents are expected to return to near-background levels.

Environmental Gamma Radiation Monitoring Conclusions

None of the stations recorded environmental gamma radiation levels greater than the applicable guidelines, indicating no significant releases to the environment.

Figure 6-33
Passive Radon Concentrations

^aStations 7 and 8 established during Quarter 2.

ASER94/GUN/TAB3

Figure 6-34
Environmental Gamma Radiation Monitoring

ASER94/GUNTAB4

Surface Water Monitoring

Surface water was monitored for radiological contaminants to assess potential environmental impacts from remedial action site activities. *Table 6-9* provides the results of the surface water analysis for radiological contaminants. Downstream water monitoring results were statistically indistinguishable from upstream results. In all cases, the results were well below DOE guidelines for water concentrations.

Surface water monitoring also was conducted for the site baseline risk assessment to determine the impact of uranium milling activities.

Figure 6-35 shows the locations of six surface water and sediment sampling points. Two sampling points are in the Gunnison River, one upstream (location 775) and one downstream (location 776) of the site. Tomichi Creek also was sampled upstream (location 778) and downstream (location 777) of the site. The fifth sampling point is the pond (location 779) used for pay fishing at a campground. Unfiltered surface water samples, sediment samples, and fish samples were collected from each of these locations in June 1993. Additional

Table 6-9 Radiological surface water results

Surface water concentrations ^a							
Location	Radionuclide	Quarter				Annual Average	Limit ^b
		1	2	3	4		
Gunnison River upstream	Radium-226	0.2	0.0	0.1	0.0	0.1 ± 0.10	100
	Thorium-230	0.0	0.5	4.6	0.0	1.3 ± 2.2	300
Gunnison River downstream	Radium-226	1.1	0.0	0.0	0.0	0.3 ± 0.6	100
	Thorium-230	1.3	0.4	0.5	0.6	0.7 ± 0.4	300
Tomichi Creek upstream	Radium-226	1.4	0.0	0.3	0.0	0.4 ± 0.7	100
	Thorium-230	0.0	0.4	0.9	0.0	0.3 ± 0.4	300
Tomichi Creek downstream	Radium-226	0.8	0.3	0.1	0.2	0.4 ± 0.3	100
	Thorium-230	0.8	0.3	0.0	0.4	0.4 ± 0.3	300

^aConcentrations reported in 1×10^{-9} microcuries per milliliter. All errors reported as twice the standard error of the mean.

^bGuidelines are from DOE Order 5400.5, *Radiation Protection of the Public and the Environment*.

surface water samples were collected from the campground pond (location 779) in May and October 1993. The sixth sampling point is the northeast corner of a gravel pit (location 780), south of the former Gunnison processing site. Surface water quality samples were collected from location 780 in May and October 1993. No sediment or fish samples have been collected from location 780.

All surface water and sediment samples were analyzed for the following parameters: calcium, magnesium, manganese, molybdenum, uranium, and zinc. Locations 779 and 780 also were analyzed for alkalinity, chloride, dissolved organic carbon, gross alpha and gross beta, iron, lead-210 (779 only), nitrate, pH, polonium-210 (779 only), potassium, radium-226 and -228, sodium, specific conductance, sulfate, thallium, thorium-230 (779 only), total dissolved solids, and total organic carbon.

Surface Water Results

Surface water data from the Gunnison River and Tomichi Creek reveal that most of the constituents detected at the downstream locations were not greater than their respective background concentrations (*Table 6-10*). Detailed information is provided in the baseline risk assessment (in preparation).

Surface Water Conclusions

Precipitation and snowmelt may have carried both dissolved and suspended constituents to the Gunnison River, Tomichi Creek, and the campground pond. Surface water in the gravel pit seeps from ground water in an adjacent gravel pit. As a result, the concentrations of some constituents may be higher because the pumped ground water has been

Figure 6-35**Surface Water, Sediment, and Fish Sampling Locations in the Processing Site Vicinity**

ASER94/GUN/SWSED&FISH

Table 6-10 Surface water quality results, processing site

Indicator parameter	Guide-line	Gunnison River upstream (775)	Gunnison River downstream (776)	Tomichi Creek upstream (778)	Tomichi Creek downstream (777)	Campground pond (779)	Gravel pit (780)
Calcium	NA						
5/93		NM	NM	NM	NM	NM	NM
6/93		22.0	13.1	29.1	33.9	55.0	NM
10/93		NM	NM	NM	NM	64.0	77.4
Magnesium	NA						
5/93		NM	NM	NM	NM	14.1	14.1
6/93		4.5	2.6	7.8	8.7	11.4	NM
10/93		NM	NM	NM	NM	12.7	14.7
Uranium ^a	0.044 ^a						
5/93		NM	NM	NM	NM	0.002	0.018
6/93		<0.001	<0.001	0.002	0.004	0.005	NM
10/93		NM	NM	NM	NM	0.001	0.046

^aMaximum concentration limit.
 NM - Not measured.
 NA - None available.

Notes: 1. Concentrations are reported in milligrams per liter.
 2. Samples were unfiltered.
 3. < symbol indicates actual is less than the detection limit (number shown).

in contact with the soil for a longer time than the surface water in the Gunnison River, Tomichi Creek, or the campground pond. Thus, deposited sediments could act as a source of site-related, surface water contamination. However, the available surface water and sediment data from the water bodies in the site vicinity suggest that contaminated ground water from the site has not adversely affected the surface water and sediment quality. Fish tissue samples suggest that aquatic life has not been adversely affected.

Surface water and sediment samples were not collected at the Gunnison disposal site during 1993.

Ground Water Monitoring

Processing Site

Ground water samples are being collected at the former Gunnison processing site to monitor water quality changes before and during surface remediation. To assess the extent of ground water contamination from former processing activities, the ground water quality was compared with the water quality of background and the proposed Environmental Protection Agency (EPA) maximum

concentration limits referred to in 40 CFR Part 192. Background ground water quality is defined as the quality of ground water that would be expected at the site if uranium processing activities had not occurred. Conversely, ground water quality is defined as the representative water quality in a monitoring well that has been influenced by uranium processing activities.

The Gunnison processing site is underlain by floodplain alluvial deposits associated with the Gunnison River and Tomichi Creek. These alluvial materials range in size from fine-grained clay to coarse-grained gravels and cobbles with occasional boulders. The thickness of these deposits at the site is undetermined; however, a borehole 200 ft southwest of the site encountered shale bedrock at 130 ft below land surface. Monitoring well clusters generally consist of a shallow well installed approximately 10 to 25 ft below land surface, an intermediate well approximately 40 to 60 ft below land surface, and a deep well approximately 90 to 100 ft below land surface. The bottom 5 ft of each of these wells is screened. *Figure 6-36* shows the locations of these monitoring wells.

The water table contour map (*Figure 6-37*) shows ground water flows to the southwest. The direction of horizontal ground water movement is comparable in the shallow, intermediate, and deep monitoring wells, indicating the alluvial aquifer is generally unconfined. However, low-hydraulic-conductivity silt and clay may create semiconfined conditions with increasing depth in the alluvium. Ground water moves to the southwest, at approximately 56 to 1700 ft per year (silty alluvium/clean gravels and cobbles).

Figure 6-36 shows monitoring well and domestic well ground water sampling locations. Monitoring well clusters 001/101 and 002/102 are background monitoring wells. The remainder of the monitoring wells measure baseline and/or downgradient water quality. Ground water samples were collected in December 1992/January 1993, May 1993, and October 1993.

DOE monitoring wells and private well samples were analyzed for the following parameters:

- Field parameters: alkalinity, oxidation-reduction potential, pH, specific conductivity, temperature, and ferrous and total iron (at selected monitoring wells).
- Laboratory analyses: aluminum, ammonium, antimony, arsenic, barium, beryllium, cadmium, calcium, chloride, chromium, cobalt, copper, dissolved oxygen, gross alpha and beta, iron, lead, lead-210, magnesium, manganese, molybdenum, nickel, nitrate, phosphate, polonium-210, potassium, radium-226 and radium-228,

Figure 6-36
Ground Water Monitoring Well Locations, Processing Site

Figure 6-37**Potentiometric Surface for Intermediate Monitoring Wells, Processing Site**

500 0 500 1000 Feet

ASER94/GUN/POTENSURF

selenium, silica, sodium, sulfate, sulfide, thallium, thorium-230, tin, total organic carbon, turbidity, total dissolved solids, uranium, vanadium, and zinc.

Sulfate and uranium are used to define the areal extent of the contamination because they are 1) found in very low concentrations in background ground water, 2) chemical by-products of ore processing at the Gunnison mill, and 3) geochemically nonreactive compounds. Other ground water contaminants of concern are cadmium, cobalt, iron, manganese, and some uranium radioactive decay products. The potential effects of elevated concentrations of hazardous and nonhazardous constituents are presented in the site baseline risk assessment.

Site Ground Water Results

Table 6-11 summarizes ground water quality results for the Gunnison processing site vicinity. Results are presented for a background monitoring well (102), a monitoring well in the contaminant plume (186), and a downgradient monitoring well (160) that appears to be encroached upon by the leading edge of the contaminated ground water. Indicator parameters presented in *Table 6-11* (total dissolved solids, sulfate, and uranium) were selected because they demonstrate the probable maximum current extent of ground water contamination and its migration. The table shows that concentrations of total dissolved solids are approximately 340 to 350 milligrams per liter (mg/L) for background, 920 to 940 mg/L in the contamination, and 410 to 450 mg/L at the outer edge of the contamination. Sulfate concentrations range from 22 to 25 mg/L in background, increase to 410 to 420 mg/L in the contamination, and fall off to 80 to 100 mg/L at the edge of the contamination.

Figure 6-38 illustrates the areal distribution of the sulfate contamination. Uranium concentrations show a similar trend, with background concentrations ranging from 0.003 to 0.005 mg/L in monitoring well 102, increasing by 1 order of magnitude in contaminant monitoring well 186 (0.054 to 0.055 mg/L), and being slightly elevated above background in downgradient monitoring well 160 (0.011 to 0.014 mg/L). The geometry and movement of the sulfate contaminants (*Figure 6-38*) mirrors that of the uranium (*Figure 6-39*). *Figures 6-40 and 6-41* illustrate the trends of sulfate and uranium over the past 4 years, showing background concentrations have remained relatively constant. Concentrations of uranium and sulfate apparently indicate an increasing trend in the downgradient monitoring well (west side of the Gunnison River).

Ground Water Conclusions

Results of the 1993 analyses show that concentrations of all measured regulated constituents were significantly below maximum concentration limits in background monitoring wells. The ground water samples collected in previous years from wells downgradient of the former

Table 6-11 Ground water quality results, processing site

Indicator parameter	Guideline	Monitoring well location		
		102 (background)	186 (plume)	160 (downgradient)
Total dissolved solids	500 ^a			
12/92		342	917	416
05/93		350	920	410
10/93		337	944	449
Sulfate	250 ^a			
12/92		25	417	80
05/93		24	416	80
10/93		22	411	96.1
Uranium	0.044 ^b			
12/92		0.005	0.054	0.011
05/93		0.004	0.055	0.014
10/93		0.003	0.054	0.014

^aSecondary Drinking Water Standard.
^bMaximum concentration limit.

Note: Concentrations are reported in milligrams per liter.

processing site show that former uranium milling activities have impacted alluvial ground water. This effect was observed in ground water samples collected during 1993.

Disposal Site

Contaminated materials from the former Gunnison processing site are being moved to the Gunnison disposal site, approximately 6 miles east of the town of Gunnison. The disposal cell is designed to prevent contaminant migration. Ground water monitoring is required at the disposal site to ensure regulatory compliance by preventing exceedances of the maximum concentration limits. *Figure 6-42* shows DOE monitoring well locations at the Gunnison disposal site that were sampled or had water levels measured in 1993.

At the Gunnison disposal site, the uppermost aquifer occurs in the lower portion of a regional Tertiary gravel unit. *Figure 6-43* is a potentiometric map. Depths to ground water beneath the disposal site range from approximately 60 to 180 ft below land surface. Aquifer testing shows the uppermost aquifer responds as a confined aquifer at the disposal site. The primary direction of ground water flow is

Figure 6-38
Sulfate Concentrations in the Alluvial Aquifer, Processing Site

500 0 500 1000 Feet

Figure 6-39
Uranium Concentrations for Intermediate Monitoring Wells, Processing Site

500 0 500 1000 Feet

Figure 6-40
Sulfate Concentrations Over Time in the
Alluvial Aquifer, Processing Site

ASER94/GUN/GWQUAL

Figure 6-41
Uranium Concentrations Over Time in the
Alluvial Aquifer, Processing Site

ASER94/GUN/URNCON

Figure 6-42
Ground Water Monitoring Well Locations, Disposal Site

ASER94/GUN/MONWELLOCS

Figure 6-43**Potentiometric Surface Map of the Tertiary Gravel Aquifer, Disposal Site**

Note: Water levels measured January 1993.

800 0 800 Feet

eastward, with an approximate linear ground water velocity ranging from 5 to 10 ft per year.

DOE monitoring wells (703, 704, 707, 708, and 713 through 717) at the Gunnison disposal site were sampled in January, May, and October 1993. This sampling complied with the surface remediation ground water protection strategy presented in the site remedial action plan (DOE, 1992).

Ground Water Results

Ground water samples collected in 1993 were analyzed for the following parameters on one or more occasions based on the quantity of water available (sample volume) for a given well.

- Field parameters: alkalinity, oxidation-reduction potential, pH, specific conductivity, and temperature for the DOE monitoring wells referenced above; and ferrous and total iron in DOE monitoring wells 703 and 704.
- Laboratory analyses: aluminum, ammonium, antimony, arsenic, barium, beryllium, cadmium, calcium, chloride, chromium, cobalt, copper, dissolved oxygen, fluoride, gross alpha and beta, iron, lead, potassium, magnesium, molybdenum, manganese, nickel, nitrate, radium-226 and radium-228, selenium, silica, silver, sodium, strontium, sulfate, tin, thallium, total dissolved solids, total organic carbon, turbidity, uranium, vanadium, and zinc.

These analyses include contaminants of concern identified in the tailings pore fluids and major constituents and field parameters that may provide early warning of contaminant migration from the disposal cell.

Evaluation of ground water elevation data revealed a relatively stable ground water flow direction over time. Ground water table fluctuations are expected to result from variations in natural recharge (precipitation and snowmelt).

Comparing analytical results of ground water samples collected during 1993 with historical water quality data shows arsenic concentrations exceeded the maximum concentration limits in monitoring wells 704 and 715. Concentrations or activities of arsenic, net gross alpha, and combined radium-226 and thorium-228 historically have exceeded maximum concentration limits in background ground water samples collected from the Tertiary gravel (uppermost) aquifer. No exceedances in net gross alpha or radium-226 and radium-228 activities were measured in 1993.

**Ground Water
Conclusions**

Concentrations or activities of all hazardous constituents measured were below maximum concentration limits in 1993, with the exception of arsenic. Several hazardous constituents, including arsenic, have historically equalled or exceeded the proposed maximum concentration limits in some samples collected from the uppermost aquifer since the wells were constructed in 1988. These exceedances occur as a result of naturally occurring sources in the aquifer materials leaching into the ground water regime. Arsenic concentrations exceeded maximum concentration limits in 1993 before tailings disposal (January 1993) and during tailings disposal (May 1993 and October 1993). No significant changes have been noted between the water quality upgradient and downgradient of the disposal cell since disposal site construction and tailings relocation began. Surface remedial action construction has not affected the ground water quality in the uppermost aquifer (Tertiary gravels) at the Gunnison disposal site.

Ecological Monitoring

A wetlands mitigation study and monitoring study was conducted in support of the U.S. Army Corps of Engineers Section 404 Permit. The studies covered six mitigation areas at the site. Objectives of the studies were to determine the extent of wetlands, determine the extent of various plant communities, and measure vegetation characteristics at the six sites. Wetland boundaries were identified according to the U.S. Army Corps of Engineers wetlands delineation manual (USACE, 1987).

Quantitative vegetation data were collected along permanent transects. Data were collected on plant species, percent cover, plant height, and percent bare ground. Methods defined by the Bureau of Land Management (BLM, 1985) and Rexford Daubenmire (Daubenmire, 1959) were followed. Specifically, quantitative vegetation data were collected from 17 transects (30-40 plots per transect) at the six sites. Maps of the plant communities and wetlands areas were prepared.

Results of the study appear in the mitigation/monitoring report. Extensive field notes are kept on file at the DOE Project Office.

SITE DESCRIPTION AND LOCATION

Old and New Rifle Sites

The Uranium Mill Tailings Remedial Action (UMTRA) Project at Rifle, Colorado, comprises two separate mills and tailings piles, known as the Old Rifle and New Rifle sites (*Figure 6-44*).

The Old Rifle site is east of the city of Rifle (*Figure 6-44*). U.S. Highway 6 runs along its north side and the Denver & Rio Grande Western Railroad tracks are on its south side. The Colorado River is immediately south of the railroad tracks. The New Rifle site is west of the city of Rifle (*Figure 6-44*). The site is bordered by the Denver & Rio Grande Western Railroad tracks on the north and Interstate 70 and the Colorado River on the south. The valley in which the tailings are located is at an elevation of approximately 5300 feet (ft). Steep cliffs and mesas up to 9300 ft are north of the tailings, and long, sloping mountains rise to 10,000 ft to the Grand Mesa National Forest on the south.

Estes Gulch Disposal Site

The Estes Gulch disposal site is approximately 6 miles north of the New Rifle site on Colorado State Highway 13 (*Figure 6-44*).

The 1990 census reports the Rifle population is 4636 and the Garfield County population is 29,974. The 1990 figures represent increases of 76 percent in the city and 57 percent in the county since 1980 (DOC, 1990).

The semiarid, continental climate has low precipitation and humidity, large temperature variations, and high evaporation. The average annual precipitation is approximately 11 inches. Winter snows are fairly frequent, but are mostly light and melt quickly. Monthly average air temperatures ranged from 22.6°F in January to 70.3°F in July.

Weather data for Rifle are gathered primarily at the Garfield County Airport south of the city, outside the Colorado River Valley. The strongest winds are channeled up and down the Colorado River Valley and are predominantly from the north. The annual average wind speed is conservatively estimated at 6.4 miles per hour. *Figure 6-45* shows wind direction and frequency at the Garfield County Airport.

SITE HISTORY AND OWNERSHIP

The Old Rifle mill was built in 1924 to recover vanadium from roscoelite ores. Extraction processes included salt roasting, water leaching, and precipitation of sodium hexavanadate with sulfuric acid. The processes were modified in 1946 to extract uranium by acid leaching and subsequent processing. Sulfuric and hydrochloric acids were used with ammonia to precipitate a green sludge product, which was purified by redissolving it in sulfuric acid and sodium chlorite and then adding sodium carbonate. Finally, uranium oxide (yellow cake) was obtained from the purified solution using an acidifying and boiling process and then adding ammonia gas.

Figure 6-44
Rifle Site Locations

Figure 6-45
Wind Rose

Ref: Garfield County Airport.
Cumulative data 1959 through 1963.

ASER94/RFL/WINDRFL

The New Rifle mill operated from July 1958 to December 1972. It was built as a part of a complex of upgraders, including Slick Rock, Colorado, and Green River, Utah. A total of 2.7 million tons of ore and upgrader products and tailings from other mills was processed. The milling processes at the New Rifle site separated and purified uranium products with solvent extraction. Ores containing uranium and low vanadium contents were separated by direct acid leaching, while ores with higher vanadium contents were initially salt-roasted. The ores were water- and acid-leached to remove the sodium vanadate and to dissolve the uranium. Solvent extraction with di(2-ethylhexyl) phosphoric acid recovered the uranium and vanadium. The vanadium was precipitated with sodium chlorite and sodium carbonate and by heating and adding sulfuric acid. Finally, the precipitates were purified by redissolving in ammoniacal solution and crystallizing ammonium metavanadate by adding ammonium chloride.

The plant recovered vanadium from roscoelite ore from 1924 to 1932. From 1942 until 1958, the process was altered to allow additional recovery of uranium. U.S. Vanadium Corporation operated the mill initially, followed by Union Carbide Corporation. Both the Old and New Rifle sites are currently owned by the state of Colorado.

Approximately 761,000 tons of ore from the Uravan mineral belt, as well as the Rifle mine, were processed for uranium and vanadium recovery, with an average grade of 0.31 percent uranium oxide. Approximately 411,000 tons of tailings were reprocessed at the New Rifle mill and deposited there.

SITE CHARACTERIZATION AND CLEANUP

Union Carbide partially stabilized the Old Rifle tailings pile in 1967, in accordance with applicable state of Colorado regulations. The southern edge of the pile was moved north, away from the river. The pile was fertilized and seeded with grasses, and a sprinkler system was installed to promote vegetation growth.

Union Carbide has partially stabilized the New Rifle tailings pile. Approximately 1000 tons of mulch and fertilizer were applied to the pile, and native grasses were planted. An irrigation system was installed to promote vegetation growth. The lack of soil cover, the steep slopes, and the strong winds in the Colorado River Valley have partially eroded the tailings pile.

UMTRA Project remedial action at the Old and New Rifle sites will consist of removing all residual radioactive materials from both sites for disposal at the Estes Gulch disposal site. The residual radioactive materials relocation will follow required interim regulations to eliminate the public health hazard presented by the abandoned mill facilities and unrestricted tailings impoundments.

The UMTRA Project began remedial action at the New Rifle site in 1993 and completion is expected in 1995. Remedial action at the Old Rifle site is scheduled to begin in 1994.

ENVIRONMENTAL COMPLIANCE STATUS

In accordance with U.S. Department of Energy (DOE) policy, the UMTRA Project at Rifle, Colorado, complies with federal and state environmental regulations. Remedial action activities are continuously evaluated for their environmental impact and to ensure they meet applicable regulatory requirements. Rifle site environmental activities include compliance with the Clean Water Act (CWA) (33 USC §1251 *et seq.*) for monitoring discharge of liquid effluents to surface waters; the Clean Air Act (CAA) (42 USC §7401 *et seq.*) for monitoring fugitive dust and asbestos emissions; the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC §9601 *et seq.*) for reporting certain quantities of hazardous materials used or stored at the site; community right-to-know regulations, Spill Prevention Control and Countermeasures Plan regulations; U.S. Department of Transportation (DOT) regulations; and local (conditional use and highway access permits/noise) regulations in 1993.

**Superfund Amendments
and Reauthorization Act**

Under the Superfund Amendments and Reauthorization Act (SARA) (Public Law 99-499), an amendment to CERCLA, the Rifle sites must comply with the Title III emergency planning and community right-to-know requirements, including notifications for threshold planning quantities of hazardous materials and notifications for spills of reportable quantities of extremely hazardous materials.

To comply with requirements of SARA, Title III, Section 311, a site inventory was developed for all materials stored on the site in excess of 10,000 pounds or in excess of the threshold planning quantities for extremely hazardous materials. The inventory included diesel fuel, oil, sulfuric acid, automotive maintenance fluids, and uranium mill tailings. Notification included State Emergency Response Commission, the local emergency planning committee, and the local fire department.

Compliance with the requirements of SARA Title III, Section 312, was achieved by developing Tier II reporting forms for the 1992 inventoried materials and submitting them to the State Emergency Response Commission, the local emergency planning committee, and the local fire department by March 1, 1993.

**Resource Conservation
and Recovery Act**

Fifty-two 55-gallon drums (primarily of trash containing some molybdenum or selenium) contaminated with residual radioactive material were deposited in the disposal cell in accordance with UMTRA Project guidelines (42 USC §6901 *et seq.*) and with the concurrence of the Colorado Department of Public Health and Environment (CDPHE).

Clean Water Act

The CDPHE, Water Quality Control Division, has regulatory authority over all CWA activities in Colorado.

*National Pollutant
Discharge Elimination
System*

Under the Colorado Discharge Permit System, the CDPHE issued discharge permits to the Rifle sites. Permits for storm water discharges were obtained for the Old Rifle (No. COR-030267), New Rifle (No. COR-030266), and the Estes Gulch disposal site (No. COR-030194). Permits were issued for wastewater discharges from the retention basins at the disposal site (No. CO-0042757) and the processing sites under one permit (No. CO-0042552). No discharges occurred under the wastewater permits in 1993.

However, a discharge caused by intense rainfall did occur from the retention basin at the disposal site before tailings were placed into the cell (May 1993). During this rainfall event, the retention basin operated under a construction dewatering permit (No. COG-070206). Approximately 6 million gallons of water were treated for total suspended solids and discharged under this construction dewatering permit. When tailings placement began, the permit was terminated (May 25, 1993).

***Spill Prevention Control
and Countermeasures
Plan***

In 1993, earthen berms were designed and constructed around existing aboveground storage tanks and around drum storage areas. These secondary containment systems are designed to provide adequate spill control. In addition, plans for inspecting berms, detecting spills, emergency spill response, and spill cleanup were developed for fuel, oil, and other storage areas.

Septic/Holding Tanks

A septic tank was installed near the office trailers on the New Rifle processing site in November 1988 and has been maintained following state and local requirements.

Storm Water

Storm water permit applications were submitted in October 1992 to meet application deadlines.

Clean Air Act***Total Suspended
Particulates***

The Rifle sites comply with the CDPHE, Air Pollution Control Division, monitoring requirements for fugitive dust. The CDPHE has adopted federal total suspended particulate levels, including a 24-hour limit of 150 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) and an annual limit of 60 $\mu\text{g}/\text{m}^3$ geometric mean.

The CDPHE granted two air emission permits to the New Rifle and disposal site in 1993. Two total suspended particulate monitoring stations operate under an approved protocol that meets CDPHE requirements, monitoring total suspended particulates every 3 days. Quarterly reports are submitted to the department.

The New Rifle site recorded total suspended particulate readings higher than the threshold limit of 150 $\mu\text{g}/\text{m}^3$ on June 6, July 21, and October 1, 1993. Off-site activities caused the October 1, 1993, exceedance. Wind caused the June 6 exceedance. The exceedance on July 21 was caused by site activity, heat, and wind. Measures were taken to increase operational hours of dust suppression equipment/dust control strategies. No violations were issued to the site.

***National Emission
Standards for
Hazardous Air
Pollutants***

Asbestos emissions at the New Rifle site met National Emission Standards for Hazardous Air Pollutants (40 CFR Part 61) in 1993. Nonfriable transite pipe was moved from the processing site to the disposal cell. Strict dust control, continuous monitoring, and proper asbestos work practices were implemented during this procedure.

***National Environmental
Policy Act***

In compliance with the National Environmental Policy Act (42 USC §4321 *et seq.*), a public scoping meeting was held in Rifle to gather information for the ground water programmatic environmental impact statement (in preparation).

**Hazardous Materials
Transportation Act**

All materials transported from the New Rifle site were in full compliance with all requirements of the Hazardous Materials Transportation Act (49 USC §1801 *et seq.*).

The DOE acquired an exemption from the DOT to transport the tailings in bulk shipments. The exemption grants the use of special markings for haul trucks, shipping documentation, and training to address tailings hazards. Approximately 735,000 cubic yards of tailings were hauled from the site under exemption E-10594 in 1993, and all requirements of the exemption were met.

Noise Control

Noise control is regulated under Noise Abatement-Colorado Revised Statutes, with specific requirements for the Rifle sites included in the Garfield County conditional-use permit. The DOE developed the Site-Specific Community Noise Minimization Plan on March 4, 1993, and implemented the plan on October 5, 1993, to ensure compliance with the conditional-use permit. The plan instituted engineering and administrative controls, as necessary, to reduce Project-related sound impacts to residential areas bordering the site.

During periods of normal operations, sound level monitoring was conducted at six fixed monitoring stations in at least one 24-hour period three times each month. Additionally, monitoring was conducted when site conditions changed or citizens complained.

**Environmental
Compliance Permits**

The Rifle sites obtained and operated under all required permits in 1993. *Table 6-12* lists all active permits under which the Rifle sites operated from January 1993 to April 1994. No permit violations were issued in 1993.

**ENVIRONMENTAL
MONITORING**

The DOE conducts a detailed environmental monitoring program for radiological and nonradiological materials at the Rifle sites, including environmental gamma-dose equivalent and radionuclide and nonradionuclide concentrations in air, surface water, and ground water. This program monitors quantities of radioactive material and nonradiological hazardous constituents released into the environment, demonstrates compliance with applicable guidelines, and indicates the efficiency of environmental protection measures.

Air Monitoring***Nonradiological Air
Particulate Monitoring***

Two total suspended particulate monitoring stations operate under an approved protocol that meets CDPHE, Air Pollution Control Division, requirements. Total suspended particulates are monitored every 3 days. Quarterly reports are submitted to the department. *Figures 6-46 and 6-47* present total suspended particulate monitoring station locations and data for the Rifle sites.

Table 6-12 Active permits

Permit description	Submittal date	Preliminary approval date	Final approval date	Permit number	Expiration date
Dredge and fill permit (U.S. Army Corps of Engineers) ^a	06/92	Final received ^b	08/92	190110228	07/97
Colorado Discharge Permit System Permits					
Process site wastewater	09/89	Final received ^b	01/92	CO-0042552	12/96
Disposal site wastewater	04/90	Final received ^b	04/92	CO-0042757	02/97
Process site storm water	09/92	Final received ^b	10/92	COR-030266 ^a	03/95
			10/92	COR-030267 ^c	03/95
Disposal site storm water	09/92	Final received ^b	08/92	COR-030194	03/95
Construction dewatering Disposal site (CDPHE) ^d	01/92	Final received ^b	02/92	COG-070206	NA
Air emission permits (CDPHE)					
Process site	06/88	01/89	Pending	88GA191	02/96
Disposal site	06/88	01/89	Pending	88GA190	02/96
Water rights (Colorado Division of Water Rights)					
Disposal site - retention basin surface	10/88	Final received ^b	01/89	88CW347	01/95
Process site water rights	—	Final received ^b	08/88	C377322	NA
Disposal site - retention basin storage	01/93	Final received ^b	04/93	93CW006	04/99
Hazardous waste storage (CDPHE)	11/88	—	02/90	OD7061567	NA

^aNew Rifle site.
^bNot applicable in 1993.
^cOld Rifle site.
^dTerminated May 25, 1993.

NA - Not applicable.

Radiological Air Particulate Monitoring

Radiological air particulate monitoring at the Old Rifle processing site, the New Rifle processing site, and the Estes Gulch disposal site was conducted in 1993. Stations 1 and 4 measured concentrations at the processing site boundaries. Stations 3, 5, and 7 gathered information in the predominant wind direction along the Colorado River between the two processing sites. Station 6 monitored the concentrations near the town of Rifle (*Figure 6-46*). Station 8 measured the Estes Gulch (*Figure 6-48*) and Station 11 measured the background (*Figure 6-49*) concentrations.

Figure 6-50 summarizes site thorium-230 concentrations, estimated from gross alpha measurements that are statistically different from

- 1000 0 1000 2000 Feet

6-85

Figure 6-47
Total Suspended Particulates, New Rifle Processing Site

Figure 6-48
Environmental Air and Gamma Radiation Monitoring Stations,
Estes Gulch Disposal Site

Figure 6-49
Environmental Air and Gamma Radiation Background Monitoring Stations

Note: Not to scale.

Figure 6-50
Environmental Airborne Radioactive Particulate (Thorium-230)
Concentrations

ASER94/RFL/TAB1

background. Background concentrations were measured at Station 11. Although the estimated thorium concentrations for all stations were statistically greater than background, the estimated annual average thorium-230 concentrations at all stations were well below the thorium-230 average annual guideline of 500×10^{-16} microcuries per milliliter ($\mu\text{Ci/mL}$) above background, indicating radioactive particulate releases from remedial action were insignificant.

Radon Monitoring

Real-Time Radon Monitoring. Monitors were located around the site perimeters and between the New Rifle and the Old Rifle processing sites. Station 1 was discontinued on March 13, 1993. Background radon concentrations were measured at Station 11. **Figures 6-46 and 6-49** show the locations of the real-time radon monitoring stations.

The annual average background radon concentration measured at Station 11 was $0.68 \times 10^{-9} \mu\text{Ci/mL}$. Although radon concentrations were greater than background levels near the remedial action sites ($0.93 \times 10^{-9} \mu\text{Ci/mL}$ for Station 3 and $2.98 \times 10^{-9} \mu\text{Ci/mL}$ for Station 4), they were less than the DOE annual average guideline of $3 \times 10^{-9} \mu\text{Ci/mL}$ above background. The elevated concentrations at the Rifle sites are expected to return to background levels after remedial action is completed. **Figure 6-51** presents the quarterly average radon concentrations for all locations statistically above background at the Rifle sites for 1993.

Passive Radon Monitoring. Seventeen stations were established around the Rifle sites. Seven stations (Stations 12 through 18) were established around the Estes Gulch disposal site in the second quarter of 1993. Background monitoring was performed at Station 11. **Figures 6-46, 6-48, and 6-49** show locations of passive radon detectors at the Rifle sites.

Figure 6-52 presents the passive radon monitoring results for stations statistically different than background for the four quarters of 1993 at the Rifle sites. The annual average background radon concentration measured at Station 11 was $0.9 \times 10^{-9} \mu\text{Ci/mL}$. Although the average concentrations at several locations were greater from background, all but one were less than the DOE guideline. Station 9 had a significantly elevated concentration because the monitoring station is at the edge of a significant accumulation of mill tailings and does not accurately reflect the conditions away from the tailings. The elevated concentrations at the Rifle sites, especially at Station 9, should return to background levels after remedial action is complete.

Air Monitoring Conclusions

With the exception of the three previously discussed exceedances, all measured total suspended particulate results were below applicable guidelines. Station 4 showed slightly elevated levels of radon for quarters 3 and 4 due to startup of remedial action of vicinity properties

Figure 6-51
Real-Time Radon Concentrations

ASER94/RFL/TAB2

Figure 6-52
Passive Radon Concentrations

^aMonitoring not performed during Quarter 1.

ASER94/RFL/TAB3

surrounding the Old Rifle site. However, the annual average for Station 4 was below the guideline. Station 9 was in proximity to the tailing piles and therefore is not representative of the exposure to the public. Measured concentrations of thorium-230 particulates and radon-222 were less than the applicable guidelines. No significant releases occurred from the site during 1993.

Environmental Gamma Radiation Monitoring

A network of thermoluminescent dosimeters measured exposure to environmental gamma radiation in the environment around the Rifle processing sites and one location at the disposal site. Monitors were placed at the site perimeters as well as in key locations between the Old Rifle and New Rifle sites and the disposal site (*Figures 6-46, 6-48, and 6-49*).

Ten dosimetry monitoring stations were active in 1993. Background dose equivalent was measured at Station 11.

Figure 6-53 presents the results of the environmental dosimetry monitoring for stations statistically different from background at the Rifle sites for 1993. The annual background dose equivalent was 132 ± 11 millirems (mrem) at Station 11. Of the locations for which annual dose equivalents were available, Station 4 was statistically different from background. Station 9 also showed a significantly elevated level of exposure. Station 9 was located at the edge of the Old Rifle tailings pile above several feet of tailings. Although Station 9 readings for the first three quarters (the fourth quarter dosimeter was lost) were significantly higher than background, they are not appropriate measures of environmental exposure because the dosimeters were located on tailings material.

Only Station 9 monitoring results indicate that the DOE dose equivalent guideline was exceeded. After remedial action, dose equivalents are expected to return to near-background levels.

Environmental Gamma Radiation Monitoring Conclusions

Station 9 recorded environmental gamma radiation levels greater than the applicable guideline. However, the elevated environmental gamma radiation levels are due to the monitoring station's location (at the edge of a significant accumulation of mill tailings) and do not accurately reflect the environmental conditions away from the tailings pile.

No stations recorded environmental gamma radiation levels greater than the applicable guideline, due to site remediation, indicating no significant releases to the environment.

Surface Water Monitoring

Surface water monitoring for radiological contaminants was conducted at the Old and New Rifle processing sites to assess potential environmental impacts from remedial action activities. *Table 6-13* gives the radiological results of the surface water analyses.

Figure 6-53
Environmental Gamma Radiation Monitoring

ASER94/RFL/TAB4

Downstream water monitoring results were statistically indistinguishable from upstream results. In all cases, the results were well below DOE guidelines given for water concentrations.

Figure 6-54 shows locations of five additional surface water samples taken for characterization. Three sampling points are in the former New Rifle processing site vicinity: the Colorado River upstream of the site (location 545), the Colorado River downstream of the site (location 572), and a gravel pit downgradient from New Rifle (location 575). Two sampling points are in the Old Rifle vicinity: the Colorado River upstream of the site (location 539) and a pond downstream of the site (location 572). Unfiltered surface water samples were collected from each of these locations in March and August 1993.

Surface water and sediment samples were not collected at the Estes Gulch disposal site in 1993.

Table 6-13 Radiological surface water results

Surface water concentration ^a							
Colorado River location	Radionuclide	Quarter				Annual Average	Limit ^b
		1	2	3	4		
Upstream of Old Rifle site	Radium-226	4.4	0.6	0.6	0.5	1.53 ± 1.92	100
	Thorium-230	0.2	0.5	0.0	0.3	0.25 ± 0.21	300
Downstream of Old Rifle site	Radium-226	3.1	0.2	0.2	0.4	0.98 ± 1.42	100
	Thorium-230	0.2	0.0	0.0	0.2	0.10 ± 0.12	300
Upstream of New Rifle site	Radium-226	1.2	3.7	0.5	1.2	1.65 ± 1.41	100
	Thorium-230	1.0	0.9	1.1	0.3	0.83 ± 0.36	300
Downstream of New Rifle site	Radium-226	1.0	5.9	0.8	0.5	2.05 ± 2.58	100
	Thorium-230	0.4	0.2	0.0	0.2	0.20 ± 0.17	300

^aMeasurements are reported in 1 x 10⁻⁹ microcuries per milliliter. All errors reported as twice the standard error of the mean.

^bGuidelines are from DOE Order 5400.5, *Radiation Protection of the Public and the Environment*.

Surface water samples were analyzed for the following parameters:

- New Rifle: ammonium, arsenic, cadmium, calcium, dissolved organic carbon, chloride, fluoride, gross beta, iron, magnesium, manganese, molybdenum, net gross alpha, nitrate, potassium, radium-226, radium-228, selenium, silica, sodium, sulfate, total dissolved solids, total organic carbon, uranium, vanadium, and zinc.
- Old Rifle: calcium, chloride, dissolved organic carbon, fluoride, gross beta, iron, magnesium, manganese, molybdenum, net gross alpha, nitrate, potassium, radium-226, radium-228, selenium, silica, sodium, sulfate, total dissolved solids, total organic carbon, uranium, and vanadium.

Rifle Surface Water Results and Conclusions

Surface water data from the Colorado River upstream and downstream of the New Rifle and Old Rifle processing sites show that, in general, the constituents detected at the downgradient locations were not greater than their respective background concentrations (*Tables 6-14 and 6-15*). However, analytical results from sample location 575

ASER94/RF/LMONWELLOCS

Table 6-14 Surface water quality results, New Rifle processing site

Indicator parameter	Guideline	Colorado River upstream (545)	Colorado River downstream (572)	Gravel pit downstream (575)
Total dissolved solids	500 ^a			
03/93		620	630	5190
08/93		390	390	9190
Sulfate	250 ^a			
03/93		134	137	3250
08/93		89	85	5600
Molybdenum	0.1 ^b			
03/93		<0.01	<0.01	0.11
08/93		<0.01	<0.01	0.19
Net gross alpha	15 ^{b,c}			
03/93		4.34	7.94	35.20
08/93		1.17	1.93	40.39
Nitrate	44 ^b			
03/93		1	1	131
08/93		<1	<1	194
Uranium	0.044 ^b			
03/93		0.003	0.003	0.214
08/93		0.002	0.002	0.365

^aSecondary Drinking Water Standard.
^bMaximum concentration limit.
^cConcentration reported in picocuries per liter.

Note: 1. Concentrations are reported in milligrams per liter, except as noted. Samples were unfiltered.
2. < symbol indicates the actual is less than the detection limit (number shown).

collected at the Roaring Fork gravel pit downgradient from the New Rifle processing site indicate the presence of elevated concentrations for several parameters. These parameters, which include molybdenum, net gross alpha, nitrate, and uranium, exceeded U.S. Environmental Protection Agency (EPA) maximum concentration limits. Sulfate concentrations are also elevated.

The samples from Old Rifle location 572 detected uranium in the surface water. However, these concentrations are below maximum concentration limits and are in the same range as background ground water concentrations.

The 1993 surface water sampling indicates no influence on Colorado River water quality; however, elevated concentrations of the above

Table 6-15 Surface water quality results, Old Rifle processing site

Indicator parameter	Guideline	Colorado River upstream (539)	Pond downstream (572)
Total dissolved solids	500 ^a		
03/93		600	500
08/93		390	210
Sulfate	250 ^a		
03/93		130	109
08/93		83	40
Nitrate	44 ^b		
03/93		1	1
08/93		<1	<1
Uranium	0.044 ^b		
03/93		0.003	0.028
08/93		0.002	0.007

^aSecondary Drinking Water Standard.
^bMaximum concentration limit.

Notes: 1. Concentrations are reported in milligrams per liter.
2. Samples were unfiltered.
3. Because no downgradient samples were collected from the Colorado River in the vicinity of the Old Rifle site, there is less basis for comparison between Old Rifle surface water quality results.
4. < symbol indicates actual is less than the detection limit (number shown).

parameters in surface water of the Roaring Fork gravel pit suggest the pit is receiving contaminated discharge from an upgradient source.

Activities at the gravel pit may be influencing gradients in the pit vicinity and inducing discharge of upgradient contaminated ground water.

Surface water and sediment samples were not collected at the Estes Gulch disposal site in 1993.

Ground Water Monitoring

Ground water samples are being collected at the former Old and New Rifle processing sites to monitor changes in water quality that occur before, during, and after removal of the tailings piles and associated contaminated soil. To assess the extent of ground water contamination from former processing activities, the baseline ground water quality before remediation was compared with the background water quality

and the proposed EPA maximum concentration limits in 40 CFR Part 192. Background ground water quality is defined as the quality of ground water that would be expected at the site if uranium processing activities had not occurred. Conversely, baseline ground water quality is defined as the representative water quality in a monitoring well that has been influenced by uranium processing activities.

The Old and New Rifle processing sites are underlain by a dual aquifer system consisting of a shallow, unconfined aquifer in the alluvium lining the Colorado River Valley and a semiconfined aquifer in the Wasatch Formation (bedrock) beneath the alluvium. The thickness of the alluvium at the sites averages approximately 20 ft. *Figures 6-55 and 6-56* show monitoring well locations at the New and Old Rifle processing sites.

The alluvial aquifer water table and Wasatch Formation potentiometric surface contour maps for the New Rifle site (*Figures 6-57 and 6-58*) show ground water generally flows southwest. Ground water at the New Rifle site in the alluvial aquifer flows southwest at a rate of approximately 280 ft per year. Ground water in the Wasatch Formation flows southwest at a rate of approximately 3 ft per year.

An alluvial aquifer water table contour map was not generated for the Old Rifle processing site due to insufficient 1993 water level data. Historical water levels at the Old Rifle processing site indicate ground water flows southwest in the alluvial aquifer. The Wasatch Formation potentiometric surface contour map for Old Rifle (*Figure 6-59*) also shows that ground water flows southwest toward the Colorado River. Ground water at the Old Rifle site in the alluvial aquifer flows southwest at a rate of approximately 840 ft per year. Ground water in the Wasatch Formation flows at a rate of approximately 0.3 ft per year.

Background wells that typify background water quality at the sites are 592 for the New Rifle alluvium, 641 for the New Rifle Wasatch Formation, and 597 for the Old Rifle alluvium. Wells that typify baseline or downgradient ground water quality are 596 and 598 for the New Rifle alluvium and 611 and 622 for the New Rifle Wasatch Formation. Old Rifle wells that typify baseline and downgradient water quality are 590 and 600 for the alluvial aquifer. Ground water samples were collected in March and August 1993.

DOE monitoring wells at the Old and New Rifle processing sites are currently sampled for the following parameters:

- Field parameters: alkalinity, oxidation-reduction potential, pH, specific conductivity, ferrous iron and total iron, and temperature.

Figure 6-55
Ground Water Monitoring Well Locations, New Rifle Processing Site

Figure 6-56
Ground Water Monitoring Well Locations, Old Rifle Processing Site

Figure 6-57
Ground Water Table Contours for Alluvial Aquifer, New Rifle Processing Site

Figure 6-58
Potentiometric Surface for the Wasatch Formation, New Rifle Processing Site

ASER94/RFL/POTEN

Figure 6-59
Potentiometric Surface for the Wasatch Formation, Old Rifle Processing Site

- Laboratory analyses (filtered): Ammonium, arsenic, cadmium, calcium, chloride, chromium, cobalt, dissolved organic carbon, dissolved oxygen, fluoride, gross alpha, gross beta, iron, magnesium, molybdenum, net gross alpha, nitrate, polonium-210, potassium, radium-226, radium-228, selenium, silica, sodium, sulfate, thorium-230, total organic carbon, total dissolved solids, uranium, vanadium, and zinc.

Seven private (domestic) wells in the New Rifle site vicinity and one private well in the Old Rifle site vicinity were sampled in August 1993. Several of these wells were also sampled in March 1993. Private wells usually were analyzed for the same parameter list but were not filtered before analysis.

New Rifle Ground Water Results

Tables 6-16 and 6-17 summarize ground water quality results for the alluvial aquifer and the Wasatch Formation, respectively, in the New Rifle processing site vicinity. In Table 6-16, recent results are presented for a monitoring well in the contaminated area (596) and a downgradient monitoring well (603). The most recent (March 1992) results were used for comparison because alluvial background well 592 at New Rifle was abandoned due to remedial action. Indicator parameters presented in *Tables 6-16 and 6-17* (total dissolved solids, sulfate, nitrate, and uranium) were selected because they are mobile and therefore demonstrate the probable maximum migration of contaminated ground water in 1993.

Table 6-16 shows that approximate concentrations of total dissolved solids in the alluvial aquifer at New Rifle range from 2010 milligrams per liter (mg/L) to 9890 mg/L at downgradient well locations. For comparison, previous water quality results indicate that background total dissolved solids are approximately 1650 mg/L. Sulfate concentrations range from 979 to 6030 mg/L at downgradient well locations. From previous analyses, the sulfate concentrations in background ground water are approximately 765 mg/L. Uranium concentrations range from 0.48 to 0.39 mg/L at downgradient well locations. Ground water quality results from previous years indicate that background concentrations of uranium range from approximately 0.04 to 0.06 mg/L (above the maximum concentration limit of 0.044 mg/L). Nitrate concentrations in the alluvial aquifer at New Rifle range from <1 to 711 mg/L at downgradient well locations. Previous results from abandoned well location 592 indicate that background nitrate concentrations have been 1.8 mg/L, significantly below the standard.

The variability of sulfate and uranium concentrations in *Figures 6-60 and 6-61* best displays the maximum areal extent of the contamination in the alluvial aquifer at the New Rifle site. *Figures 6-62 and 6-63*

Table 6-16 New Rifle processing site alluvial ground water quality results

Indicator parameter	Guideline	Monitoring well location		
		592 (background)	596 (contaminant)	603 (downgradient)
Total dissolved solids	500 ^a			
03/92		1650		
03/93		NM	9530	2010
08/93		NM	9890	NM
Sulfate	250 ^a			
03/92		765		
03/93		NM	6030	979
08/93		NM	5390	NM
Nitrate	44.0 ^b			
03/92		1.80		
03/93		NM	506	<1
08/93		NM	711	NM
Uranium	0.044 ^b			
03/92		0.037		
03/93		NM	0.313	0.048
08/93		NM	0.281	NM

^aSecondary Drinking Water Standard.
^bMaximum concentration limit.

NM - Not measured. Background monitoring well cluster was abandoned and recent water quality results are not available. Last available analytical results (March 1992) are used for comparison.

Note: 1. Concentrations are reported in milligrams per liter.
2. < symbol indicates actual is less than the detection limit (number shown).

show the trends for sulfate and uranium in the alluvial aquifer at New Rifle over the past 4 years.

Table 6-17 shows that indicator parameters are elevated in the contaminated well (well 611). However, the downgradient well (650) reveals a significant decline in concentrations of indicator parameters.

Table 6-17 Wasatch ground water quality results, New Rifle processing site

Indicator parameter	Guideline	Monitoring well location		
		641 (background)	611 (contaminated area)	650 (downgradient)
Total dissolved solids	500 ^a			
03/93		2980	8600	2710
08/93		NM	10900	3500
Sulfate	250 ^a			
03/93		1120	7580	99
08/93		14 ^c	7290	99
Nitrate	44.0 ^b			
03/93		<1	<1	2
08/93		<1 ^c	<1	2
Uranium	0.044 ^b			
03/93		0.005	0.097	0.005
08/93		0.009 ^a	0.121	<0.002
^a Secondary Drinking Water Standard. ^b Maximum concentration limit. ^c Unfiltered sample. NM - Not measured. Insufficient water available. Note: 1. Concentrations are reported in milligrams per liter. 2. < symbol indicates actual is less than the detection limit (number shown).				

This trend of relatively elevated concentrations near the tailings pile and relatively sharp decreases in concentrations downgradient from the pile is a result of the less transmissive hydrogeologic properties characteristic of the Wasatch Formation. Because of these characteristic properties, contaminants do not migrate as quickly or as extensively as in the more permeable alluvial aquifer. *Figures 6-64 and 6-65* are the New Rifle site sulfate and uranium distribution maps, respectively, for the Wasatch Formation. Because of these characteristic properties, contaminants do not migrate as quickly or as

Figure 6-60
Sulfate Concentrations for the Alluvial Aquifer, New Rifle Processing Site

Figure 6-61
Uranium Concentrations for the Alluvial Aquifer, New Rifle Processing Site

ASER94/RFL/URNMAP

Figure 6-62
Sulfate concentrations Over Time in the Alluvial
Aquifer, New Rifle Processing Site

LEGEND	
— 592	Background ground water monitoring well
- - - 603	Downgradient ground water monitoring well
- - - 596	Contaminated ground water monitoring well

ASER94/RFL/SULCON-592, 596, 598

Figure 6-63
Uranium Concentrations Over Time in the Alluvial
Aquifer, New Rifle Processing Site

LEGEND		
— 592	Background ground water monitoring well	
— 603	Upgradient ground water monitoring well	
- - - 596	Contaminated ground water monitoring well	

ASER94/RFL/URNCON-592, 596, 598

Figure 6-64
Sulfate Concentrations for Ground Water in the Wasatch Formation,
New Rifle Processing Site

ASER94/RFL/SULDIS

Figure 6-65
Uranium Concentrations for the Wasatch Formation, New Rifle Processing Site

ASER94/RFL/URNPLUME

extensively as in the more permeable alluvial aquifer. *Figures 6-66 and 6-67* show the trends for sulfate and uranium in the Wasatch Formation over the past 4 years.

Selenium, net gross alpha, and uranium continue to be elevated above EPA maximum concentration limit in several private wells sampled in 1993 in the New Rifle processing site vicinity. The source of this contamination (processing-related or naturally occurring) is being investigated as part of the Rifle baseline risk assessment, scheduled for completion in 1995.

Old Rifle Ground Water Results

Table 6-18 summarizes ground water quality results for the alluvial aquifer in the Old Rifle processing site vicinity. The table presents results for a background monitoring well (597), a well in the contaminated area (590), and a downgradient monitoring well (600).

Total dissolved solids, sulfate, and uranium were selected as indicator parameters because they demonstrate the probable extent of ground water contamination and plume migration in 1993.

Table 6-18 shows the approximate concentrations for total dissolved solids: 2180 to 2510 mg/L in background ground water, 1560 to 2350 mg/L in the contaminated well, and 2140 mg/L at the downgradient well location. Sulfate concentrations vary from 944 to 1240 mg/L in background ground water, from 653 to 1120 mg/L in the contaminated area, and from 733 to 822 mg/L further downgradient of the tailings pile. Uranium concentrations range from 0.026 to 0.034 mg/L in background ground water, 0.073 to 0.098 mg/L in the contaminated area, and 0.006 to 0.007 mg/L further downgradient.

These concentration ranges suggest that background alluvial ground water is naturally elevated with respect to indicator parameters. The areal extent of the contaminants in the alluvial aquifer at the Old Rifle site is much less extensive than at the New Rifle site. *Figures 6-68 and 6-69* show sulfate and uranium distributions within the alluvial aquifer in the Old Rifle site vicinity. Contamination at the Old Rifle site probably discharges into the Colorado River, a short distance downgradient from the site where beds of lower hydraulic conductivity are situated. *Figures 6-70 and 6-71* show trends in sulfate and uranium concentrations in the alluvium at Old Rifle over the past 4 years.

Because the underlying Wasatch Formation is much less transmissive than the alluvial aquifer, the extent of contamination in the Wasatch is even more limited. However, very limited ground water sampling was conducted in 1993 in the Wasatch Formation at Old Rifle.

Figure 6-66
Sulfate Concentrations Over Time in the Wasatch
Formation, New Rifle Processing Site

ASER94/RFL/SULCON-611, 641, 650

Figure 6-67
Uranium Concentrations Over Time in the Wasatch Formation,
New Rifle Processing Site

ASER94/RFL/URNCON-611, 641, 650

Table 6-18 Alluvial ground water quality results, Old Rifle processing site

Indicator parameter	Guideline	Monitoring well location		
		597 (background)	590 (contaminated area)	600 (downgradient)
Total dissolved solids	500 ^a			
03/93		2180	1560	2140
08/93		2510 ^a	2350	2140
Sulfate	250 ^b			
03/93		944	653	733
08/93		1240 ^c	1120	822
Uranium	0.044 ^b			
03/93		0.026	0.073	0.006
08/93		0.034	0.098	0.007

^aSecondary Drinking Water Standard.
^bMaximum concentration limit.
^cUnfiltered sample.

Note: Concentrations are reported in milligrams per liter.

Therefore, contaminated area and trend maps are not presented in this document.

Selenium and uranium concentrations continue to be elevated in several private well sampled upgradient from the Old Rifle site. The source of these contaminants (processing-related or naturally occurring) is being investigated as part of the Rifle baseline risk assessment scheduled for completion in fiscal year 1995.

Ground Water Conclusions

Ground water samples collected in 1993 and previous years from wells downgradient of the former processing sites show that former uranium milling activities have impacted alluvial and Wasatch Formation ground water. Total dissolved solids, sulfate, nitrate, and uranium are used to define the areal extent of the contamination because 1) they are found in relatively low concentrations in background ground water, 2) they are chemical by-products of ore processing at the Rifle mill, and 3) geochemically, they are nonreactive compounds. Other ground water contaminants of concern are arsenic, molybdenum, net gross alpha, and radium-226, radium-228, and selenium.

Figure 6-68
Sulfate Concentrations for the Alluvial Aquifer, Old Rifle Processing Site

Figure 6-69
Uranium Concentrations for the Alluvial Aquifer, Old Rifle Processing Site

ASER94/RFL/URNDISTRIB

Figure 6-70
Sulfate Concentrations Over Time in the Alluvial
Aquifer, Old Rifle Processing Site

LEGEND		
---	590	Contaminated ground water monitoring well
---	600	Downgradient ground water monitoring well
---	597	Background ground water monitoring well

Figure 6-71
Uranium Concentrations Over Time in the Alluvial
Aquifer, Old Rifle Processing Site

ASER94/RFL/URNCON-590, 597, 600

Results of ground water quality sampling in the New Rifle processing site vicinity generally indicate contaminants continue to migrate southwest and toward the Colorado River.

Net gross alpha, selenium, and uranium continue to be elevated above EPA maximum concentration limit in several private wells sampled in 1993 in the New Rifle processing site vicinity. The source of this contamination (processing-related or naturally occurring) is being investigated.

Limited sampling in the Old Rifle processing site vicinity indicates contaminated ground water is not migrating extensively downgradient. Contaminants are most likely discharged into the Colorado River, a short distance southwest of the site. The Colorado River may act as a discharge boundary to ground water flow and contaminant transport.

A private well sampled upgradient from the Old Rifle site continues to show elevated selenium and uranium concentrations. The source of these contaminants (processing-related or naturally occurring) is being investigated.

Ground water was not monitored at the Estes Gulch disposal site in 1993 because the disposal cell is geologically isolated from the uppermost aquifer.

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Code of Federal Regulations	<p>10 CFR Part 40, <i>Domestic Licensing of Source Material</i>, U.S. Nuclear Regulatory Commission (1994).</p> <p>40 CFR Part 61, <i>National Emission Standards for Hazardous Air Pollutants</i>, U.S. Environmental Protection Agency (1994).</p> <p>40 CFR Part 192, <i>Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings</i>, U.S. Environmental Protection Agency (1994).</p>
DOE Order	DOE Order 5400.5, <i>Radiation Protection of the Public and the Environment</i> , February 1990, Environmental Protection Division.
Public Law	99-499, <i>Superfund Amendments and Reauthorization Act</i> , amendment to CERCLA, October 17, 1986.
United States Code	<p>16 USC §1531 <i>et seq.</i>, <i>Endangered Species Act</i>, December 28, 1973.</p> <p>33 USC §1251 <i>et seq.</i>, <i>Clean Water Act</i>, October 18, 1972.</p> <p>42 USC §4321 <i>et seq.</i>, <i>National Environmental Policy Act</i>, January 1, 1970.</p> <p>42 USC §6901 <i>et seq.</i>, <i>Resource Conservation and Recovery Act</i>, October 21, 1976.</p> <p>42 USC §7401 <i>et seq.</i>, <i>Clean Air Act</i>, December 17, 1963.</p> <p>42 USC §9601 <i>et seq.</i>, <i>Comprehensive Environmental Response, Compensation, and Liability Act</i>, December 11, 1980.</p> <p>49 USC §1801 <i>et seq.</i>, <i>Hazardous Materials Transportation Act</i>, January 3, 1975.</p>

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CHAPTER 7 IDAHO SITE

IDAHO SITE

This chapter provides detailed Uranium Mill Tailings Remedial Action (UMTRA) Project data on environmental monitoring activities conducted at the Lowman, Idaho, site during 1993 and the first quarter of 1994.

Numerous documents describe the existing environmental and construction conditions at UMTRA Project sites. These documents, including environmental impact statements, environmental assessments, and remedial action plans, are available at the U.S. Department of Energy (DOE) UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Lowman

The Lowman site is in Boise County in central Idaho (*Figure 7-1*). Site remedial action was completed in April 1991. Because surface remedial action is complete, air monitoring and environmental gamma radiation monitoring were not conducted in 1993. However, during 1993, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

CHAPTER 7 — IDAHO

Figure 7-1
Lowman Site Location

ASER94/LOW/SITELOC

SITE DESCRIPTION AND LOCATION

The Lowman Uranium Mill Tailings Remedial Action (UMTRA) Project site is on Clear Creek in the South Fork Payette River drainage basin in the western slope of the Sawtooth Range. The area immediately around the site is mountainous. The steep, heavily forested slopes are part of the Boise National Forest. The disposal cell covers about 9 acres of the 18-acre site. The east and south boundaries of the generally west-sloping site follow a ridge top. The site ranges from about 3850 feet (ft) above mean sea level (MSL) at the entrance gate to about 4200 ft above MSL on the ridge top at the northeast corner of the site.

The estimated population of Boise County, Idaho, is 3509 (DOC, 1990).

Dry, warm summers and cold winters characterize the Lowman site. The varied topography of the region creates considerable differences in weather. Temperature and precipitation vary mostly with elevation and the local topography significantly influences wind flow.

The nearest weather station is in the village of Lowman, about 0.5 mile from the site. From 1951 through 1973, the average annual maximum and minimum temperatures in Lowman were 60 degrees Fahrenheit (°F) and 27°F. Temperature extremes for this period ranged from -35°F to 107°F. Temperatures below freezing are reported throughout the year.

SITE HISTORY AND OWNERSHIP

Between 1955 and 1960, the Porter Brothers Corporation of Boise, Idaho, operated the Lowman mill site to recover columbite/euxenite and monazite concentrates. Approximately 200,000 tons of dredge concentrates were processed at this site. Final concentrates were sent to the Mallinckrodt Chemical works at Hematite, Missouri. Radioactive sands with low-leachability characteristics remained at the site and were placed in the disposal cell during surface remedial action.

The Lowman site contained residual radioactive material (radioactive sands, concrete structures, rubble from the mill buildings, and soil) transported from the site by wind and runoff water. However, the heavily forested areas east and south of the site show no signs of radioactive contamination.

The state of Idaho acquired 37 acres of land for the disposal site from NWI Land Management Corporation. With site remediation complete, title to the disposal site is being processed for transfer from the state to the federal government, under the jurisdiction of the DOE. Title transfer is required under Section 104 (f)(B) of the Uranium Mill Tailings Radiation Control Act (42 USC §7901 *et seq.*).

SITE CHARACTERIZATION AND CLEANUP

When UMTRA remedial action was completed at the Lowman site, 129,400 cubic yards of residual radioactive material, including material from the site and all vicinity properties, had been relocated to a disposal cell. The material was recontoured to provide proper drainage. After final grading, all disturbed areas were mulched. Because it was determined the site would revegetate itself naturally over time, the site was not seeded. To prevent destruction of the existing riparian habitat, supplemental standards were applied to the areas adjacent to Clear Creek. Supplemental standards (40 CFR Part 192) were applied north of the windblown area to avoid the environmental harm that could result from removing the residual radioactive material.

ENVIRONMENTAL COMPLIANCE STATUS

With surface remedial action complete, the remaining compliance issues include U.S. Nuclear Regulatory Commission (NRC) licensing under the provisions of 10 CFR Part 40 and the site long-term surveillance plan (in preparation) for continued long-term surveillance and maintenance of the completed disposal site.

ENVIRONMENTAL MONITORING

The DOE conducts an environmental monitoring program for radiological and nonradiological materials in surface water and ground water. This program monitors the amount of radioactive and nonradiological hazardous constituents that may be released into the environment, demonstrates compliance with applicable guidelines, and indicates the efficiency of environmental protection measures.

With the surface remedial action complete, air and gamma radiation monitoring data were not collected for the UMTRA environmental monitoring program in 1993.

Surface Water Monitoring

In April 1993, surface water samples were collected from an on-site perennial spring near the southwest corner of the disposal cell (location 561). *Figure 7-2* shows the location of spring 561 in relation to the disposal cell.

Surface Water Results and Conclusions

Parameters that were sampled include antimony, barium, chromium, lead, molybdenum, nitrate, uranium, and radionuclides. *Table 7-1* lists the analytical values for antimony (the indicator parameter), barium, and nitrate for the April 1993 sampling event. Antimony is considered an indicator parameter as well as a hazardous constituent because pore fluids collected from the tailings sand during site characterization exceeded the statistical maximum for background ground water quality. Barium and nitrate values are included as indicator parameters in *Table 7-1* because they were detected in tailings sand pore fluids collected during site characterization.

Figure 7-2
Surface Water and Ground Water Sampling Locations and Potentiometric Surface, Disposal Cell

MAC: SITE/LOW/POTENTIO

Table 7-1 Surface water quality results (surface location 561)

Indicator parameter	Guideline	Date	Concentration
Antimony	0.006	04-93	<0.003
Barium	1	04-93	0.08
Nitrate	44	04-93	1.0

- Notes: 1. Guideline is the maximum concentration limit. Concentrations are reported in milligrams per liter.
2. < symbol indicates actual is less than the detection limit (number shown).

Sampling results indicate these sampled parameters are below both the maximum concentration limits established by the U.S. Environmental Protection Agency (EPA) and background concentrations. Some values (for example, antimony) are below the laboratory analytical detection limit.

Surface water quality is not adversely affected by the disposal cell or by past uranium processing activities.

Ground Water Monitoring

In April 1993, ground water samples were collected from two background monitoring wells upgradient of the disposal cell and four monitoring (point-of-compliance) wells downgradient of the disposal cell.

Ground Water Results and Conclusions

Figure 7-2 shows ground water sampling locations and the potentiometric surface of the disposal site in April 1993. These locations represent the long-term surveillance ground water monitoring network (upgradient monitoring wells 641 and 583 and downgradient point-of-compliance monitoring wells 548, 549, 575, and 580).

Parameters that were sampled include antimony, barium, chromium, lead, molybdenum, nitrate, uranium, and radionuclides. Analytical values for antimony (the indicator parameter), barium, and nitrate for the April 1993 sampling event are listed in *Table 7-2*. Antimony is considered an indicator parameter and a hazardous constituent because pore fluids collected from the tailings sand during site characterization exceeded the statistical maximum for background ground water quality. Nitrate and barium values are included in *Table 7-2* because they consistently exceed laboratory detection limits in ground water samples and they were detected in tailings sand pore fluids that were collected during site characterization. Nitrate and barium are easily detected and monitored in the site area.

Table 7-2 Ground water quality results, Lowman site

Indicator parameter ^a	Guideline	Monitoring well					
		583 (upgradient)	641 (upgradient)	548 (POC)	549 (POC)	575 (POC)	580 (POC)
Antimony	0.006	<0.003	<0.003	<0.003	b	<0.003	<0.003
Barium	1	0.08	0.27	0.10	b	0.09	0.26
Nitrate	44	<1.0	<1.0	8.4	b	5.3	8.1

^aApril 1993 sampling date.
^bWell did not yield enough water for sampling.
 POC - point of compliance.

Notes: 1. Results are reported in milligrams per liter.
 2. Guideline is the maximum concentration limit.
 3. < symbol indicates actual is less than the detection limit (number shown).

The sampling results indicate that sampled parameters are below the maximum concentration limits and background. Some values (for example, antimony) are below the laboratory analytical detection limit. *Figures 7-3 and 7-4* illustrate time plots for barium and nitrate. These plots indicate that these constituents are well below the maximum concentration limits and that their concentrations vary seasonally.

Ground water quality at the Lowman site is not adversely affected by the disposal cell. Because uranium was never chemically extracted at the processing site, ground water quality is not affected at the processing site.

Figure 7-3
Barium Concentrations Over Time in
Ground Water, Disposal Site

ASER94/LOW/BARCON

Figure 7-4
Nitrate Concentrations Over Time in
Ground Water, Disposal Site

ASER94/LOW/NITCON

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- United States Code** 42 USC §7901 *et seq.*, *Uranium Mill Tailings Radiation Control Act of 1978*, November 8, 1978.

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CHAPTER 8 NEW MEXICO SITES

NEW MEXICO SITES

This chapter provides detailed Uranium Mill Tailings Remedial Action (UMTRA) Project data on environmental monitoring activities conducted at the Ambrosia Lake and Shiprock, New Mexico, sites during 1993 and the first quarter of 1994.

Numerous documents describe the existing environmental and construction conditions at the UMTRA Project sites. These documents, including environmental impact statements, environmental assessments, and remedial action plans, are available at the U.S. Department of Energy (DOE) UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Ambrosia Lake

The Ambrosia Lake site is in McKinley County in western New Mexico. The site is undergoing remedial action. During 1993, air monitoring for both thorium-230 particulate and radon-222 and for environmental gamma radiation were conducted. Only the data found to be statistically above background concentrations are reported here. Due to the lack of available surface water at the site, surface water samples were not collected during 1993. Typically, ground water sampling is conducted once each year during construction. However, the site was not sampled in calendar year 1993. Instead, ground water was sampled during construction in late 1992 and is scheduled again in the summer of 1994.

Shiprock

The Shiprock site is in San Juan County in northwestern New Mexico. Site remedial action was completed in May 1989. Because surface remedial action is complete, air monitoring and environmental gamma radiation monitoring were not conducted in 1993. However, during 1993, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

CHAPTER 8 — NEW MEXICO

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SITE DESCRIPTION AND LOCATION

The Ambrosia Lake Uranium Mill Tailings Remedial Action (UMTRA) site is in McKinley County (population 60,686), New Mexico, about 25 miles north of Grants (population 8626), New Mexico (DOC, 1990). The site is 1 mile east of New Mexico Highway 509 (*see Figure 8-1*). The town closest to the tailings pile is San Mateo, about 13 miles southeast. The site is approximately 7000 feet (ft) above mean sea level (MSL), within the Ambrosia Lake Mining District, near the center of the Grants Mineral Belt. The immediate area includes several non-UMTRA uranium mills, numerous mine shafts and vents, tailings piles, and mine waste piles.

Land in the area is used for low-density grazing, dry land farming, milling, and some commercial timber production. Most land near the site is privately owned, with the closest residence approximately 5 miles south of the site.

The New Mexico Environment Department operated a meteorological monitoring station approximately 0.25 mile north of the tailings pile from June 1978 to April 1979. Temperatures recorded at the station indicated a mean daily minimum of 41 degrees Fahrenheit (°F) and a mean daily maximum of 65°F.

This region is characterized by large daily and annual temperature variations, low precipitation, and low relative humidity. The rainy season generally occurs in late summer, although rainfall patterns can vary considerably. A San Mateo meteorological monitoring station reported a long-term annual average precipitation of 8.83 inches.

The average wind speed measured by the New Mexico Environment Department was 5.8 miles per hour. The wind blows most frequently from the west. *Figure 8-2* plots wind direction frequency measured at the Kerr-McGee Mill south of the Ambrosia Lake site.

SITE HISTORY AND OWNERSHIP

The Ambrosia Lake mill was constructed in 1957 by the Phillips Petroleum Company; Phillips operated the mill from June 1958 to March 1963. United Nuclear Corporation operated the mill from March to April 1963 and then used part of the mill as a resin ion exchange facility until 1982, when all operations ceased. The site is currently owned by the state of New Mexico. During its operating period, the mill processed 2.97 million tons of ore with an average uranium oxide concentration of 0.23 percent. An estimated 396,000 tons of tailings were removed from the site and used as mine fill. The volume of these tailings is estimated to be 2.5 million tons, or 2 million cubic yards.

An alkaline sodium-carbonate leach process was used to extract uranium from the ores at the Ambrosia Lake site. The alkaline mill solutions were continuously recirculated, regenerated with caustic

Figure 8-1
Ambrosia Lake Site Location

Figure 8-2
Wind Rose

Ref: DOE, 1987.
Cumulative data 1959 through 1963.

ASER94/AMB/WINDAMB

soda, and recarbonated with carbon dioxide and soda. Pressurized pachuca tanks leached uranium from the ore. Drum filters separated uranium from the waste solution before the waste was pumped to the tailings pile. In the precipitation process, sulfuric acid and ammonia were converted to a sodium salt, which was disposed of in the tailings pond with other chemical constituents.

SITE CHARACTERIZATION AND CLEANUP

Remedial action at the Ambrosia Lake site was conducted in two phases. In Phase I, UMTRA site facilities were constructed (fencing, retention ponds, and decontamination pads) and all mill buildings were demolished by 1989. Phase II remedial action began in August 1992 and is scheduled for completion by 1995. In Phase II, all windblown and water-eroded tailings are being excavated and placed on the existing pile. In 1993, the pile was reshaped to form a single disposal cell. Contaminated building demolition debris was placed in the disposal cell and clean rubble that met radiological release limits was buried on the site in a pit near the disposal cell. The cover will be layered with a compacted clay radon/infiltration barrier, a bedding layer, and riprap erosion protection on the top and sides. This use of only natural materials in the disposal cell will ensure compliance with the longevity requirements of the disposal cell.

**ENVIRONMENTAL
COMPLIANCE
STATUS**

UMTRA Project activities at the Ambrosia Lake site must comply with the Clean Water Act (CWA) (33 USC §1251 *et seq.*); the Clean Air Act (CAA) (42 USC §7401 *et seq.*); the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC §9601 *et seq.*); and community right-to-know, Spill Prevention Control and Countermeasures Plan requirements, and local regulations.

**Superfund Amendments
and Reauthorization Act**

Under the Superfund Amendments and Reauthorization Act (SARA) (Public Law 99-499), an amendment to CERCLA, the Ambrosia Lake site must comply with the Title III emergency planning and community right-to-know requirements. These requirements include notifying the appropriate authorities if spills of extremely hazardous materials occur.

In 1993, the site was in compliance with the requirements of SARA Title III, Section 311, because the site was inventoried for all materials stored on the site in excess of 10,000 pounds or in excess of the threshold planning quantities for extremely hazardous materials. The inventory included diesel fuel, oil, sulfuric acid, automotive maintenance fluids, and uranium mill tailings. The inventory was submitted to the State Emergency Response Commission, the local emergency planning committee, and the local fire department.

In 1993, the site was in compliance with the requirements of SARA Title III, Section 312, because Tier II reporting forms for the 1993 inventoried materials were developed and submitted to the State Emergency Response Commission, the local emergency planning committee, and the local fire department on March 1, 1993.

**Resource Conservation
and Recovery Act**

One hundred sixty drums, primarily containing trash and nonhazardous solid waste contaminated with residual radioactive material, were deposited in the disposal cell at the Ambrosia Lake site. The New Mexico Environment Department reviewed management options for this waste and concurred with the UMTRA Project proposal to treat eight drums of wastes contaminated by residual radioactive materials on-site with bioremediation and solidification. All the drums were placed in the disposal cell after treatment.

Clean Water Act

The U.S. Environmental Protection Agency (EPA) has authority over all CWA activities in New Mexico.

*National Pollutant
Discharge Elimination
System*

In 1992, the EPA issued the Ambrosia Lake site a zero-discharge permit under the National Pollutant Discharge Elimination System. A general storm water permit was applied for and received in 1993. There were no wastewater discharges in 1993.

*Spill Prevention Control
and Countermeasures
Plan*

This plan addresses requirements for spill response and reporting and for secondary spill containment systems for bulk chemical storage areas. Earthen berms around existing aboveground storage tanks and

around oil drum storage areas were designed and constructed. These secondary containment systems provide adequate spill control.

Septic/Holding Tanks

Septic/holding tanks were installed in accordance with all applicable requirements. The tanks are emptied at least once each year, or as required.

Clean Air Act

The Ambrosia Lake site complies with state requirements for fugitive dust emissions (total suspended particulates). Although the state of New Mexico requires the control of fugitive dusts, monitoring was not required for fugitive dust at the Ambrosia Lake site. However, dust was suppressed and emissions were controlled by applying water sprays during construction activities, as needed.

Hazardous Materials Transportation Act

All materials transported at the Ambrosia Lake site were in full compliance with all applicable requirements of the Hazardous Materials Transportation Act (HMTA) (49 USC §1801 *et seq.*).

Environmental Compliance Permits

The Ambrosia Lake site operated under all required permits from January 1, 1993, to April 1994 (*Table 8-1*).

Table 8-1 Active permits

Permit description	Submittal date	Preliminary approval date	Final approval date	Permit number	Expiration date
National Pollutant Discharge Elimination System (EPA)					
Process site wastewater	10/87 ^a	Final received ^b	8/92	NM0029742	09/97
Process site storm water (general)	10/93	Pending	Pending		
Ground water discharge notice and plan (state)	8/87	Final received ^b	11/87	DP-513	11/94
Air quality construction permit (state) ^c	7/87	Pending	Pending	Pending	None

^aResubmitted for zero discharge in 1992.
^bNot applicable because final approval has been received.
^cAir permit for screening equipment is required.

ENVIRONMENTAL MONITORING

The DOE conducts a detailed environmental monitoring program for radiological and nonradiological materials at the Ambrosia Lake site, including environmental gamma-dose equivalent and radionuclide/nonradionuclide concentrations in air, surface water, and ground water. This program monitors quantities of radioactive material and

nonradiological hazardous constituents that may be released into the environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

Surface water is not monitored because flow in the Arroyo del Puerto, the major watercourse in the Ambrosia Lake area, had been sustained almost entirely by ground water discharged from mines located in deeper aquifers. Because ground water is no longer discharged from the mines, the flow in Arroyo del Puerto is now considered ephemeral, occurring only as a result of heavy rainfall. Definition of surface water quality in Arroyo del Puerto is not applicable to remedial action at the Ambrosia Lake site. There were no discharges in 1993.

Due to scheduling constraints, ground water was not monitored in calendar year 1993. The site was sampled during construction in late 1992 (the early part of the fiscal 1993 construction year) and is scheduled for sampling again in the summer of 1994; therefore, no ground water data are presented in this report.

Air Monitoring

Nonradiological Air Particulate

In 1993, monitoring was not required for fugitive dusts (total suspended particulates) at the Ambrosia Lake site under New Mexico regulations.

Radiological Air Particulate Monitoring

Radiological air particulate monitoring at the Ambrosia Lake site was conducted at Stations 1 through 5, which were equipped with real-time radon monitoring equipment (*Figure 8-3*). Station 4 was established to give additional information for the east boundary of the site and was discontinued on June 1, 1993. Station 1, approximately 5 miles south of the site, provided background measurements.

Figure 8-4 summarizes site thorium-230 concentrations estimated from gross alpha measurements statistically above background. All stations except Station 3 reported annual average results that were statistically different from background. However, the estimated annual average thorium-230 concentration at all stations was well below the thorium-230 average annual guideline of 500×10^{-16} microcuries per milliliter ($\mu\text{Ci/mL}$) above background, indicating radioactive particulate releases from remedial action were insignificant. The elevated concentrations at the Ambrosia Lake site should return to background levels when remedial action is complete.

Figure 8-3
Environmental Air and Gamma Radiation Monitoring Stations, Processing Site

LEGEND

- ⊕ Real-time radon monitoring station
- Passive radon monitoring station
- ⊕ Environmental gamma monitoring station
- ▲ Thorium-230 air particulate monitoring station
- = = = Dirt road

ASER94/AMB/ENVMONSTAT

Figure 8-4
Environmental Airborne Radioactive Particulate (Thorium-230) Concentrations

^aStation 4 discontinued June 1, 1993.

Radon Monitoring

Real-Time Radon Monitoring. Real-time radon monitoring was conducted at Stations 1 through 5 (*Figure 8-3*), with Station 1 providing background measurements. Station 4 was discontinued on June 1, 1993.

Figure 8-5 shows the 1993 quarterly average radon concentrations statistically above background at the Ambrosia Lake site. The annual average background radon concentration measured at Station 1 was 1.4×10^{-9} $\mu\text{Ci/mL}$. Although all annual average radon concentrations were statistically greater than background levels, none of the areas exceeded the DOE guideline of 3×10^{-9} $\mu\text{Ci/mL}$ above background. The elevated concentrations at the Ambrosia Lake site should return to background levels when remedial action is complete.

Passive Radon Monitoring. Eight stations were established around the Ambrosia Lake site perimeter. Background monitoring was conducted at Station 1 south of the site. Station 4 was discontinued on July 1, 1993. *Figure 8-3* shows the locations of passive radon detectors at the Ambrosia Lake site.

The site passive radon monitoring results for stations statistically above background for the four quarters of 1993 are presented in *Figure 8-6*.

The annual average background radon concentration measured at Station 1 was 1.6×10^{-9} $\mu\text{Ci/mL}$. The annual average concentrations were statistically greater than background at all locations except Station 3. Only one station (Station 5) reported radon concentrations greater than the DOE guideline of 3×10^{-9} $\mu\text{Ci/mL}$ above background. Station 5 recorded high readings during the first two quarters of 1993 (7.2×10^{-9} $\mu\text{Ci/mL}$ and 5.7×10^{-9} $\mu\text{Ci/mL}$, respectively). The radon concentration at that station decreased significantly during the last two quarters (3.7×10^{-9} $\mu\text{Ci/mL}$ and 3.8×10^{-9} $\mu\text{Ci/mL}$, respectively). Radon concentrations were lower because remedial action in the first half of 1993 was limited and because two uranium mine vents on the site were capped at the end of the second quarter. The elevated concentrations at the Ambrosia Lake site should return to near background levels when remedial action is complete. However, radon levels may remain above background because the mine vents, ore piles, and evaporation ponds on adjacent properties are not included in the remedial action.

*Air Monitoring
Conclusions*

All measured concentrations of thorium-230 particulate were less than the applicable guidelines. No significant releases occurred at this site during 1993.

Radon monitoring Station 5 recorded concentrations greater than the applicable guideline. The elevated concentrations decreased during the course of the year due to remedial action at the site, suggesting that

Figure 8-5
Real-Time Radon Concentrations

ASER94/AMB/TAB2

Figure 8-6
Passive Radon Concentrations

ASER94/AMB/TAB3

concentrations will be much lower at this station in the future. All other measured concentrations of radon-222 were less than the applicable guidelines. No significant releases occurred at the site during 1993.

Environmental Gamma Radiation Monitoring

Gamma radiation in the environment around the Ambrosia Lake site is monitored by a network of thermoluminescent dosimeters around the site perimeter (*Figure 8-3*).

Eight dosimetry monitoring stations were active in 1993. Background dose was measured at Station 1, approximately 5 miles south (upwind) of the site. Station 4 was discontinued on July 1, 1993.

Figure 8-7 presents the 1993 results of environmental dosimetry monitoring for stations statistically above background at the Ambrosia Lake site. The annual background dose equivalent was 144 ± 11 millirem (mrem) at Station 1. Of the locations for which annual dose equivalents are available, all locations except Station 3 were statistically different from background.

Gamma ray exposure at Stations 5 and 8 decreased significantly by the last quarter of 1993. This decrease can be attributed to the reduction in remedial action during 1993.

All dose equivalents exceeding the DOE guideline of 100 mrem above background were measured along the site boundary. Dose equivalents are expected to return to near-background levels after remedial action is complete.

Environmental Gamma Radiation Monitoring Conclusions

Stations 5 and 8 recorded environmental gamma radiation levels greater than the applicable guidelines. These stations should report levels near background when remedial action is complete.

Figure 8-7
Environmental Gamma Radiation Monitoring

ASER94/AMB/TAB4

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SITE DESCRIPTION AND LOCATION

In San Juan County, New Mexico, the Shiprock site is on a 230-acre tract of the Navajo Indian Reservation, on the southwest side of the San Juan River. The site is approximately 1 mile south of the town of Shiprock.

Accurate population data for Shiprock (estimated population 7687) are difficult to obtain because it is unincorporated and has no defined boundaries. In addition, people who live as much as 10 or more miles from Shiprock often associate themselves with the town and are considered Shiprock residents. The population of San Juan County is 91,605 (DOC, 1990).

The Shiprock Uranium Mill Tailings Remedial Action (UMTRA) disposal site is on Navajo Nation land in northwestern New Mexico (*Figure 8-8*). The elevation of the site ranges from 4890 ft to about 5010 ft above mean sea level (MSL). The tailings disposal cell is on an alluvial terrace about 70 ft above the northwest-flowing San Juan River. A layer of terrace gravel 10 to 15 ft thick caps the terrace over the Mancos Shale bedrock. A cliff marks the edge of the terrace to the north and east. The cliff (about 60 ft high) is continuous except for a small area at the northwest part of the site where Bob Lee Wash drains to the north and breaches part of the cliff. Surface drainage in the area is generally north and east toward the San Juan River. An abandoned canal crosses the San Juan River floodplain.

The region is semiarid, with an average precipitation of 6.4 inches. Vegetation is sparse, except along the river. Land along the river is used predominantly for low-density open grazing, north and south from the river, and irrigated farming. The annual average temperature at the Shiprock site is 52.3 degrees Fahrenheit (°F). Temperatures measured from 1983 to 1984 ranged from 15°F to 94°F.

SITE HISTORY AND OWNERSHIP

The former Navajo Mill at the Shiprock site was constructed and operated from 1954 to 1963 by Kerr-McGee Oil Industries, Inc., and from 1963 to 1968 by Vanadium Corporation of America and its successor, Foote Mineral Company. Before and during milling operations, the site was leased from the Navajo Nation. When this lease expired in 1973, the site reverted to the Navajo Nation.

The mill processed approximately 1.5 million short tons of ore and smaller quantities of bulk precipitates from the Monument Valley area and from purchased vanadium liquor. Ore processing consisted of crushing, leaching with sulfuric acid, washing, and solvent extraction.

Tailings from the washing circuit were pumped to tailings ponds. Raffinate from the solvent extraction operation was disposed of by evaporation in unlined lagoons west of the tailings piles.

Figure 8-8
Shiprock Site Location

Between 1984 and 1986, the tailings were stabilized permanently on-site by consolidating the tailings and associated contaminated soils into a recontoured pile. The final cover at Shiprock consists of a 7-ft thick compacted, clayey layer that prevents radon emanation and water infiltration. The riprap cap is designed to provide erosion protection for the effective life of the cell (up to 1000 years) and to prevent plant and animal intrusion. The disposal cell covers about 76 acres. A security fence encloses the embankment.

The U.S. Department of Energy (DOE) and the Navajo Nation entered into a cooperative agreement pursuant to the provisions of Uranium Mill Tailings Radiation Control Act (UMTRCA) (42 USC §7901 *et seq.*) to provide for planning, fund expenditures, remediation, and long-term surveillance and maintenance for the disposal site. This cooperative agreement authorizes the Navajo Nation to transfer custody of the disposal site to the DOE until ground water remediation is completed under congressional extensions of UMTRCA.

Ownership and control of the site will comply with a land-withdrawal agreement between the DOE and the Navajo Nation.

SITE CHARACTERIZATION AND CLEANUP

Surface remedial action at the Shiprock site was completed in 1986, with 1,079,000 cubic yards of residual radioactive material, including 22,000 cubic yards of material from vicinity property remedial action, placed in the disposal site. The top of the disposal cell is covered with seepage barrier material and pit run rock and is sloped to drain into the permanent ditch. The arroyos along the escarpment adjacent to the disposal cell are filled and stabilized. The stabilized material is fenced to discourage intrusion.

ENVIRONMENTAL COMPLIANCE STATUS

With surface remedial action at the Shiprock site complete, the remaining surface-related compliance issues include U.S. Nuclear Regulatory Commission (NRC) licensing under the provisions of 10 CFR Part 40 for long-term surveillance and maintenance, and continued surveillance and maintenance of the completed disposal site, as defined in the site long-term surveillance plan (DOE, 1993). Under the UMTRA Ground Water Project, ground water, surface water, and sediment samples are collected and analyzed to evaluate the ground water contamination resulting from the former uranium processing site activities. Two UMTRA documents address the evaluation and sampling requirements in detail: the site baseline risk assessment (in preparation), and the site water sampling and analysis plan (in preparation).

In compliance with the National Environmental Policy Act (42 USC §4321 *et seq.*), a public scoping meeting was held in Shiprock to gather information for the ground water programmatic environmental impact statement (in preparation).

ENVIRONMENTAL MONITORING

The DOE conducts an environmental monitoring program at the Shiprock site for radiological and nonradiological materials in surface water and ground water. This program monitors the radioactive material and nonradiological hazardous constituents that may be released into the environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

With surface remedial action at the Shiprock site complete, air and environmental gamma radiation monitoring data were not collected for the UMTRA environmental monitoring program in 1993.

Surface Water Monitoring

Surface water and sediment samples were collected in April and May 1993 at 10 locations (546 through 555) along the San Juan River (*Figure 8-9*). Two water and sediment samples were collected from seeps on the escarpment above the floodplain (locations 425 and 426). Two surface water and sediment samples were collected along the drainage ditch traversing the floodplain (locations 655 and 656). Three water and sediments samples were collected from wetland areas on the floodplain (locations 657, 658, and 659). Three surface water and sediment samples were collected from Bob Lee Wash (locations 662, 761, and 762).

Two samples of surface water and sediments were also collected from small areas (less than 2 ft in diameter) of ponded water on the floodplain (locations 660 and 661).

Sediment and unfiltered surface water samples collected from the San Juan River were analyzed for arsenic, cadmium, calcium, chloride, chromium, iron, lead, lead-210, manganese, molybdenum, polonium-210, radium-226, selenium, strontium, thorium-230, uranium, and vanadium. These constituents were selected as indicators of the effects of the former milling operations in support of the baseline risk assessment.

Sediment and unfiltered surface water samples collected from the seeps, the floodplain surface water bodies, and location 662 in Bob Lee Wash were analyzed for manganese, nitrate, selenium, strontium, and uranium, as indicators of contamination by the former milling operations.

Unfiltered surface water samples collected at locations 761 and 762 in Bob Lee Wash were analyzed for alkalinity, ammonium, arsenic, antimony, arsenic, cadmium, calcium, chloride, chromium, cobalt, copper, gross alpha, gross beta, iron, lead, lead-210, manganese, molybdenum, net gross alpha, nitrate, pH, phosphate, polonium-210, radium-226, selenium, sodium, specific conductance, strontium, sulfate,

Figure 8-9
Surface Water and Sediment Sampling Locations

ASER94/SHP/LOC/FLOODPLAIN

temperature, thorium-230, total dissolved solids, total organic carbon, uranium, vanadium, and zinc.

Surface Water Results and Conclusions

Sulfate, uranium, and nitrate are considered indicators of contamination from the former uranium milling operations. *Table 8-2* lists the surface water and sediment quality data for these three indicators from two upstream locations (546 and 547) and two downstream locations (548 and 549) along the San Juan River.

Table 8-2 San Juan River surface water and sediment quality results

Indicator parameter	Guideline	Monitoring well location			
		SHP01 546 (upstream)	SHP01 547 (upstream)	SHP01 548 (downstream)	SHP01 549 (downstream)
Sulfate	250 ^a				
Water		116	202	192	121
Sediment		NM	NM	NM	NM
Uranium	0.044 ^b				
Water		<0.001	0.003	0.001	0.001
Sediment		45	3.4	4.9	4.4
Nitrate	44 ^b				
Water		<1	2.4	1.5	1.1
Sediment		NM	NM	NM	NM

^aSecondary Drinking Water Standard.
^bMaximum concentration limit.
 NM - Not measured.

Notes: 1. Water samples are nonfiltered (totals).
 2. All water and sediment quality samples were taken in February 1993.
 3. Surface water results are reported in milligrams per liter.
 4. Sediment results are reported in milligrams per kilogram.
 5. < symbol indicates actual is less than the detection limit (number shown).

Comparing surface water and sediment samples from the San Juan River downstream of the site to upstream, background samples showed no differences in quality related to the former uranium milling activities. Similarly, no changes attributable to the former milling operations were recognized in the water or sediments in Bob Lee Wash or in the wetlands downstream of Bob Lee Wash. However, concentrations that could present a risk to human health and to the environment were observed in surface water and sediments collected directly below the seeps along the escarpment, the canal, the two small

areas of ponded water on the floodplain, and the small wetland area at the base of the escarpment that receives water from seep 425.

Too little historical data are available to identify trends in the surface water or sediment quality.

Ground Water Monitoring

Ground water is perched in the alluvium and the upper 20 to 30 ft of fractured Mancos Shale on the terrace beneath the former uranium mill site. Seepage from the milling activities significantly contributed to the volume of ground water, resulting in a contaminant plume that extends east, south, and west of the site. Contaminated ground water in the shale moves through fractures to the north and appears as seeps on the escarpment separating the terrace and the floodplain. Paleochannels eroded into the bedrock surface control ground water movement in the alluvium on top of the shale.

Terrace Ground Water Monitoring

Six new monitoring wells (725, 726, 727, 728, 730, and 731) were installed on the terrace in 1993 to further delineate the areal extent of the contamination (*see Figure 8-10*).

Water levels were measured to improve understanding of ground water flow patterns and to assess the amount of seasonal recharge reaching the water table.

Ground water samples were collected from the new wells and from previously existing wells 600 and 602 near the disposal cell. Water samples also were collected from the free-flowing artesian well (648) west of Bob Lee Wash.

The February 1993 ground water samples from wells 600 and 602 were analyzed for chloride, sulfate, sodium, potassium, magnesium, calcium, ammonium, nitrate, phosphate, arsenic, cadmium, chromium, lead, manganese, molybdenum, selenium, strontium, uranium, total dissolved solids, radium-226, radium-228, lead-210, polonium-210, and thorium-230.

Both unfiltered (total) and filtered ground water samples were collected from monitoring wells 725, 726, 727, 728, 730, 731, and artesian well 648 in April 1993. The unfiltered samples were analyzed for the same constituents (except radium-228) as the February samples from monitoring wells 600 and 602. These samples were also analyzed for total organic carbon, antimony, iron, copper, chromium, and cobalt.

The filtered samples were analyzed for sodium, potassium, magnesium, calcium, arsenic, cadmium, chromium, lead, manganese, molybdenum, selenium, strontium, uranium, total organic carbon, and radium-228.

Figure 8-10
Ground Water Monitoring Well Locations

ASER94/SHP/GWSAMPLOCS

The August samples from wells 725, 726, 727, 728, 730, and 731 were unfiltered. They were analyzed for the same constituents as in April as well as silica, chlorine, dissolved organic carbon, and fluoride.

Terrace Ground Water Results

The six new wells installed during 1993 have not defined the areal extent of the contamination to the east, south, or west of the former mill site. All samples show evidence of contamination by the former milling operations and contaminated ground water continues to seep from the escarpment. Therefore, background ground water quality was not sampled on the terrace.

Sulfate, uranium, and nitrate are considered indicators of ground water contamination from the former uranium milling operations. *Table 8-3* lists the water quality data on these three indicators from wells 602, near the disposal cell, and well 727, west and downgradient of the former mill site.

Table 8-3 Terrace and floodplain ground water quality results

Indicator parameter	Guideline	Location				
		Terrace (SHP02)		Floodplain (SHP01)		
		602 (at source)	727 (downgradient)	615 (contaminated)	734 (downgradient)	733 (background)
Sulfate	250 ^a					
02/93 ^b		16,900	c	c	c	c
04/93 ^d		c	18,100	c	3400	3420
09/92 ^b		c	c	13000	c	c
Uranium	0.044 ^d					
02/93 ^b		0.81	c	c		
04/93 ^d		c	0.5	c	0.12	0.023
09/92 ^b		c	e	2.1		
Nitrate	44 ^b					
02/93 ^b		80	c	c	c	c
04/93 ^d		c	2310	c	1	<1
09/92 ^b		c	c	5300	c	c

^aSecondary Drinking Water Standard.
^bFiltered water sample.
^cNot measured in 1993.
^dNonfiltered water sample (totals).
^eMaximum concentration limit.

Notes: 1. Results are reported in milligrams per liter.
 2. < symbol indicates actual is less than the detection limit (number shown).

There are insufficient water level measuring points to permit preparation of a ground water contour map, but the perched ground water on the terrace is expected to follow paleochannels to the southwest and west. The ground water layer in the alluvium above the bedrock is thin (generally less than 3 ft), and the monitoring wells recharge slowly.

Terrace Ground Water Conclusions

The ground water samples collected from terrace wells at and downgradient of the former processing site show ground water beneath the terrace is contaminated by the former uranium milling activities. Hydrogeologic information on the aquifer characteristics, however, indicate the quantity of ground water in the perched aquifer is limited.

Because of minimal recharge and the slow ground water flow, rapid changes in ground water quality on the terrace are not anticipated. The analytical data from preexisting well 602 show a trend toward decreasing uranium concentration (*Figure 8-11*), but no such trends can be recognized in well 600 or for the other constituents. Data from the newly installed wells are not sufficient to define trends.

Floodplain Ground Water Monitoring

The floodplain alluvium on both sides of the San Juan River contains shallow ground water that flows generally parallel to the river. Water is recharged from the river at the upstream end of the floodplain and discharges back into the river along the downstream end (*Figure 8-12*). The floodplain on the south side of the river (the site side) also is recharged from Bob Lee Wash (primarily from the flowing artesian well) and minor seeps on the escarpment.

Two new monitoring wells were installed in the floodplain along the northern edge of the river to better define background ground water quality. Three new monitoring wells were installed during 1993 in the floodplain along the south side of the river to measure water quality along the river's edge.

Background ground water samples were collected from monitoring wells 732 and 733 on the north side of the floodplain (*Figure 8-10*). Ground water samples were collected from previously existing ground water monitoring wells 608, 610, 614, 615, 617, 619, 620, 626, 628, and 630, and from new monitoring wells 734, 735, and 736 installed in 1993 on the floodplain on the south side of the San Juan River.

Water levels were measured in the monitoring wells to assess the direction and rate of ground water movement through the floodplain sediments, and to calculate the quantity of ground water discharging into the San Juan River along the downstream edge of the southern floodplain.

Figure 8-11
Uranium Concentrations Over Time, Terrace Area

ASER94/SHP/URNCONVSTIME

Ground water samples were collected from the previously existing monitoring wells in February 1993 and from the new floodplain monitoring wells in April and August 1993. The new wells were sampled more frequently than the existing wells to increase the data base for these wells. Water level elevations were measured before the wells were sampled to define the direction and rate of ground water movement.

The February ground water samples from the previously existing wells were analyzed for chloride, sulfate, sodium, potassium, magnesium, calcium, ammonium, nitrate, phosphate, arsenic, cadmium, chromium, lead, manganese, molybdenum, selenium, strontium, uranium, total dissolved solids, radium-226, radium-228, lead-210, polonium-210, and thorium-230.

Both unfiltered (total) and filtered ground water samples were collected from monitoring wells 732 through 736 in April 1993. The unfiltered samples were analyzed for the same constituents as the February samples (with the exception of radium-228) and also for total organic carbon, antimony, iron, copper, chromium, and cobalt.

Figure 8-12
Ground Water Table Contours and Gradient on Floodplain

The April filtered samples were analyzed for sodium, potassium, magnesium, calcium, arsenic, cadmium, chromium, lead, manganese, molybdenum, selenium, strontium, uranium, chloride, ammonium, nitrate, phosphate, sulphate, total dissolved solids, polonium-210, lead-210, and radium-226 and -228.

The August filtered samples from wells 732 and 736 were analyzed for the same constituents as the April filtered samples plus silica, chlorine, dissolved organic carbon, and fluoride. Nonfiltered samples were not collected.

Floodplain Ground Water Results

All ground water samples collected from the floodplain on the south side of the river are affected by the former milling operations. Sulfate, uranium, and nitrate are considered indicators of this contamination. *Table 8-3* gives water quality data on these three indicators from well 615, in the contaminated area near the foot of the escarpment, and well 734, along the edge of the downstream end of the floodplain. Contamination isopleth maps for sulfate, uranium, and nitrate are presented in *Figures 8-13, 8-14, and 8-15*.

Ground water samples from wells 732 and 733 on the floodplain north of the river indicate sulfate concentrations in the background ground water are relatively high, but uranium concentrations are low.

Floodplain Ground Water Conclusions

Ground water levels in the monitoring wells on the north side of the river show ground water moves toward the river. Similarly, water levels in monitoring wells on the south side of the river show San Juan River water enters the floodplain along the upstream portion of the floodplain and discharges back to the river along the downstream part of the floodplain (*Figure 8-12*). No data indicate ground water from the floodplain on the south side of the river could move under the river to the floodplain on the north side. Therefore, the two new wells installed during 1993 on the north side of the San Juan River provide representative water quality data on the uncontaminated background ground water quality beneath the floodplain.

Monitoring well 735, installed at the extreme upstream end of the floodplain on the south side of the river, was expected to provide data on the background ground water quality in that location. Analytical results, however, indicate that it also exhibits contaminated ground water.

Contaminant concentrations in the monitoring wells have fluctuated over time, but no increasing or decreasing trends have been recognized.

Figure 8-13
Sulfate Concentrations in Alluvium

ASER94/SHP/SULISO

Figure 8-14
Uranium Concentrations in Alluvium

ASER94/SHP/URNISO

Figure 8-15
Nitrate Concentrations in Alluvium

ASER94/SHP/NITISO

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- 42 USC §4321 *et seq.*, *National Environmental Policy Act*, January 1, 1970.
- 42 USC §7401 *et seq.*, *Clean Air Act*, December 17, 1963.
- 42 USC §7901 *et seq.*, *Uranium Mill Tailings Radiation Control Act of 1978*, November 8, 1978.
- 42 USC §9601 *et seq.*, *Comprehensive Environmental Response, Compensation, and Liability Act*, December 11, 1980.
- 49 USC §1801 *et seq.*, *Hazardous Materials Transportation Act*, January 3, 1975.

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CHAPTER 9 NORTH DAKOTA SITES

NORTH DAKOTA SITES

This chapter provides detailed Uranium Mill Tailings Remedial Action (UMTRA) Project data on environmental monitoring activities at the Belfield and Bowman, North Dakota, sites during 1993.

Numerous documents describe the existing environmental and construction conditions at the UMTRA Project sites. These documents, including environmental impact statements, environmental assessments, and remedial action plans, are available at the U.S. Department of Energy (DOE) UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Belfield

The Belfield site is in Stark County in southwestern North Dakota. Site remedial action is scheduled to begin in 1996. Because surface remedial action has not begun, air monitoring and environmental gamma radiation monitoring were not conducted in 1993. However, during 1993, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

Bowman

The Bowman site is in Bowman County in southwestern North Dakota. Site remedial action is scheduled to begin in 1996. Because surface remedial action has not begun, air monitoring and environmental gamma radiation monitoring were not conducted in 1993. However, during 1993, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

CHAPTER 9 — NORTH DAKOTA

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**SITE DESCRIPTION
AND LOCATION**

The Belfield Uranium Mill Tailings Remedial Action (UMTRA) Project site is in Stark county in southwestern North Dakota (*Figure 9-1*). The Belfield site is approximately 1 mile southeast of the town of Belfield.

The inactive Belfield lignite ashing site is bounded on the south by the Burlington Northern Railroad tracks and on the north by the North Branch of the Heart River. The site covers 10.7 acres and contains ash-contaminated soil.

Belfield has been affected by the decline in the oil industry that began in 1982. The present population is composed of farmers or small business owners. Area towns are small, with populations between several hundred to several thousand. The 1990 population of Stark County was 22,800, a 3.6 percent decrease from 1980. The 1990 population of Belfield was 887, a 30 percent decrease from 1980 (DOC, 1990).

The site is in the Northern Great Plains and has a semiarid climate. The average annual temperatures recorded at Dickinson, North Dakota, 19 miles east of the Belfield site, are 54 degrees Fahrenheit ($^{\circ}\text{F}$) (maximum) and 30 $^{\circ}\text{F}$ (minimum), with extremes of 105 $^{\circ}\text{F}$ and -35 $^{\circ}\text{F}$ for the 30-year period of record. The annual average rainfall is 16 inches, 80 percent of which falls between April and September. Average annual snowfall is 30 inches. The predominant wind direction recorded at Dickinson is west-northwest at an average annual speed of 13 miles per hour.

**SITE HISTORY AND
OWNERSHIP**

Uraniferous lignite was processed at the Belfield site in the 1960s. Uranium-rich ash from the rotary kiln process was loaded into rail cars and transported to uranium mills in Rifle, Colorado, and Ambrosia Lake, New Mexico. Ash-contaminated soil remains at the processing site.

The site is used for commercial, light industrial, and agricultural activities.

The Burlington Northern Railroad and Gary and Julie Newton of Belfield own the Belfield site. A construction company (L.P. Anderson Construction), a propane supply company (Cenex), and a rabbit grower currently occupy the site.

**SITE
CHARACTERIZATION
AND CLEANUP**

The Belfield designated processing site is 10.7 acres. An additional 20 acres have been contaminated by windblown material, creating approximately 58,000 cubic yards of ash-contaminated soil that require remediation. Remedial action for this site probably will be carried out through a remedial action agreement with the property owners. The

Figure 9-1
Belfield Site Location

ash-contaminated soils have slightly elevated concentrations of molybdenum, arsenic, and radium-226.

In the proposed remedial action, scheduled to start in fiscal year 1996, all residual radioactive material from the Belfield site will be relocated to the Bowman site for codisposal. Materials from both sites will be consolidated and stabilized in a single disposal cell. The disposal cell will be covered with a low-permeability infiltration/radon barrier and erosion protection cover to ensure long-term stability of the cell, retard infiltration, reduce seepage of tailings fluids to ground water, and prevent radon emanation.

Remedial action will also include cleanup of vicinity properties. Vicinity properties are properties outside the designated site boundary that have been contaminated by dispersed lignite ash or by the removal and use of contaminated soils before the potential hazards were known.

ENVIRONMENTAL COMPLIANCE STATUS

Environmental Compliance Permits

An air emission permit issued by the North Dakota Department of Health may be required for the crushing and screening operation after the onset of surface remedial action. A permit administered by the U.S. Environmental Protection Agency (EPA) will be required under the National Pollutant Discharge Elimination System for storm water at Bowman once the site is active. A U.S. Army Corps of Engineers Section 404 Permit is required for the nearby floodplain. These permits are expected to be issued soon after permit applications are submitted. Other permits may be required as the site approaches remedial action startup.

ENVIRONMENTAL MONITORING

The U.S. Department of Energy (DOE) conducts a detailed environmental monitoring program at the Belfield site for radiological and nonradiological materials in surface water and ground water. This program monitors quantities of radioactive and nonradiological hazardous constituents that may be released into the environment, demonstrates compliance with applicable guidelines, and indicates the efficiency of environmental protection measures.

Air monitoring will not be conducted at this site until surface remedial action begins.

Surface Water Monitoring

Surface water was not sampled for site characterization or compliance monitoring at the Belfield processing site in 1993. However, surface water was sampled at several locations along the North Branch of the

Heart River in the site vicinity for the site baseline risk assessment (in preparation). The river is an intermittent (ephemeral) stream flowing in response to precipitation events, making representative surface water quality data difficult to obtain. Available data indicate site-related contamination does not impact surface water quality in the North Branch of the Heart River.

Ground Water Monitoring

Ground water was sampled in July and August 1993 at the Belfield processing site to evaluate ground water quality and for baseline risk assessment between completion of initial site characterization and the startup of surface remedial action.

Processing Site

The Belfield site is underlain by sediments of the Tertiary Fort Union Group. Ground water occurs in the uppermost aquifer, which includes the saturated portion of the upper zone of fine-grained sediments and the underlying middle lignite zone, under unconfined to confined conditions. Depth to ground water in the upper zone is more than 15 feet (ft) below land surface, with hydraulic connection between the two zones.

Monitoring wells at the Belfield site provide representative ground water samples from upgradient, on-site, and downgradient areas in the uppermost aquifer (*Figure 9-2*). Nine monitoring wells (520, 521, 522, 532, 534, 537, 539, 540, and 541) in the uppermost aquifer at the Belfield site were sampled in 1993. Samples were not collected from four of these monitoring wells due to insufficient recharge (533), hydrocarbon contamination (535), or inaccessibility (536 and 538).

In 1993, ground water quality data were compared with the maximum concentration limits of the proposed EPA ground water protection standards (40 CFR part 192). Background ground water quality at the site is affected by widespread ambient concentrations of naturally occurring uranium and other constituents not related to uranium processing activities at the processing sites. The list of constituents analyzed was restricted to hazardous constituents of concern and parameters needed for geochemical evaluation. Potentially hazardous constituents included antimony, arsenic, cadmium, chromium, lead, molybdenum, radium, selenium, uranium, and vanadium.

Ground Water Results

The indicator parameter for the Belfield site is uranium because it is the constituent most likely related to the uraniferous lignite ashing activities at the site (*Table 9-1*). No inorganic or organic chemicals were used in the processing operation, so none were expected in ground water.

Analyses of ground water samples from the monitoring wells indicate uranium concentrations exceeded the maximum concentration limit in 1993 in two monitoring wells in the upper zone (520 and 534). Net

Figure 9-2
Ground Water Monitoring Well Locations, Processing Site

ASER94/BEL/GWSAMP

gross alpha activities also exceeded the maximum concentration limit in several monitoring wells.

Table 9-1 Ground water quality results, processing site

Zone	Monitoring well	Uranium ^a
Upper		
Background	539	<0.001
On-site	520	0.106
Downgradient	537	0.002
Lignite		
Background	541	<0.001
On-site	521	<0.001
Downgradient	540	<0.001

^aConcentrations reported in milligrams per liter.

Notes:

1. Guideline is the maximum concentration limit (0.044).
2. Ground water quality data are from the uppermost aquifer, which consists of the upper zone of fine-grained sediment and the underlying middle lignite zone.
3. < symbol indicates actual is less than the detection limit (number shown).

Ground Water Conclusions

Ground water in the upper zone generally flows southeast. A component of flow to the southwest is influenced by the sewage lagoons and possibly the North Branch of the Heart River (*Figure 9-3*). Ground water in the lignite zone generally flows east (*Figure 9-4*). The ground water flow pattern has remained relatively constant over time. The average linear ground water velocity in the upper zone is approximately 0.07 ft per day (25 ft per year) and in the lignite zone is 0.27 ft per day (100 ft per year).

The extent of ground water contamination related to uranium processing activities at the Belfield site is difficult to determine. The contamination was minimal because of the low intensity of the processing activities (only the physical process of burning lignite). Concentrations of some constituents in ground water may be elevated because of the potential for naturally occurring uranium mineralization in the area and ground water-sediment interactions. *Figure 9-5* shows uranium distribution in ground water in the uppermost aquifer. In general, uranium processing activities at the Belfield site have only slightly impacted the ground water.

Figure 9-3
Potentiometric Surface of the Upper Aquifer, Processing Site

ASER94/BEL/POTENSURF

Figure 9-4
Potentiometric Surface of the Lignite Aquifer, Processing Site

ASER94/BEL/LIGPO

Figure 9-5
Uranium Concentrations in the Upper and Lignite Aquifers, Processing Site

ASER94/BEL/URNDIS

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**SITE DESCRIPTION
AND LOCATION**

The Bowman Uranium Mill Tailings Remedial Action (UMTRA) Project site is in Bowman County in southwestern North Dakota (*Figure 9-6*). The Bowman site is approximately 7 miles west of the town of Bowman (DOC, 1990). Bowman is about 65 miles southwest of the Belfield site.

The Bowman lignite ashing site is bounded by the Burlington Northern Railroad tracks on the north and cultivated fields and pastureland on the east, south, and west. The 12.1-acre site is separated into two tracts by an unpaved county road and is overgrown with nonnative grasses. Structures and equipment used at the site have been removed; only a small amount of concrete rubble and a few pieces of piping remain.

The 1990 population of the town of Bowman was 1740, down 16 percent from 1980. The 1990 population of Bowman County was 3600, a 1-percent decrease from 1980 (DOC, 1990).

Data recorded at the Bowman weather station 7 miles east of the site are almost identical to those recorded at Dickinson, North Dakota. Bowman and Dickinson are in the Northern Great Plains, which is semiarid. The average annual temperatures recorded at Dickinson are 54 degrees Fahrenheit (°F) (maximum) and 30°F (minimum), with extremes of 105°F and -35°F for the 30-year period of record. The annual average rainfall is 16 inches, 80 percent of which falls between April and September. The average annual snowfall is 30 inches. The predominant wind direction recorded at Dickinson is west-northwest, with an average annual speed of 13 miles per hour.

**SITE HISTORY AND
OWNERSHIP**

Uraniferous lignite was processed at the Bowman site in the 1960s. Uranium-rich ash from the rotary kiln process was loaded into rail cars and transported to uranium mills in Rifle, Colorado, and Ambrosia Lake, New Mexico.

The Bowman site is on private property owned by Roger Stearns. In fiscal year 1995, the U.S. Department of Energy (DOE) will authorize the state of North Dakota to acquire the privately owned tracts within the site boundaries. The acquisition will be based on recent state appraisals.

**SITE
CHARACTERIZATION
AND CLEANUP**

The Bowman designated processing site is 12.1 acres. An additional 53 acres have been contaminated by windblown materials, creating approximately 128,400 cubic yards of ash-contaminated soils that require remediation. The ash-contaminated soils have slightly elevated concentrations of molybdenum, arsenic, and radium-226.

In the proposed remedial action, scheduled to start in fiscal year 1996, all residual radioactive material from both the Belfield and the

Figure 9-6
Bowman Site Location

Bowman sites will be consolidated and stabilized in a single disposal cell on the Bowman site. The disposal cell will be covered with a low-permeability infiltration/radon barrier and erosion protection cover to ensure long-term stability of the cell, retard infiltration, reduce seepage of tailings fluids to ground water, and prevent radon emanation.

Remedial action will also include cleanup of one associated vicinity property. Vicinity properties are properties outside the designated site boundary that have been contaminated by dispersed lignite ash or by the removal and use of the contaminated soils before the potential hazards were known.

ENVIRONMENTAL COMPLIANCE STATUS

In compliance with the National Environmental Policy Act (42 USC §4321 *et seq.*), a public meeting was held at Bowman to gather information for the ground water programmatic environmental impact statement (in preparation). In addition, an environmental assessment is being prepared.

ENVIRONMENTAL MONITORING

The DOE implements an environmental monitoring program at the Bowman site for radiological and nonradiological materials in surface water and ground water. This program monitors quantities of radioactive material and nonradiological hazardous constituents released into the environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

Air monitoring will not be conducted until surface remedial action begins.

Surface Water Monitoring

Surface water was not sampled for site characterization or compliance monitoring at the Bowman processing site in 1993. However, surface water was sampled at several locations in the site vicinity for the site baseline risk assessment. These data indicate site-related contamination does not impact surface water quality in the vicinity.

Ground Water Monitoring

Ground water was sampled in July and August 1993 at the Bowman processing site to evaluate ground water for quality and risk assessment during the interim between completion of initial site characterization and the startup of surface remedial action.

Processing and Disposal Site

The Bowman site is underlain by sediments of the Tertiary Fort Union Group. Ground water occurs in the uppermost aquifer, which includes the saturated portion of the upper zone of fine-grained sediments and the underlying middle lignite zone, under unconfined to confined conditions. Depth to ground water in the upper zone is more than 6 ft below land surface, with hydraulic connection between the two zones.

Monitoring wells at the Bowman site provide representative ground water samples from upgradient, on-site, and downgradient areas in the uppermost aquifer (*Figure 9-7*). Nineteen monitoring wells (514 through 520 and 523 through 534) in the uppermost aquifer at the Bowman processing site were sampled in July 1993.

In 1993, ground water quality data were compared with the maximum concentration limits of the proposed EPA ground water protection standards. Background ground water quality at the sites is affected by widespread ambient concentrations of naturally occurring uranium and other constituents not related to uranium processing activities at the processing sites. The list of constituents analyzed was restricted to hazardous constituents of potential concern and parameters needed for geochemical evaluation. Potentially hazardous constituents included antimony, arsenic, cadmium, chromium, lead, molybdenum, radium, selenium, uranium, and vanadium.

The indicator parameter for the Bowman site is uranium because it is the constituent most likely related to the uraniferous lignite ashing activities at the site (*Table 9-2*). No inorganic or organic chemicals were used in the processing operation, so none were expected in ground water.

Ground Water Results

Analyses of ground water samples from the monitoring wells indicate concentrations of uranium, selenium, and molybdenum and activities of radium and net gross alpha exceeded the maximum concentration limits in monitoring well 517 (upper zone on the site). Uranium concentrations also exceeded the maximum concentration limit in monitoring well 528 and activities of radium and net gross alpha exceeded maximum concentration limits in monitoring wells 530 and 531 and 528 and 531, respectively.

Ground Water Conclusions

Defined by ground water elevations in monitoring wells completed in the upper zone, the water table configuration indicates a northwest-southeast trending ridge (from monitoring well 517 to 530), with local ground water flow to the northeast and southwest (*Figure 9-8*). These data indicate the saturated interval in the upper zone is not a laterally continuous, integrated aquifer unit, but consists of ground water in perched zones and in heterogeneous units with lateral and vertical variations (with a predominance of clay- and silt-sized material). There is hydraulic connection within this saturated interval in the upper zone, but the different water levels are the result of differential equilibration as water percolates through the interval. Ground water flow in the lignite zone is generally east (*Figure 9-9*). The ground water flow pattern has remained relatively constant over time. The average linear ground water velocity in the upper zone is 4.6×10^{-3} ft per day. In the lignite zone it is 0.20 ft per day.

Figure 9-7
Ground Water Monitoring Well Locations, Processing Site

ASER94/BEL/GWSAMPLOCS

Table 9-2 Ground water quality results, processing site

Zone	Monitoring well location number	Uranium ^a
Upper		
Background	527	0.001
On-site	517	0.259
Downgradient	531	0.040
Lignite		
Background	520	0.003
On-site	526	<0.001
Downgradient	516	0.001

^aConcentrations reported in milligrams per liter.

Notes:

1. Guideline is the maximum concentration limit (0.044).
2. Ground water quality data are from the uppermost aquifer, which consists of the upper zone of fine-grained sediment and the underlying middle lignite zone.
3. < symbol indicates actual is less than the detection limit (number shown).

The extent of ground water contamination related to uranium processing activities at the Bowman site is difficult to determine. The contamination is minimal because of the low intensity of the processing activities (only the physical process of burning lignite). Concentrations of some constituents in ground water may be elevated because of the potential for naturally occurring uranium mineralization in the area and ground water/sediment interactions. *Figure 9-10* shows uranium distribution in ground water in the uppermost aquifer. In general, uranium processing activities at the Bowman site have minimally impacted ground water.

Figure 9-8
Potentiometric Surface of the Upper Aquifer, Processing Site

ASER94/BEL/POTENUPPER

Figure 9-9
Potentiometric Surface of the Lignite Aquifer, Processing Site

100 0 200 400 Feet

Figure 9-10

Uranium Concentrations in the Upper and Lignite Aquifers, Processing Site

REFERENCES

DOC (U.S. Department of Commerce), 1990. *Census of Population: General Population Characteristics, Economics and Statistics Administration, Bureau of the Census, Washington, D.C.*

Code of Federal Regulations

40 CFR Part 192, *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings*, U.S. Environmental Protection Agency (1994).

United States Codes

42 USC §4321 *et seq.*, *National Environmental Policy Act*, January 1, 1970.

UWTPA PROJECT

CHAPTER 10 OREGON SITE

OREGON SITE

This chapter provides detailed Uranium Mill Tailings Remedial Action (UMTRA) Project data on environmental monitoring activities conducted at the Lakeview, Oregon, site during 1993 and the first quarter of 1994.

Numerous documents describe the existing environmental and construction conditions at UMTRA Project sites. These documents, including environmental impact statements, environmental assessments, and remedial action plans, are available at the U.S. Department of Energy (DOE) UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Lakeview

The Lakeview site is in Lake County in south-central Oregon. Site remedial action was completed in October 1989. Because surface remedial action is complete, air monitoring and environmental gamma radiation monitoring were not conducted in 1993. However, during 1993, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

CHAPTER 10 — OREGON

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**SITE DESCRIPTION
AND LOCATION**

The Lakeview processing site is approximately 1.5 miles northwest of the town of Lakeview in Lake County, Oregon (*Figure 10-1*). Klamath Falls is about 96 miles west of the site, and the California-Oregon border is approximately 16 miles south of the site.

The Lakeview site covers 258 acres; approximately 30 acres were covered by the nearly square tailings pile, approximately 64 acres contained the evaporation ponds, and approximately 164 more acres were occupied by the former mill structures, the former ore storage area, and miscellaneous areas.

The areas north and west of the processing site are swampy during much of the year, due to the high water table and geothermal springs. East of the site, the land is swampy during the spring and early summer and remains dry until fall and winter.

The Lakeview disposal site, also known as the Collins Ranch disposal site, is in south-central Oregon near the northern end of Goose Lake Valley, a large flat mountain valley at 4750 feet (ft) above mean sea level (MSL) (*Figure 10-1*). Mountain peaks in surrounding ranges to the east and west (in the Fremont National Forest) reach elevations of more than 8000 ft above MSL. The area contains many lakes; the largest is Goose Lake, about 17 miles south of the disposal site. Vegetation consists of pine cover in the higher mountain areas with trees, sage, and scrub brush in the foothills. The valleys are grassy meadows used primarily as ranch land.

The Lakeview processing site is in the vicinity of the city of Lakeview, the major population center in Lake County. The estimated 1993 Lakeview population was 2526. The estimated population of Lake County for 1990 was 7186 (DOC, 1990).

Lakeview receives moderate amounts of precipitation (2.5 inches each in December and January), mostly in the form of sleet and snow; light snow (1 to 2 inches per month during the spring and fall), and minor rainfall (0.25 to 0.5 inch per month during summer). Average annual precipitation is 16 inches, with 61 inches of snow. Average high summer temperatures are 70 degrees Fahrenheit (°F) to 80°F, and average winter lows are below 25°F.

**SITE HISTORY AND
OWNERSHIP**

The Lakeview Mining Company constructed the Lakeview uranium processing mill in 1958. Between 1960 and 1978, the property had six owners, including the Atlantic Richfield Company. Atlantic Richfield conducted a cleanup operation on the site under a plan approved by the Oregon State Health Division. In 1977, the property was sold to Precision Pine Lumber Company, which used the site and structures as a lumber mill and stockpile for sawdust and scrap waste. In 1987, Goose Lake Lumber Company purchased the property containing the

Figure 10-1
Lakeview Site Location

mill buildings, office area, and acreage for timber storage. Precision Pine Lumber Company retained title to the former tailings pile area until it was sold to John Ryan, a former partner in the Precision Pine Lumber Company.

From 1958 to 1961, the mill treated 130,000 tons of ore, using a sodium chlorate and sulfuric acid leach process. Ore processed at the mill site came from the White King and Lucky Lass mines, approximately 16 road miles northwest of Lakeview.

Although the state of Oregon presently holds title to the Lakeview disposal site, the site is surrounded by ranch land owned by John and Bridget Collins and is also known as the Collins Ranch disposal site. The disposal site title is being processed for transfer from the state to the federal government. When the title transfer process is complete, the U.S. Nuclear Regulatory Commission (NRC) will proceed with site licensing.

SITE CHARACTERIZATION AND CLEANUP

Atlantic Richfield conducted remedial action activities from 1974 to 1977 at the Lakeview tailings site, cleaning up and stabilizing the former mill area, partially excavating material in the evaporation ponds, and applying cover material over the tailings pile. The DOE remedial action began in September 1986 and was completed in October 1989. During this remedial action, 736,000 tons of dry uranium mill tailings were moved about 7 miles from the old mill site to the Collins Ranch/Lakeview disposal site.

ENVIRONMENTAL COMPLIANCE STATUS

Surface remedial action at the Lakeview site is complete. The remaining surface-related compliance issues for the disposal site are NRC licensing under the provisions of 10 CFR Part 40 and continued surveillance and maintenance. This continued surveillance and maintenance includes point-of-compliance ground water monitoring, as defined in the site long-term surveillance plan (DOE, 1993a).

Under the UMTRA Ground Water Project, ground water, surface water, and sediment samples were collected from the processing site and analyzed to further evaluate the ground water contamination resulting from the former uranium processing site activities. The two UMTRA documents that address evaluation and sampling requirements in detail are the site baseline risk assessment (in preparation) and the site water sampling and analysis plan (DOE, 1993b).

In compliance with the National Environmental Policy Act (42 USC §4321 *et seq.*), public scoping meetings were held in Lakeview to gather information for the ground water programmatic environmental impact statement (in preparation).

**ENVIRONMENTAL
MONITORING**

The DOE conducts an environmental monitoring program at the Lakeview site for radiological and nonradiological materials in surface water and ground water. This program monitors quantities of radioactive material and nonradiological hazardous constituents that may be released into the environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

With the surface remedial action at the Lakeview site complete, air and environmental gamma radiation monitoring data were not collected for the UMTRA Project environmental monitoring program in 1993. However, some ecological monitoring was conducted on the vegetative cover of the Collins Ranch disposal site.

Surface Water Monitoring*Processing Site*

Surface water was monitored in preparation for the baseline risk assessment, scheduled for completion in 1994. Surface water features in the site area include Hunters Hot Springs, three creeks, several ponds, and drainage ditches. Hunters Hot Springs, approximately 0.5 mile north of the former processing site, is important to the surface water hydrology. These springs feed thermal water into other surface water sources and recharge the hydrologic units beneath the site.

Five surface water and sediment samples (four along the western side and one on the eastern side) were collected near the former processing site (*Figure 10-2*). Sampling was conducted during the fall rainy season (late October to early November) to obtain samples from intermittent streams that flow only during the wet season. A sediment sample was collected adjacent to each surface water sampling location.

Surface water and sediment samples were analyzed for the following parameters: sulfate, magnesium, calcium, arsenic, iron, manganese, molybdenum, nickel, tin, uranium, vanadium, and zinc.

**Surface Water Results
and Conclusions**

Surface water data from Hunters Creek, Thomas Creek, and the pond north of the mill buildings show that most constituents detected at the downstream locations were not greater than their respective background concentrations. Sulfate, arsenic, and molybdenum are reported as selected potential hazardous constituents of concern (*Table 10-1*). A baseline risk assessment (in preparation) will provide detailed information.

Figure 10-2
Surface Water Sediment Sampling and Ground Water
Monitoring Well Locations, Processing Site Vicinity

Table 10-1 Surface water quality results, processing site

Indicator parameter	Guideline	Upper Hunters Creek (609)	Lower Hunters Creek (608)	Confluence E. Thomas/ Warner Creek (605)	Upper E. Thomas Creek (606)	Eastern pond north of mill buildings (613)
Sulfate	250 ^a	305	257	262	257	4.5
Arsenic	0.05 ^b	0.240	0.160	0.160	0.160	0.005
Molybdenum	0.1 ^b	0.03	0.04	0.04	0.04	<0.01

^aSecondary Drinking Water Standard.
^bMaximum concentration limit.

Note: 1. Concentrations are reported in milligrams per liter. Samples were collected in October 1993.
2. < symbol indicates actual is less than the detection limit (number shown).

Surface water in the area is of two types: low-temperature and thermal. Arsenic and sulfate concentrations in the thermal water from the Hunters Hot Springs area (Upper Hunters Creek) are higher than in the low-temperature water (East Branch of Thomas Creek). The lower constituent concentrations result from low-temperature water mixing with thermal water in Upper Hunters Creek. Sulfate and arsenic concentrations are considerably lower in the eastern pond along Hammersly Creek north of the mill buildings than in either western creek.

Ground Water Monitoring

Processing Site

In 1993, ground water samples were collected at the former Lakeview processing site to monitor water quality changes that have occurred since the removal of the tailings pile, evaporation ponds, and associated contaminated soil. To assess the extent of ground water contamination caused by former processing activities, the baseline ground water quality was compared to the background ground water quality and the proposed U.S. Environmental Protection Agency (EPA) maximum concentration limits in 40 CFR Part 192. Background ground water quality is defined as the quality of ground water that would be expected at the site if uranium processing activities had not occurred. Conversely, baseline ground water quality is defined as the water quality (taken from a monitoring well) that has been influenced by uranium processing activities.

The former processing site is underlain by more than 2000 ft of unconsolidated sediments. Shallow unconsolidated silt and sandy clay (from the ground surface to approximately 20 ft deep) are underlain by

discontinuous lenses of unconsolidated to consolidated water-bearing gravels, sands, and silts. DOE monitoring wells used to characterize the ground water quality at the former processing site generally consist of clusters of two wells: a shallow well screened and filter-packed from about 16 to 30 ft deep and a deeper well screened and filter-packed from about 70 to 80 ft. *Figure 10-3* shows DOE monitoring well locations at the processing site. Only the shallow monitoring wells were sampled in 1993.

Measuring water elevations better defines ground water movement and the relationship between ground water and surface water. *Figure 10-3* shows the water table contours of the shallow ground water zone at the processing site. The water table beneath the Lakeview processing site generally occurs 4 to 10 ft below land surface, under unconfined to semiconfined conditions. Ground water moves southwest at estimated linear flow velocities of 50 ft per year in the shallow zone and 160 ft per year in the deep zone. These zones are hydraulically connected.

The following DOE monitoring wells were sampled in late August and early September 1993: 501, 503, 505, 507, 509, 518, 540, and 541. Well 501 is a low-temperature background monitoring well. The remaining wells are downgradient from the former evaporation pond area and/or the tailings pile areas (*Figure 10-3*). In December 1993, the DOE decommissioned two additional downgradient wells (525 and 526) that were irreparably damaged.

Private (domestic) wells in the processing site vicinity were also sampled in support of risk assessment, based on their proximity to the site boundary, the residence location relative to the contaminated area (i.e., upgradient, downgradient, crossgradient), and ease of access. These sampling locations included low- and high-temperature background, private locations at greatest risk, and downgradient locations beyond the extent of the plume (*Figure 10-2*). Fourteen private wells were sampled in August and/or October 1993.

DOE monitoring wells and private wells were sampled for the following field parameters: alkalinity, oxidation-reduction potential, pH, specific conductivity, and temperature. Laboratory analyses were conducted for the following analytes: calcium, chloride, iron, potassium, magnesium, sodium, silica, sulfate, arsenic, manganese, nickel, tin, total dissolved solids, turbidity (DOE wells only), vanadium, zinc, molybdenum, and uranium.

Lakeview processing site ground water quality results are summarized in *Table 10-2*. In addition to total dissolved solids and sulfate, arsenic and molybdenum were selected as indicator parameters because they have historically exceeded their maximum concentration limits. Manganese, iron, vanadium, nickel, tin, and zinc also were analyzed

Figure 10-3
Potentiometric Surface of Shallow Monitoring Wells, Processing Site

ASER94/LKV/SHALLOWMONWELLS

Table 10-2 Ground water quality results, processing site

Well location	Total dissolved solids (500 ^a)	Sulfate (250 ^a)	Arsenic (0.05 ^b)	Molybdenum (0.1 ^b)	Uranium (0.044 ^b)
Background well 501	160	3	<0.005	0.01	<0.001
Contaminated well 503	6430	2730	0.110	0.13	<0.001
Downgradient well 518	1210	323	<0.005	<0.01	<0.001
Upgradient domestic well 544	820	258	0.157	0.04	<0.001
Crossgradient domestic well 536	200	3	<0.005	<0.01	<0.001
Downgradient contaminated domestic well 548	6000	713	0.008	<0.01	<0.001

^aSecondary Drinking Water Standard.
^bMaximum concentration limit.

Note: 1. Concentrations are reported in milligrams per liter. Samples were unfiltered.
 2. All samples collected August 1993.
 3. < symbol indicates actual is less than the detection limit (number shown).

as potential health risk parameters. The major cationic and anionic constituents and the field parameters track changes in background and baseline ground water quality and in contaminant migration. Sulfate appears to best define the contaminated area. Contouring the sulfate concentration data suggests separate or bifurcated contaminated areas associated with the location of the former tailings pile and the location of the former evaporation ponds (*Figure 10-4*). These areas appear to merge in the southwestern portion of the site.

Ground Water Results and Conclusions

Ground water elevation data show that ground water flow direction has remained relatively stable over time. Water levels are expected to fluctuate as a result of natural recharge and discharge and localized pumpage in private wells.

Compared with historical water quality data, analytical results of ground water samples collected during 1993 indicate no significant changes in water quality. *Figure 10-5* graphs sulfate trends over the past 3 years. Sulfate concentrations in background ground water (monitoring well 501) are very low (less than 15 milligrams per liter [mg/L]) compared to baseline ground water concentrations (between 2600 to 3400 mg/L) in a contaminated well (monitoring well 503). Downgradient, sulfate concentrations decrease significantly with increasing distance from the processing site (monitoring well 518). *Table 10-2* compares selected ground water quality results for

Figure 10-4
Sulfate Concentrations in the Shallow Lacustrine Aquifer, Processing Site

Figure 10-5
Sulfate Concentrations Over Time in the
Lacustrine Aquifer

ASER94/LKV/SULCON

background monitoring well 501, contaminated monitoring wells 503 and 548, crossgradient monitoring well 536, upgradient monitoring well 544, and downgradient monitoring well 518.

Arsenic and molybdenum exceeded maximum concentration limits in the shallow zone in 1993. Of the potentially hazardous constituents that do not have maximum concentration limits, only chloride, manganese, iron, and sulfate exceeded background values in wells screened within this zone in 1993.

Ground water samples collected in previous years from DOE wells downgradient of the Lakeview processing site show the shallow ground water is affected by the former uranium milling activities. Two hazardous constituents, arsenic and molybdenum, are of particular concern. Manganese concentrations were significantly elevated compared to background. However,

lumber-milling activities and high concentrations occurring naturally in the area also may contribute manganese to the ground water. Therefore, elevated manganese concentrations may not be related solely to uranium processing activities.

The potential effects of elevated hazardous and nonhazardous constituent concentrations will be evaluated further in the Lakeview baseline risk assessment, scheduled for completion in 1994.

Disposal Site

Contaminated materials from the former Lakeview processing site were moved to the Lakeview (Collins Ranch) site for disposal. The disposal cell is designed to prevent contaminant migration. Ground water monitoring is required at the disposal site to ensure the disposal cell complies with applicable environmental regulations and that maximum concentration limits are not exceeded.

The Collins Ranch disposal site is underlain by up to 1000 ft of unconsolidated to consolidated sands, silts, and high-plasticity clays from ancient lakebeds.

Figure 10-6 shows DOE monitoring well locations at the Collins Ranch disposal site that were sampled in 1993. *Figure 10-6* also shows water table contours. Ground water beneath the disposal site ranges from 10 ft below land surface upgradient of the disposal cell to

Figure 10-6
Ground Water Table Contours for the Lacustrine Aquifer

ASER94/LKV/SURFMAP

125 ft below land surface downgradient of the disposal cell at the point of compliance. Unconfined to semiconfined ground water is expected within the fine silty sands and clayey silts. Ground water flows primarily southeast, with an approximate linear ground water velocity of 10 to 20 ft per year.

At the disposal cell, DOE monitoring wells (515 and 606 through 609) were sampled in late August to monitor baseflow conditions. Monitoring well 515 is the background (upgradient) monitoring well closest to the disposal cell. Wells 606 through 609 are DOE point-of-compliance monitoring wells, at the downgradient edge of the disposal cell (*Figure 10-6*). The eight point-of-compliance wells are in four monitoring well clusters; each cluster consists of two wells, a shallow well screened at approximately 100 ft below land surface, and a deeper well screened at approximately 150 ft below land surface.

Fewer (9) monitoring wells were sampled in 1993 than in past years (16). Wells not sampled in 1993 include three additional background wells farther upgradient from the disposal cell and four wells downgradient from the point-of-compliance monitoring wells. Additional background wells were not sampled in 1993 because the background historical base is sufficiently established. The four downgradient monitoring wells were not sampled because the eight point-of-compliance wells provide sufficient compliance monitoring at the point-of-compliance.

Ground water samples collected in 1993 were analyzed for the following field parameters: alkalinity, oxidation-reduction potential, pH, specific conductivity, and temperature. Laboratory analyses were conducted for the following analytes: calcium, chloride, iron, potassium, magnesium, manganese, sodium, silica, sulfate, arsenic, cadmium, chromium, molybdenum, nitrate, radium-226 plus radium-228, and total dissolved solids.

Analyzing contaminants of concern identified in the tailings pore fluids, major constituents, and field parameters may provide early warning of contaminant migration from the disposal cell.

Ground Water Results and Conclusions

Ground water elevation data at the Lakeview disposal site show the direction of ground water flow has remained relatively stable over time. Ground water levels are expected to fluctuate from variations in natural recharge (precipitation and snowmelt). Compared with historical water quality data, analytical results of ground water samples collected during 1993 indicate no significant changes in ground water quality.

Concentrations or activities of all measured hazardous constituents were below maximum concentration limits in the point-of-compliance

wells in 1993. Water quality of background ground water at the disposal site was compared to that of samples collected from the point of compliance. No significant differences were noted between the water quality upgradient of the disposal cell from that at the point of compliance. Water quality data collected from the point-of-compliance wells demonstrate the disposal cell is performing in accordance with the design requirements.

ECOLOGICAL MONITORING

A study of the rooting patterns and amount of plant cover on the Lakeview disposal cell has been ongoing since 1991. Plant excavations in 1991 and 1992 showed plant roots had grown into the top 5 inches of the radon barrier. Excavation in 1993 showed some species (tall wheat-grass and big sagebrush) had sent roots through the radon barrier into the tailings. The estimated amount of plant cover on the rock/soil matrix part of the cell (22 percent of the rock/soil matrix was covered in 1991) had decreased to 8 percent in 1993. The major reason for this decrease was a drought condition in 1992 that destroyed much of the crested wheat-grass, the most common species growing on the cell. The results of this study appear in a special report (DOE, 1992) and in field notes.

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UMTPA PROJECT

CHAPTER 11 PENNSYLVANIA SITES

PENNSYLVANIA SITES

This chapter provides detailed Uranium Mill Tailings Remedial Action (UMTRA) Project data on environmental monitoring activities conducted at the Burrell and Canonsburg, Pennsylvania, sites, during 1993 and the first quarter of 1994.

Numerous documents describe the existing environmental and construction conditions at the UMTRA Project sites. These documents, including environmental impact statements, environmental assessments, and remedial action plans, are available at the U.S. Department of Energy (DOE) UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Burrell

The Burrell site is in Indiana County in southwestern Pennsylvania. Site remedial action was completed in July 1987. Because surface remedial action is complete, air monitoring and environmental gamma radiation monitoring were not conducted in 1993. However, during 1993, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

Canonsburg

The Canonsburg site is in Washington County in southwestern Pennsylvania. Site remedial action was completed in December 1985. Because surface remedial action is complete, air monitoring and environmental gamma radiation monitoring were not conducted in 1993. However, during 1993, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

CHAPTER 11 — PENNSYLVANIA

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SITE DESCRIPTION AND LOCATION

The Burrell site is not one of the uranium processing sites designated in the Uranium Mill Tailings Radiation Control Act (UMTRCA) (42 USC §7901 *et seq.*), but is considered a vicinity property associated with the Canonsburg, Pennsylvania, site. The Burrell site is an inactive landfill 1 mile east of the borough of Blairsville (population 3595), in rural southwestern Pennsylvania (*Figure 11-1*) in Indiana County (population 89,994) (DOC, 1990). The property is bordered on the south by the Conemaugh River and on the north by the Conrail Railroad tracks. The site ranges in elevation from approximately 930 feet (ft) above mean sea level (MSL) at the Conemaugh River to approximately 1005 ft at the top of the tailings embankment. The Burrell vicinity property covers approximately 72 acres.

The Burrell site is in the humid continental climate region. This region experiences distinct seasons that are slightly moderated by the Great Lakes and the Atlantic seaboard. The average annual temperature is approximately 50 degrees Fahrenheit (°F). The average annual precipitation is 44 inches. The wind is predominantly from the west and northwest. Wind distribution reflects a strong topographical influence on local wind conditions, with an annual average wind speed of 4.7 miles per hour.

SITE HISTORY AND OWNERSHIP

The Pennsylvania Railroad owned and operated the Burrell site as a railroad landfill from 1956 to 1957. A total of 86,000 wet tons of radioactively contaminated material was removed from the Canonsburg site and placed at the Burrell site. The radioactively contaminated material was moved by railroad from Canonsburg and dumped into the landfill. The Burrell site was closed in July 1987.

Civil action in the United States District Court for the western district of Pennsylvania finalized federal acquisition of the Burrell site. In accordance with this civil action, the federal government is the recorded owner of the Burrell site, said action being filed in the office of the Indiana County Clerk. Final disposition of the case is dated December 27, 1988. The U.S. Nuclear Regulatory Commission (NRC) license for this site has not been determined.

SITE CHARACTERIZATION AND CLEANUP

A one-time disposal operation caused the radiological contamination at the Burrell site. From October 1956 through January 1957, Vitro Rare Metals Company (Vitro) disposed of radioactively contaminated materials reportedly containing carbonate cake, pitchblende, calcium fluoride, and magnesium fluoride. The total radium-226 and uranium-238 activity in the contaminated materials was estimated at 4 curies and 1.3 curies, respectively. These materials were distributed between the Conrail tracks and the ponds in the western portion of the Burrell site. Approximately 75 percent of the contaminated materials were deposited between 10 and 36 ft below the surface.

Figure 11-1
Burrell Site Location

ASER94/CAN/BUR-SITELOC

Remedial action at the Burrell site consisted of excavating all contaminated materials and placing them into a single disposal cell with a clay liner and 3-ft-thick radon barrier. Erosion protection consists of a 1-ft drain layer (coarse sand) and a 1-ft layer of riprap. Remedial action started in December 1985 and was completed in July 1987.

ENVIRONMENTAL COMPLIANCE STATUS

With surface remedial action at the Burrell site complete, the only compliance issues remaining are NRC licensing, long-term surveillance and maintenance (10 CFR Part 40), and ground water monitoring.

In compliance with the National Environmental Policy Act (42 USC §4321 *et seq.*), public scoping meetings were held in Canonsburg to gather information for the ground water programmatic environmental impact statement (in preparation).

ENVIRONMENTAL MONITORING

The U.S. Department of Energy (DOE) conducts an environmental monitoring program at the Burrell site for radiological and nonradiological materials in surface water and ground water. This program monitors quantities of radioactive material and nonradiological hazardous constituents that may be released into the environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

With surface remedial action at the Burrell site complete, air and environmental gamma radiation monitoring data were not collected for the Uranium Mill Tailings Remedial Action (UMTRA) Project environmental monitoring program in 1993.

Surface Water Monitoring

Surface water samples were collected in July 1993 from the Conemaugh River at upstream (620) and downstream (622) locations to evaluate the disposal site's potential impact to surface water (*Figure 11-2*).

Only hazardous constituents of potential concern (lead, molybdenum, nitrate, radium, selenium, uranium, and vanadium) and parameters needed for geochemical evaluation were analyzed for this site.

Surface Water Results and Conclusions

Analyses of surface water samples from the Conemaugh River show that maximum concentration limits were not exceeded by any hazardous constituents of concern. The disposal site does not impact surface water adjacent to the Burrell site.

Figure 11-2
Surface Water Sampling and Ground Water Monitoring Well Locations,
Disposal Site

ASER94/BUR/GWSAMPLOCS

Ground Water Monitoring

Ground water was sampled in July 1993 at the Burrell site to meet long-term surveillance requirements.

The Burrell site is on a sequence of unconsolidated materials overlying the bedrock. The unconsolidated materials generally consist of up to 50 ft of landfill debris, soil, clay, alluvium, and colluvium. The bedrock consists of alternating layers of shale, limestone, sandstone, siltstone, coal, and claystone of the shallow bedrock.

Ground water occurs in the unconsolidated materials under unconfined (water table) conditions and in the underlying bedrock under semiconfined to confined conditions. Depth to ground water in the unconsolidated material is more than 30 ft below land surface. Hydraulic connection is not apparent between these two units. Ground water flows southwest in the unconsolidated materials and south in the bedrock. Neither unit functions as a viable aquifer, and ground water is not used for drinking or other domestic or industrial purposes.

Monitoring wells at the Burrell site provide representative ground water samples from upgradient and downgradient areas in the unconsolidated materials (400 series) and the shallow bedrock (500 series) (*Figure 11-2*). Ten monitoring wells (420 through 424 and 520 through 524) were sampled to meet long-term surveillance requirements.

Comparing 1993 ground water quality data with the proposed U.S. Environmental Protection Agency (EPA) ground water protection standards shows background ground water quality at the Burrell site does not exceed the maximum concentration limits. For long-term surveillance monitoring, only hazardous constituents of potential concern (lead, molybdenum, nitrate, radium, selenium, uranium, and vanadium) and parameters needed for geochemical evaluation were analyzed for this site.

The indicator parameter for the Burrell site is uranium because it is the constituent most likely related to uranium disposal activities at the site.

Ground Water Results

Analyses of ground water samples from the monitoring wells indicate that hazardous constituent concentrations did not exceed the maximum concentration limits in ground water during 1993 (*Table 11-1*).

**Ground Water
Conclusions**

Ground water in the unconsolidated materials generally flows southwest toward the Conemaugh River (*Figure 11-3*). Ground water in the shallow bedrock generally flows south (*Figure 11-4*). The ground water flow pattern has remained relatively constant over time.

Hazardous constituent concentrations in ground water beneath and downgradient from the site did not exceed their maximum

Table 11-1 Ground water quality results

	Monitoring well location	Uranium ^a
Unconsolidated material		
Background	421	<0.001
Downgradient	423	0.007
Shallow bedrock		
Background	521	<0.001
Downgradient	523	0.001

^aConcentrations are reported in milligrams per liter. Sampling period is July 1993.

Note: 1. Guideline is maximum concentration limit (0.044 milligrams per liter).
2. < symbol indicates actual is less than the detection limit (number shown).

concentration limits. Shallow ground water in the unconsolidated materials and bedrock is a potential pathway for contaminant migration. This ground water is hydraulically connected with surface water in the Conemaugh River, but there is no evidence of site-related contamination in the surface water. There are no receptors in the vicinity of the site because shallow ground water is not used for drinking water or other domestic purposes.

Ground water at the Burrell site will be sampled during August or September 1994 to meet compliance requirements.

Figure 11-3
Ground Water Table of the Unconsolidated Materials, Disposal Site

ASER94/BUR/POTENSURFUNCON

Figure 11-4
Potentiometric Surface of the Shallow Bedrock, Disposal Site

**SITE DESCRIPTION
AND LOCATION**

The Canonsburg site is within the borough of Canonsburg, Washington County, in southwestern Pennsylvania, approximately 20 miles southwest of downtown Pittsburgh (*Figure 11-5*).

The Canonsburg site is bounded on the north and west by Chartiers Creek, on the east by Strabane Avenue, and on the south by the Conrail Railroad. The residential community of Canonsburg is north and east of the site. South of the site and the railroad are the township of North Strabane. The site ranges in elevation from approximately 930 to 970 feet (ft) above mean sea level (MSL). Slopes are gentle across the site except for one steep slope along the west and northwest, which drops about 30 ft to the creek bed. Shallow bedrock in this area consists of shale and siltstone. On the site, it is exposed only in the bed of Chartiers Creek and in the bottom of an erosional rill north of the site, just beyond the northeast-directed outflow channel.

Four municipalities are within a 1-mile radius of the Canonsburg site: the boroughs of Canonsburg and Houston, and the townships of Chartiers and North Strabane. Nearly 27 percent of this area is residential and is concentrated primarily in the boroughs of Canonsburg and Houston and in the village of Strabane (a residential development of North Strabane Township). This area also includes several industries and the commercial centers of Canonsburg and Houston.

The population of Washington County is 204,584. The population of the borough of Canonsburg is 9200; of Houston, 1445; of Chartiers, 7603; and of North Strabane, 815 (DOC, 1990).

The Canonsburg site is in the humid continental climatic region. This region experiences distinct seasons that are slightly moderated by the Great Lakes and the Atlantic seaboard. The average annual temperature is approximately 50 degrees Fahrenheit (°F). The average annual precipitation is 37 inches and the average annual snowfall is 45 inches. The wind is predominantly from the west-northwest, with an average annual speed of 4.7 miles per hour.

**SITE HISTORY AND
OWNERSHIP**

Standard Chemical Company owned the Canonsburg facility from 1909 to 1922, producing vanadium and then radium from Colorado Plateau carnotite ore. Vitro Rare Metals Company (Vitro) purchased the property in 1922, extracting radium and uranium salts from on-site residues and carnotite ore. The operation turned to recovering uranium from ores, concentrates, and other materials in 1942. Operations ceased by 1957. Vitro stored the remaining residues and processing wastes on the site. The real property was sold to developers in 1962, but Vitro retained title to the uranium-containing materials. In 1965, with a permit from the state of Pennsylvania, Vitro buried the radioactive contaminated materials beneath a relatively impermeable

Figure 11-5
Canonsburg Site Location

layer of slag covered by clean fill material. In 1966, the property was developed into the Canon Industrial Park. The state of Pennsylvania acquired the property in 1982.

The state of Pennsylvania currently owns the Canonsburg site. The state bought the site from Canon Development Company and numerous private owners. Title to the site is being processed for transfer from the state to the federal government, under the jurisdiction of the U.S. Department of Energy (DOE). This title transfer is required under Section 104(f)(B) of the Uranium Mill Tailings Radiation Control Act (UMTRCA) (42 USC §7901 *et seq.*).

SITE CHARACTERIZATION AND CLEANUP

Remedial action at the Canonsburg site was conducted in three areas (A, B, and C; see "Environmental Monitoring," below). The Canon Industrial Park in Area A was contaminated to depths of up to 6 ft. A large subsurface portion of Area B was contaminated by fill material placed on the original contaminated surface and as much as 20 ft of cover material placed over that. Area C contained residual radioactive material at least 10-ft deep from liquid process waste piped to a pond in that area. The pond was filled with processing waste and later covered with tailings materials and waste from nearby steel mills. Depth to ground water in the area generally varied from 10 to 20 ft. Minor ground water contamination was evidenced by elevated uranium concentrations, particularly in and around Area C (the mill site waste disposal lagoon).

The Canonsburg site was cleaned up to meet criteria established in the site remedial action plan. Approximately 172,000 cubic yards of residual radioactive material were placed in the encapsulation cell. Vicinity property material was below concentrations requiring encapsulation (100 picocuries per gram [pCi/g] for projected radium-226). Therefore, the vicinity property materials were placed in the area immediately west of the encapsulation cell and within a fenced area (after the area was surveyed to ensure no material in place exceeded the 100 pCi/g for radium-226). A clean cover at least 2 ft thick was placed over all vicinity property material. Additional vicinity property materials may be accommodated in an area designated for that purpose without affecting long-term stability of the encapsulation cell. Area C was cleaned up to meet unrestricted-use criteria in accordance with U.S. Environmental Protection Agency (EPA) regulations. The area is backfilled with clean soil and is available for release to the state of Pennsylvania. Before cover materials were placed on the cell, borings of the residual radioactive material were obtained to establish the final radium-226 concentrations in the cell and to calculate the projected radon flux. These borings verify the design criteria were met.

**ENVIRONMENTAL
COMPLIANCE
STATUS**

With surface remedial action at the Canonsburg site complete, the only compliance issues remaining are U.S. Nuclear Regulatory Commission (NRC) licensing, long-term surveillance and maintenance as defined in 10 CFR Part 40, and ground water monitoring.

In compliance with the National Environmental Policy Act (42 USC §4321 *et seq.*), public scoping meetings were held in Canonsburg to gather information for the ground water programmatic environmental impact statement (in preparation).

With surface remedial action complete, active environmental permits are not needed for the Canonsburg site.

**ENVIRONMENTAL
MONITORING**

The DOE conducts an environmental monitoring program at the Canonsburg site for radiological and nonradiological materials in surface water and ground water. This program monitors quantities of radioactive material and nonradiological hazardous constituents that may be released into the environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

With surface remedial action at the Canonsburg site complete, air and environmental gamma radiation monitoring data were not collected for the Uranium Mill Tailings Remedial Action (UMTRA) Project environmental monitoring program in 1993.

Surface Water Monitoring

Surface water samples were collected from Chartiers Creek in July 1993 at upstream (601) and downstream (602) locations to evaluate the disposal site potential impact to surface water (*Figure 11-6*).

Only hazardous constituents of potential concern (lead, molybdenum, nitrate, radium, selenium, uranium, and vanadium) and parameters needed for geochemical evaluation were analyzed for this site.

**Surface Water Results
and Conclusions**

Analyses of surface water samples from Chartiers Creek show that maximum concentration limits were not exceeded by any hazardous constituents of concern. The disposal site does not impact surface water adjacent to the Canonsburg site.

Ground Water Monitoring

Ground water was sampled in July 1993 at the Canonsburg site to meet long-term surveillance monitoring requirements and again in October 1993 to further evaluate ground water quality and for risk assessment.

The Canonsburg site is on a sequence of unconsolidated materials overlying the bedrock. The unconsolidated materials generally consist of up to 30 ft of soil, clay, alluvium, and fill material. The bedrock consists of interbedded gray and black carbonaceous shales and sandy

Figure 11-6
Surface Water Sampling and Ground Water Monitoring Well Locations,
Disposal Site

ASER94/CAN/GWSAMPS

shales, with several thin coal seams and limey shales of the shallow bedrock.

Ground water occurs in the unconsolidated materials under unconfined (water table) conditions and in the underlying bedrock under semiconfined to confined conditions. Depth to ground water in the unconsolidated materials ranges from 3 to 14 ft below land surface. These two units appear to be hydraulically connected, with a generally downward vertical gradient. Ground water generally flows north toward Chartiers Creek in the unconsolidated materials and northeast in the bedrock. Neither unit functions as a viable aquifer, and ground water is not used as drinking water or for other domestic or industrial purposes.

Monitoring wells at the Canonsburg site provide representative ground water samples from upgradient, on-site, and downgradient areas in the unconsolidated materials (400 series) and the shallow bedrock (500 series) (*Figure 11-6*).

Seven monitoring wells (410, 412 through 414, and 504 through 506) at the Canonsburg site were sampled to meet compliance monitoring requirements. Eight additional monitoring wells (422 through 425 and 507 through 510) were installed and sampled in areas not previously investigated. Nine other off-site monitoring wells (401, 402, 405 through 409, 502, and 503) also were sampled to evaluate outlying ground water quality.

Comparing 1993 ground water quality data with the maximum concentration limits of the proposed EPA ground water protection standards shows maximum concentration limits did not exceed background ground water quality standards at the Canonsburg site. Only hazardous constituents of concern and parameters needed for geochemical evaluation were analyzed for long-term surveillance monitoring. Potentially hazardous constituents for this site are lead, molybdenum, nitrate, radium, selenium, uranium, and vanadium. The list of constituents analyzed during the October/November sampling period was increased to meet risk assessment requirements, sample new monitoring wells, and sample monitoring wells not recently sampled.

The indicator parameter for the Canonsburg site is uranium because it is the constituent most likely related to uranium processing activities at this site.

Ground Water Results

Analyses of 1993 ground water samples from the monitoring wells indicate uranium concentrations exceeded the maximum concentration limit in ground water in monitoring wells in the unconsolidated materials (413) and in the shallow bedrock (506) (*Table 11-2*).

Uranium concentrations in ground water from these two monitoring wells have been consistently above the maximum concentration limit.

Table 11-2 Ground water quality results

Monitoring well location		Uranium ^a
Unconsolidated material		
Background	410	<0.001
On-site	413	0.068
Downgradient	424	<0.001
Shallow bedrock		
Background	504	0.023
On-site	506	0.500
Downgradient	510	0.004

^aConcentrations reported in milligrams per liter. Sampling period is October/November 1993.

Notes: 1. Guideline is maximum concentration limit (0.044).
 2. Monitoring wells are representative of the respective units.
 3. < symbol indicates actual is less than the detection limit (number shown).

Ground Water Conclusions

Ground water in the unconsolidated materials generally flows north-northeast toward Chartiers Creek (*Figure 11-7*). Ground water in the shallow bedrock generally flows northeast (*Figure 11-8*). The ground water flow pattern has remained relatively constant over time.

Uranium concentrations in monitoring wells 412, 413, and 506 exceed the maximum concentration limit (*Figure 11-9*) ground water quality beneath and downgradient from the site. Uranium is the key indicator of site-related contaminant migration in ground water beneath the Canonsburg site. Uranium is mobile in ground water because of the neutral pH conditions and apparent abundance of bicarbonate acting as a complexing agent. The shallow ground water in the unconsolidated materials and bedrock is a potential pathway for contaminant migration. This ground water is hydraulically connected with surface water in Chartiers Creek, but there is no evidence of site-related contamination in the surface water. There are no receptors in the vicinity of the site because shallow ground water is not used as drinking water or for other domestic or industrial purposes.

Figure 11-7
Potentiometric Surface of the Unconsolidated Materials, Disposal Site

ASER94/CAN/POTENURN

Figure 11-8
Potentiometric Surface of the Shallow Bedrock, Disposal Site

ASER94/CAN/POTGWSHAL

Figure 11-9
Uranium Concentrations in the Unconsolidated Material and Shallow Bedrock,
Disposal Site

Ground water at the Canonsburg site will be sampled again in August or September 1994 to meet compliance requirements.

REFERENCES

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42 USC §7901, *Uranium Mill Tailings Radiation Control Act*, November 8, 1978.

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CHAPTER 12 TEXAS SITE

Texas Site

This chapter provides detailed Uranium Mill Tailings Remedial Action (UMTRA) Project data on environmental monitoring activities conducted at the Falls City, Texas, site during 1993 and the first quarter of 1994.

Numerous documents describe the existing environmental and construction conditions at the UMTRA Project sites. These documents, including environmental impact statements, environmental assessments, and remedial action plans, are available at the U.S. Department of Energy (DOE) UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Falls City

The Falls City site is in Karnes County in southeast Texas. During 1993, the air was monitored for thorium-230 and radon-222. Environmental gamma radiation monitoring was conducted, as well. Only the data found to be statistically above background concentrations are reported here. In 1993, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters are discussed here.

CHAPTER 12 — TEXAS

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SITE DESCRIPTION AND LOCATION

The Falls City Uranium Mill Tailings Remedial Action (UMTRA) Project site is in Karnes County, Texas, approximately 8 miles southwest of the town of Falls City and 46 miles southeast of San Antonio, Texas (*Figure 12-1*). The tailings site at Falls City consists of two parcels: Parcel A (the former mill site, one mill building, five tailings piles, and one tailings pond northwest of the intersection of Farm-to-Market Road 1344 [FM-1344] and FM-791) and Parcel B (a tailings pile north of the intersection of FM-1344 and FM-791).

The Falls City area is primarily agricultural (cattle grazing and cropland), with about 14 farmhouses within 1 mile of the site. Open pit mines are scattered throughout the area. About 460 persons live in Falls City; approximately 4337 live in Karnes County (DOC, 1990).

The average annual rainfall is 30.3 inches per year. The greatest rainfall occurs in late spring, summer, and early fall. The average annual rainfall reported from the San Antonio International Airport from 1951 through 1980 was 26.8 inches. Winds are predominantly northerly in the winter and southeast to southerly in the spring, summer, and fall (*Figure 12-2*). From 1951 through 1980, the average maximum temperature for San Antonio was 77 degrees Fahrenheit (°F), while the average minimum was 55°F.

SITE HISTORY AND OWNERSHIP

In 1954, the first shallow uranium ore deposits were discovered in western Karnes County, Texas. These discoveries of uranium, the first in the Gulf Coastal Plain, led to intensive exploratory drilling. Susquehanna Western, Inc., built and operated a uranium mill at the Falls City site from April 1961 until August 1973. The mill used a sulfuric acid leach extraction process to treat approximately 2.5 million tons of ore averaging 0.16 percent uranium oxide; more than 3.1 million tons of waste were discharged to tailings ponds 1 through 7. More than 700 tons of uranium oxide concentrate (yellow cake) were sold to the U.S. Atomic Energy Commission while the mill was in operation. Currently, the state of Texas owns the site, but the title is being processed for transfer to the federal government.

Waste tailings and processing solutions from the Susquehanna Western, Inc., milling operation were impounded in seven separate ponds, four of which had been open pit mines excavated into the ore-bearing sandstone. The tailings ponds were 30 to 35 feet (ft) deep and unlined, except for natural-clay foundation soils and sediments.

In 1975, the mill site and residual tailings piles were sold to Solution Engineering, Inc., and its partner, Basic Resources, Inc. From late 1978 to early 1982, Solution Engineering, Inc., conducted secondary solution mining of uranium from four of the piles (piles 1, 2, 4, and 7). Their operation included a system of shallow injection/recovery

Figure 12-1
Falls City Site Location

Figure 12-2
Wind Rose

Ref: DOE, 1991.
Cumulative data 1979 through 1985.

ASER94/FCT/WINDFCT

wells and an ion exchange resin/carbon bed treatment system to recover uranium and molybdenum from solution. The uranium leaching agent was acid water from tailings pond 7. Residual process waters were pumped back to this pond. All ponds were evaporated except for pond 6, which is thought to have been recharged by natural seepage. Spent filter carbon, extracted molybdenum, and calcium carbonate wastes were stored in drums for eventual off-site disposal or dumped into a small pit adjacent to the northern border of tailings pile 1. In 1993, small amounts of the original tailings surrounded the perimeter of pond 6 and may have been present in the sediment.

SITE CHARACTERIZATION AND CLEANUP

One mill building remained intact in the mill site area. Most of the area was fenced. Windblown contamination was associated with Parcel A (tailings piles 1, 2, 4, 5, 6, and 7) and Parcel B (pile 3). Windblown contamination, the tailings piles, and the pond in Parcel A covered 459 acres. Pile 3 and windblown contamination in Parcel B covered 132 acres. Parcels A and B contained an estimated 5.5 million cubic yards of contaminated materials.

Before remediation, the Falls City, Texas, site contained 4,509,000 cubic yards of residual radioactive material. By the end of 1992 (December 31, 1992), approximately 1,809,000 cubic yards of the

residual radioactive material had been placed in the disposal cell. By the end of 1993, an additional 1,668,000 cubic yards (all residual radioactive material) had been placed in the disposal cell. Placement of the radon barrier layer and riprap and revegetation activities, begun late in 1993, were completed in early 1994.

The disposal cell, which was completed in the spring of 1994, consists of an earthen embankment (containing the residual radioactive materials) and a multilayer cover. All buildings were demolished and residual radioactive materials around the tailings pile were excavated. The demolition debris and excavated materials were placed in the existing pile to form a single disposal embankment. The embankment cover consists of compacted clay to limit radon emissions and precipitation infiltration. A coarse sand drain layer and 6 to 12 inches of rock armor protect the embankment from erosion and from intrusion by vegetation; using only natural materials in the cell cover ensures the required longevity of the disposal cell.

ENVIRONMENTAL COMPLIANCE STATUS

In accordance with U.S. Department of Energy (DOE) policy, the UMTRA Project at Falls City, Texas, complies with all applicable federal and state environmental regulations. Remedial action activities are continuously evaluated for environmental impact and to ensure that they meet applicable regulatory requirements. In 1993, Falls City site environmental activities included compliance with the Clean Water Act (33 USC §1251 *et seq.*) for monitoring and discharging liquid effluents to surface waters; the Clean Air Act (42 USC §7401 *et seq.*) for controlling fugitive dust; the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC §9601 *et seq.*) for reporting certain quantities of hazardous materials used or stored at the site; community right-to-know, Spill Prevention Control and Countermeasures Plan regulations, transportation, and local (conditional use and highway access permits) regulations.

Superfund Amendments and Reauthorization Act

Under the Superfund Amendments and Reauthorization Act (SARA) (Public Law 99-499), an amendment to CERCLA, the Falls City site must comply with the Title III emergency planning and community right-to-know requirements. These requirements include notifications for threshold planning quantities of hazardous materials and notifications for reportable quantities of extremely hazardous materials, if spills occur.

In 1993, the site was in compliance with the requirements of SARA Title III, Section 311, having developed a site inventory for all materials stored on the site in excess of 10,000 pounds or in excess of the threshold planning quantities for extremely hazardous materials. The inventory included diesel fuel, oil, sulfuric acid, automotive maintenance fluids, and uranium mill tailings and was submitted to the

state Emergency Response Commission, the local emergency planning committee, and the local fire department.

In 1993, the site was in compliance with the requirements of SARA Title III, Section 312, having developed and submitted Tier II reporting forms for the 1992 inventoried materials to the state Emergency Response Commission, the local emergency planning committee, and the local fire department on March 1, 1993.

Clean Water Act

National Pollutant Discharge Elimination System

A wastewater discharge permit (TWC-3382) was issued for the site in January 1993 by the Texas Water Quality Commission. The Falls City site did not discharge wastewater in 1993. An industrial activity storm water permit (TXR00B708) was issued to the site in May 1993. The Falls City site did not discharge water in 1993.

Spill Prevention Control and Countermeasures Plan

In 1993, earthen berms had already been designed and constructed around existing aboveground storage tanks and drum storage areas. This secondary containment system provides adequate spill control. In addition, plans for berm inspection, spill detection, emergency spill response, and spill cleanup were developed for fuel, oil, and other storage areas.

Septic/Holding Tanks

In 1993, waste from the Falls City office facilities went into septic or holding tanks. These tanks meet local codes and are emptied at least yearly or as required.

National Environmental Policy Act

In compliance with the National Environmental Policy Act (42 USC §4321 *et seq.*), a public scoping meeting was held in Falls City to gather information for the ground water programmatic environmental impact statement (in preparation).

Safe Drinking Water Act

The UMTRA Project does not own or operate a drinking water supply at any site. Each site uses the services of the local, publicly owned treatment works for all potable water. Bottled water is purchased from appropriate vendors for use at remote locations. Proper well abandonment techniques are followed to protect area drinking water resources.

National Historic Preservation Act

Consultation with the Texas State Historic Preservation Officer determined that cultural resource surveys are not required for the Falls City site or for the two borrow sites. A cultural resource survey of a third borrow site identified one prehistoric site that is eligible for listing in the National Register of Historic Places. This area was avoided during remedial action; therefore, a data recovery program was not needed. The Falls City environmental assessment (DOE, 1991)

includes a record of the consultation with the state historic preservation officer and the cultural resource survey.

Clean Air Act

The state of Texas Air Quality Control Board has regulatory authority over fugitive dust emissions (total suspended particulates) and other air quality standards. The Falls City site was not required to monitor fugitive dust emissions in 1993, although 1993 site activities complied with fugitive dust requirements by using water sprays to control dust and limiting vehicle speeds.

**Hazardous Materials
Transportation Act**

All materials transported at the Falls City site were in full compliance with all applicable requirements of the Hazardous Materials Transportation Act (49 USC §1801 *et seq.*).

The DOE acquired an exemption (E-10594) from the U.S. Department of Transportation (DOT) to transport the tailings in bulk shipments. The exemption grants the use of special markings for haul trucks, shipping documentation, and training to address tailings hazards. Approximately 3,477,000 cubic yards of tailings were hauled from the site under exemption E-10594 in 1993 and all requirements of the exemption were in compliance.

Noise Control

Following the requirements of DOE Order 6430.1A, *General Design Criteria*, in March 1993, the Falls City site revised a noise minimization plan to evaluate and monitor site activities for noise impact to the surrounding community. The plan was implemented in November 1993. No noise-related complaints were received in 1993.

**Environmental
Compliance Permits**

The Falls City site obtained and operated under all required permits in 1993. *Table 12-1* lists all applicable environment-related active permits under which the Falls City site operated from January 1, 1993, to April 1994.

**ENVIRONMENTAL
MONITORING**

The DOE implements a detailed environmental monitoring program for radiological and nonradiological materials at the Falls City site, including environmental gamma-dose equivalent and radionuclide and nonradionuclide concentrations in air, surface water, and ground water. This program monitors quantities of radioactive material and nonradiological hazardous constituents that may be released into the environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

Air Monitoring

*Nonradiological Air
Particulate Monitoring*

The Falls City site was not required to monitor fugitive dust emissions (total suspended particulates) in 1993.

Table 12-1 Active Permits

Permit description	Submittal date	Preliminary approval date	Final approval date	Permit number	Expiration date
National Pollutant Discharge Elimination System					
Wastewater discharge	10/93	7/93	10/93	TX01070468	7/95
Storm water discharge (construction activity)	8/93	6/93	8/93	TXR10F397	Not listed
Storm water discharge (industrial activity)	9/92	10/92	5/93	TXR00B708	9/97
State wastewater discharge (Texas Water Commission)	1/93	9/91	1/93	TWC3382	1/98

NA—Not applicable in 1993.

Radiological Air Particulate Monitoring

Radiological air particulate monitoring at the Falls City site was conducted at Stations 1 through 5, which were collocated with active radon monitoring stations (*Figure 12-3*). Stations 2 and 4 were established to give additional information for residential locations. Station 1 provided background measurements.

None of the stations reported concentrations statistically different from background (106×10^{-16} microcuries per milliliter [$\mu\text{Ci/mL}$]). In addition, the estimated annual average thorium-230 concentration at all stations was well below the thorium-230 average annual guideline of $500 \times 10^{-16} \mu\text{Ci/mL}$ above background, indicating radioactive particulate releases from remedial action were not significant.

Radon Monitoring

Real-Time Radon Monitoring. Background radon concentrations were measured at Station 1, south of the site. Station 5 was discontinued on October 1, 1993. *Figure 12-3* shows the locations of the real-time radon monitoring stations.

Figure 12-4 shows the 1993 quarterly average radon concentrations for all locations statistically above background at the Falls City site. The annual average background radon concentration measured at Station 1 was $0.73 \times 10^{-9} \mu\text{Ci/mL}$. Although radon concentrations were greater than background levels ($1.10 \times 10^{-9} \mu\text{Ci/mL}$ for Station 3 and $0.88 \times 10^{-9} \mu\text{Ci/mL}$ for Station 4), they were much less than the DOE guideline of $3 \times 10^{-9} \mu\text{Ci/mL}$ above background. The elevated concentrations at the Falls City site should return to background levels when remedial action is complete.

Passive Radon Monitoring. Five stations were established around the site. Background monitoring was performed at Station 1 south of

Figure 12-3
Environmental Air and Gamma Radiation Monitoring Stations

ASER94/FCT/ENVMONLOCS

Figure 12-4
Real-Time Radon Concentrations

ASER94/FCT/TAB2

the site. *Figure 12-3* illustrates locations of passive radon detectors at the Falls City site.

The annual average background radon concentration measured at Station 1 was $0.9 \times 10^{-9} \mu\text{Ci/mL}$. None of the reported annual average concentrations were statistically different from background and they were all much lower than the DOE guideline.

Air Monitoring Conclusions

All measured concentrations of thorium-230 particulate and radon-222 were lower than the applicable guidelines. No significant releases occurred at this site during 1993.

Environmental Gamma Radiation Monitoring

A network of thermoluminescent dosimeters around the site perimeter measured penetrating gamma radiation at the Falls City site (*Figure 12-3*).

Nineteen dosimetry monitoring stations were active in 1993. Background dose is measured at Station 1, southeast of the site.

An unusually high reading (591 ± 65 millirems [mrem] per year) occurred at Station 7 because it was located on an outcropping of naturally existing uranium ore. The annual background dose

equivalent was 99 ± 11 mrem at Station 1. Of the locations for which annual dose equivalents are available, only stations 6, 12, and 13 were statistically different from background (*Figure 12-5*).

Figure 12-5
Environmental Gamma Radiation Monitoring

ASER94/FCT/TAB4

None of the annual dose equivalents greater than background exceeded the DOE guideline of 100 mrem per year above background. After remedial action is complete, dose equivalents are expected to return to near-background levels.

Environmental Gamma Radiation Monitoring Conclusions

Station 7 recorded elevated environmental gamma radiation levels because it was located above a natural outcropping of uranium ore, and the elevated radiation level reflects the natural conditions not related to uranium milling or remedial action. Therefore, Station 7 is not indicative of site-related activities and it is not included in *Figure 12-5*. All other stations recorded levels less than the applicable guideline. No significant releases occurred at this site in 1993.

Surface Water Monitoring and Results

Surface water was monitored for radiological contaminants to assess the potential environmental impacts of site remedial action activities. *Table 12-2* gives the results of the surface water analysis. Upstream monitoring was not possible because both Tordilla Creek and Scared Dog Creek are intermittent streams. These streams did not have enough water to sample. The downstream results were well below the guidelines given for water concentrations in DOE Order 5400.5, *Radiation Protection of the Public and the Environment*.

Table 12-2 Radiological surface water results, downstream

Location	Radionuclide	Quarter				Limit ^a
		1	2	3	4	
Tordilla Creek	Radium-226	b	2.3 ± 1.6	5.0 ± 1.2	2.8 ± 0.8	100
	Thorium-230	b	1.3 ± 1.0	2.6 ± 1.2	1.4 ± 0.4	300
Scared Dog Creek	Radium-226	b	4.3 ± 2.1	b	4.1 ± 1.3	100
	Thorium-230	b	1.9 ± 1.1	b	4.8 ± 1.4	300

^aGuidelines are from DOE Order 5400.5, *Radiation Protection of the Public and the Environment*.
^bSamples could not be obtained.

Note: Concentrations are reported in 1×10^{-9} $\mu\text{Ci/mL}$. All errors reported as twice the standard error of the mean.

Ground Water Monitoring

The Falls City site is underlain by sedimentary rock that dips gently southeast. These strata are composed locally of generally unlithified sand, silt, and clay deposits. The site rests on outcrops of the Dubose Clay Member, Deweesville Sandstone Member, Conquista Clay Member, and the Dilworth Member of the Whitsett Formation. The Deweesville/Conquista and Dilworth aquifers are two low-yield aquifers that occur in the upper 100 to 200 ft of the Whitsett Formation sediments underlying the site.

Ground water elevations were measured and samples were collected from 30 monitoring wells at the Falls City site during two sampling rounds in 1993. Potentiometric surface maps for the Deweesville/Conquista and Dilworth aquifers are shown in *Figures 12-6 and 12-7*, respectively.

The ground water monitoring network consists of 25 wells screened in the Deweesville/Conquista aquifer and 5 wells screened in the underlying Dilworth aquifer. The Deweesville/Conquista aquifer monitoring wells are within or just beyond the edge of four contaminated areas identified at the site. Due to disposal cell construction activities, all monitoring wells screened in the ground

Figure 12-6
Potentiometric Surface of the Deweesville/Conquista Aquifer

Figure 12-7
Potentiometric Surface of the Dilworth Aquifer

ASER94/FCT/DILPOTEN

water contamination in the Dilworth aquifer beneath pile 4 were decommissioned and no longer exist. Ground water sampling in the Dilworth aquifer consisted of sampling five wells, primarily to monitor background and downgradient ground water quality conditions. *Figure 12-8* shows the sampling locations for Deweesville/Conquista and Dilworth aquifers.

The last water quality sampling round was completed in January 1994. The next regularly scheduled water quality sampling round is scheduled for September 1994.

Ground Water Results and Conclusions

Ground water geochemistry at the Falls City site is complex because no single ground water quality parameter can quantify the extent of ground water contamination. Therefore, several indicator parameters related to uranium processing activities were selected for analysis: aluminum, calcium, sulfate, and uranium. Aluminum is a good indicator of acidic conditions. Examining calcium-to-sulfate ratios in ground water distinguishes natural mineralization from tailings seepage. Uranium occurs naturally as well in tailings seepage. *Table 12-3* shows ground water quality data for the Deweesville/Conquista and Dilworth aquifers.

Results from the two 1993 sampling rounds show that concentrations of arsenic, cadmium, chromium, molybdenum, nitrate, selenium, and uranium and activities of net gross alpha, radium-226, and radium-228 exceeded maximum concentration limits in Deweesville/Conquista aquifer ground water beneath the site. Concentrations of arsenic and uranium and activities of net gross alpha, radium-226, and radium-228 exceeded maximum concentration limits in Dilworth aquifer ground water beneath the site.

Contamination from the uranium processing activities is still in ground water at the Falls City site. Contaminant migration in ground water from the Deweesville/Conquista aquifer may be occurring but the extent of contamination is not known because so few monitoring wells were placed in off-site locations (*Figure 12-9*).

Figure 12-8
Ground Water Monitoring Well Locations

ASER94/FCT/GWSAMPLOCS

Table 12-3 Ground water quality data

Deweeseville/Conquista aquifer				
Indicator parameter	Guideline	Background well 951	Contaminated well 880	Downgradient well 922
Aluminum	0.05 - 0.2 ^a	0.05	58.8	<0.05
Calcium	NA	338	480	725
Sulfate	250 ^a	910	11200	2080
Uranium	0.044 ^b	0.0162	1.38	<0.001
Dilworth aquifer				
Indicator parameter	Guideline	Background well 968	Contaminated well 834	Downgradient well 902
Aluminum	0.05 to 0.2 ^a	<0.05	<0.05	0.11
Calcium	NA	67	351	171
Sulfate	250 ^a	141	1100	662
Uranium	0.044 ^b	0.094	0.0018	<0.001

^aSecondary Drinking Water Standard.

^bMaximum concentration limit (0.44 mg/L) is the mass equivalent of 30 pCi/L, assuming uranium-234 and uranium-238 are in equilibrium.

NA - Not available.

Notes: 1. Ground water samples were collected September 1993. Results are reported in milligrams per liter.

2. Monitoring well 951 was last sampled in June 1992.

3. Monitoring well 834 is the only Dilworth well located in the plume and was destroyed during construction of the disposal cell. It was last sampled in December 1991.

4. < symbol indicates actual is less than the detection limit (number shown).

Figure 12-9
Distribution of Tailings-Contaminated Ground Water

1000 0 1000 2000 Feet

ASER94/FCT/APPROXDIS

REFERENCES

DOC (U.S. Department of Commerce), 1990. *Census of Population: General Population Characteristics, Economics and Statistics Administration, Bureau of the Census, Washington, D.C.*

DOE (U.S. Department of Energy), 1991. *Environmental Assessment of Remedial Action at the Falls City Uranium Mill Tailings Site, Falls City, Texas*, DOE/EA-0468, prepared by the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

DOE Orders

Order 5400.5, *Radiation Protection of the Public and the Environment*, February 8, 1990, U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Order 6430.1A, *General Design Criteria*, April 6, 1989, U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Public Law

99-499, Superfund Amendments and Reauthorization Act, amendment to CERCLA, October 17, 1986.

United States Codes

16 USC §470 *et seq.*, *National Historic Preservation Act*, October 15, 1966.

33 USC §1251 *et seq.*, *Clean Water Act*, October 18, 1972.

42 USC §300f *et seq.*, *Safe Drinking Water Act*, December 16, 1974.

42 USC §4321 *et seq.*, *National Environmental Policy Act*, January 1, 1970.

42 USC §7401 *et seq.*, *Clean Air Act*, December 17, 1963.

42 USC §9601 *et seq.*, *Comprehensive Environmental Response, Compensation, and Liability Act*, December 11, 1990

49 USC §1801 *et seq.*, *Hazardous Materials Transportation Act*, January 3, 1975.

CHAPTER 13 UTAH SITES

UTAH SITES

This chapter provides detailed Uranium Mill Tailings Remedial Action (UMTRA) Project data on environmental monitoring activities conducted at the Green River, Mexican Hat, and Salt Lake City, Utah, sites during 1993 and the first quarter of 1994.

Numerous documents describe the existing environmental and construction conditions at UMTRA Project sites. These documents, including environmental impact statements, environmental assessments, and remedial action plans, are available at the U.S. Department of Energy (DOE) UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Green River

The Green River site is in Grand County in eastern Utah. Site remediation was completed in 1989. Because surface remedial action is complete, air monitoring and environmental gamma radiation monitoring were not conducted in 1993. However, during 1993, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters at this site are discussed here.

Mexican Hat

The Mexican Hat site is on Navajo Nation land approximately 1.5 miles southwest of Mexican Hat, Utah. The site is undergoing remedial action. During 1993, the air was monitored for both thorium-230 particulate and radon-222. Environmental gamma radiation monitoring was conducted, as well. Only the data found to be statistically above background concentrations are reported here. In addition, ground water was monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters at this site are discussed here. Due to the lack of available surface water at the site, surface water samples were not collected during 1993.

Salt Lake City

The Vitro processing site is in Salt Lake County; the South Clive disposal site is in Tooele County. Both sites are in northern Utah. Remedial action at the Vitro processing site was completed in 1988; air monitoring and environmental gamma radiation monitoring were not conducted at this site in 1993. However, during 1993, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters at this site are discussed here.

CHAPTER 13 — UTAH

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SITE DESCRIPTION AND LOCATION

The Green River Uranium Mill Tailings Remedial Action (UMTRA) Project disposal site is in Grand County, Utah, about 1.5 miles southeast of the city of Green River, in east central Utah (*Figure 13-1*). The main track of the Denver & Rio Grande Western Railroad is north of the site and U.S. Highway 70 is south of the site. Brown's Wash, an intermittent stream, lies between the railroad tracks and the disposal site and joins the Green River west of the site. The disposal site is in the northern part of the Canyon Lands section of the Colorado Plateau, which is bordered on the north by the Book Cliffs and on the south by the San Rafael Valley. The area contains flat to hilly terrain, cliffs, mesas, and the Gray Canyon of the Green River. The site lies at an elevation of approximately 4100 feet (ft). The Green River is approximately 3000 ft west of the disposal site. The physiography of the immediate area is described as the Mancos Shale Lowland and Green River Desert.

Historically, population growth in the Green River area is related primarily to uranium mining and milling activities. Beginning in 1980, the population began to decline as energy exploration and production decreased, area uranium mines closed, and other employment opportunities dwindled. The population of Grand County is 6620; the population of Green River is 866 (DOC, 1990).

The climate in the Green River area is arid, with large ranges in daily and annual temperatures. From 1951 through 1980, annual temperatures averaged 52 degrees Fahrenheit (°F), ranging from 23°F in January to 78°F in July.

The average annual precipitation at Green River from 1951 through 1980 was 6 inches; the average annual snowfall was 10 inches. Rainfall was fairly evenly distributed throughout the year.

SITE HISTORY AND OWNERSHIP

The Green River site is owned by the state of Utah, which acquired it from Umetco Minerals Corporation on December 8, 1988. Title to the site is being processed for transfer from the state to the federal government, under the jurisdiction of the U.S. Department of Energy (DOE). This title transfer is required under Section 104 (f)(B) of the Uranium Mill Tailings Radiation Control Act (UMTRCA) (42 USC §7901 *et seq.*).

The mill at the Green River site was built in 1957 by Union Carbide Corporation. Operating from March 1958 through January 1961, the mill processed 183,000 tons of ore averaging 0.29 percent uranium oxide; the ore concentrate was shipped by rail to the company's processing plant in Rifle, Colorado.

Figure 13-1
Green River Site Location

ASER94/GRN/SITELOC

**SITE
CHARACTERIZATION
AND CLEANUP**

Remedial action began in November 1988 and was complete in September 1989. Mill tailings, the windblown contaminants stockpile, and the vicinity property contaminants stockpile were stabilized on the former processing site in a permanent disposal facility. The excavated tailings and residual radioactive materials consist of approximately 382,000 cubic yards of material. After remedial action, the area of excavation was backfilled, graded to promote surface drainage, and revegetated. All other areas disturbed at the site by remedial action were backfilled and graded to promote surface drainage.

**ENVIRONMENTAL
COMPLIANCE
STATUS**

With surface remedial action at the Green River site complete, the remaining surface-related compliance issues include U.S. Nuclear Regulatory Commission (NRC) licensing under the provisions of 10 CFR Part 40 for long-term surveillance and maintenance of the completed disposal site, including point-of-compliance ground water monitoring, as defined in the site long-term surveillance plan (DOE, 1992). Under the UMTRA Ground Water Project, ground water, surface water, and sediment samples are collected and analyzed to further evaluate the ground water contamination resulting from the former uranium processing site activities. The site baseline risk assessment (in preparation) and the site water sampling and analysis plan (DOE, 1993) address this evaluation and the sampling requirements in detail.

**ENVIRONMENTAL
MONITORING**

The DOE conducts an environmental monitoring program at the Green River site for radiological and nonradiological materials in surface water and ground water. This program monitors quantities of radioactive material and nonradiological hazardous constituents that may be released into the environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

With surface remedial action at the Green River site complete, air and environmental gamma radiation monitoring data were not collected for the UMTRA environmental monitoring program in 1993.

Surface Water Monitoring

Surface water features in the vicinity of the Green River site include the Green River, Brown's Wash, and several ephemeral drainages.

Completed in 1989, the disposal cell is on an elevated alluvial terrace approximately 600 ft south of Brown's Wash. No surface water features are closely associated with the disposal cell.

In past years, surface water samples were collected from the Green River and Brown's Wash. Samples collected from the Green River were obtained upstream and downstream from the confluence of Brown's Wash and the Green River. Analysis of these samples

indicates the former uranium milling processes have not affected the water quality of the Green River.

Brown's Wash is an ephemeral stream that flows only during prolonged rainy seasons and storm events. Because of the difficulty in collecting samples from Brown's Wash when it is flowing, most samples were collected from stagnant pools of water. Analysis of these samples indicates the surface water in the wash is affected by the former uranium milling processes. Constituent values range from below maximum concentration limits upstream from the processing site area to above maximum concentration limits adjacent to and downstream from the processing site area.

Surface water samples were collected at only one location near the processing site area in 1993, in support of the baseline risk assessment. *Figure 13-2* shows the location of surface sample 718, which is downstream from the processing site area. Stagnant ponded water was collected from pools standing on a hard, bedrock surface.

Parameters sampled at location 718 include calcium, cadmium, magnesium, molybdenum, nitrate, selenium, and uranium. Analytical results for nitrate, selenium, and uranium are illustrated in *Table 13-1*.

Surface Water Results

Analytical results indicate that nitrate, selenium, and uranium are above maximum concentration limits. Molybdenum and cadmium either were not detected or were detected at concentrations less than maximum concentration limits.

Surface Water Conclusions

Elevated levels of nitrate, selenium, and uranium at Brown's Wash surface location 718 are due to a combination of the following factors:

- Natural presence of constituents.
- Concentration of constituents as they evaporate from standing water.
- Sampling techniques.
- Contribution of contaminated ground water from the processing site through seeps along Brown's Wash.

Ground Water Monitoring

The Green River site consists of the remediated processing site area and the disposal cell. Ground water was monitored in both areas in 1993.

Figure 13-2
Ground Water Monitoring Well Locations, Processing Site

ASER94/GRN/SAMPLOCS

Table 13-1 Surface water quality results

Parameter	Date	Guideline ^a	Location 718
Nitrate	09/93	44	1160
Selenium	09/93	0.05	0.77
Uranium	09/93	0.044	1.89

^aMaximum concentration limit.

Notes: 1. Sample was unfiltered.
2. Results are reported in milligrams per liter.

Processing Site

Figure 13-2 shows the locations of processing site area monitoring wells sampled in December 1993 to support the baseline risk assessment. These locations include monitoring wells 582, 583, 584, 585, 588, 707, 806, 810, 811, and 817. Monitoring well 707 is completed in Brown's Wash alluvium. The remaining monitoring wells are completed in sandstones, shales, siltstones, and limestones of the Cedar Mountain Formation.

Monitoring well locations 702, 704, 705, 708, completed in the Brown's Wash alluvium, are decommissioned. They are shown in *Figure 13-2* because they provide the most recent data regarding the direction of ground water flow and plume location in the Brown's Wash alluvium. Information from these wells is relevant because the uranium mill tailings were stored near Brown's Wash before remediation. Contamination from the tailings seeped into the alluvium.

Figure 13-3 illustrates the ground water table for the unconfined alluvial aquifer in Brown's Wash in January 1988. *Figure 13-4* illustrates the uranium contamination for the unconfined alluvial aquifer in Brown's Wash in January 1988. These are the most recent data collected before monitoring wells 702, 704, 705, and 708 were decommissioned. At that time, the contamination was migrating in the direction of ground water flow.

It can be reasonably assumed that ground water still flows in the direction illustrated by 1988 data. However, the present configuration of the uranium contamination is uncertain.

Ground Water Results

Table 13-2 gives the results of the last 3 years of ground water quality monitoring for wells 707, 806, and 584. Well 707 is shown because it is the only remaining well completed in the alluvium. Well 806 is

Figure 13-3
Ground Water Table of the Brown's Wash Alluvium, Processing Site

LEGEND	
	707
4070.20	Ground water elevation (ft above MSL), January 1988
	705
4063.50	Ground water elevation (ft above MSL), January 1988
	Direction of ground water flow
4064	Ground water elevation contour (ft above MSL)
====	Dirt road

Figure 13-4
Uranium Concentrations in the Brown's Wash Alluvium, Processing Site

Table 13-2 Ground water quality results, processing site

Indicator parameter	Guideline	Monitoring well location		
		707	806	584
Uranium	0.044 ^a			
01/92		0.022	0.001	0.003
07/92		0.021	0.005	0.002
12/93		0.017	ND	0.001
Nitrate	44 ^a			
01/92		24.7	ND	ND
07/92		27.1	1.22	ND
12/93		24.5	ND	ND
TDS	500 ^b			
01/92		10,100	2440	5410
07/92		9170	2420	5240
12/93		9780	2390	5420
Arsenic	0.05 ^a			
01/92		ND	ND	ND
07/92		ND	ND	ND
12/93		<0.005	<0.005	<0.005
^a Maximum concentration limit. ^b Secondary Drinking Water Standard. ND - Not detected. TDS - Total dissolved solids. Note: 1. Results reported in milligrams per liter. 2. < symbol indicates actual is less than the detection limit (number shown).				

in the shallow bedrock nearby and well 584 is representative of shallow bedrock ground water quality distant from both the disposal cell and processing site (about 2000 ft downgradient from the processing site and about 1200 ft downgradient of the disposal cell).

Ground Water Conclusions

The following conclusions can be drawn from monitoring ground water levels and quality in the processing site area:

- Ground water in the alluvium near the processing site flows northwest along Brown's Wash.

- Concentrations of hazardous constituents in the remaining disposal cell monitoring wells are below background or maximum concentration limits, although a small area of uranium contamination existed in 1988 in portions of Brown's Wash.
- Uranium levels in the alluvium are 1 order of magnitude higher than those in the bedrock, reflecting the influence of the milling process and the relative isolation of alluvium ground water from the bedrock.

Disposal Cell

Ground water was sampled three times from disposal cell monitoring wells during 1993 to comply with long-term surveillance and monitoring requirements. The ground water protection strategy at the disposal cell requires that concentrations of designated hazardous constituents in point-of-compliance monitoring wells downgradient from the disposal cell must meet either the maximum concentration limits or background concentration limits. Parameters that were sampled include total dissolved solids, uranium, selenium, nitrate, sulfate, and several radionuclides.

Figure 13-5 illustrates the point-of-compliance monitoring network at the Green River site, which consists of seven downgradient and crossgradient monitoring wells (171 to 176 and 813) and four background wells (177 to 180). (A point-of-compliance well is at a location where ground water quality must meet specific standards.) These monitoring wells are completed in sandstones and fine-grained rocks of the Cedar Mountain Formation. The alluvium is very thin or absent at the disposal site, unsaturated, and not monitored. The disposal site was sampled in January, June to August, and December 1993.

Figure 13-6 illustrates the potentiometric surface of the aquifer underlying the disposal cell in October 1993 and shows ground water flows northwest.

Ground Water Results

Table 13-3 lists the 1993 concentration values for nitrate, uranium, arsenic, and total dissolved solids. The samples were collected from upgradient monitoring well 179, crossgradient well 176, and downgradient well 813.

Nitrate and uranium are below background concentration limits. Arsenic exceeds the background concentration limit (0.06 milligrams per liter [mg/L]) in well 813. The arsenic exceedance does not reflect a failure of the disposal cell for the following reasons:

- Arsenic has never been detected in any crossgradient or downgradient point-of-compliance monitoring wells (171 through

Figure 13-5
Ground Water Monitoring Well Locations, Disposal Site

Figure 13-6
Potentiometric Surface of the Upper Cedar Mountain Formation, Disposal Site

ASER94/GRN/DISPOT

Table 13-3 Ground water quality results, disposal site

Indicator parameter	Guideline	Monitoring well location		
		179 (upgradient)	176 (crossgradient)	813 (downgradient)
Nitrate	44 ^a			
01/93		110	129	ND
06/93		173	120	ND
12/93		171	195	ND
Uranium	0.04 ^a			
01/93		0.176	0.069	0.054
06/93		0.116	0.066	0.055
12/93		0.126	0.051	0.045
Arsenic	0.05 ^a			
01/93		ND	ND	0.0734
06/93		ND	ND	ND
12/93		ND	ND	0.111
TDS	500 ^b			
01/93		6130	7280	6680
06/93		6120	7220	6740
12/93		6100	7270	6850

^aMaximum concentration limit.
^bSecondary drinking water standard.
TDS - Total dissolved solids.
ND - Not detected.

Note: Results are reported in milligrams per liter.

176). These monitoring wells are closer to the disposal cell than monitoring well 813 (see *Figure 13-6*).

- *Figure 13-7* shows the natural variability of arsenic in monitoring well 813. This figure indicates that arsenic concentrations are highly variable. January 1993 and August 1992 exceedances reflect arsenic concentration variability in the natural, background water around monitoring well 813.

Figure 13-7
Arsenic Concentrations Over Time in the Upper
Cedar Mountain Formation, Disposal Site

ASER94/GRN/ARSENVSTIME

Total dissolved solids range from 6000 to 8000 mg/L, which is normal background for shallow ground water in the Cedar Mountain formation in the site area.

Ground Water Conclusions

The following conclusions can be made:

- Ground water in the disposal site area flows northwest.
- Concentrations of hazardous constituents are below background or maximum concentration limits, except for arsenic, which was detected sporadically at monitoring well 813.
- The arsenic exceedance in monitoring well 813 reflects the natural background variability of the ground water around monitoring well 813.
- Total dissolved solid concentrations are within the normal range of background measurements for the site area.

The disposal site area was scheduled to be sampled again in May to June 1994. Semiannual sampling is scheduled through 1995.

SITE DESCRIPTION AND LOCATION

The Mexican Hat Uranium Mill Tailings Remedial Action (UMTRA) Project is in San Juan County, on Navajo Nation land, 1.5 miles southwest of the town of Mexican Hat, Utah (*Figure 13-8*). The former mill housing area, now the community of Halchita, is 0.5 mile southwest of the mill site.

The tailings site is in an area surrounded by ephemeral streams that drain north and northeast toward the San Juan River, 1 air mile away. The elevation at the site is 4300 feet (ft) above mean sea level (MSL). Vegetation is sparse and consists of various drought-resistant plant species adapted to the dry, desert environment.

Population growth in the area of the tailings site is primarily related to energy development activities: coal, oil, and gas exploration and development. The population of Navajo communities fluctuates and is difficult to estimate. The population of San Juan County is 12,621 (DOC, 1990).

The Mexican Hat tailings site is arid, with large ranges in daily and annual temperatures. The winters are cold (temperatures below freezing prevail from November through March), and summers are hot with high temperatures from 90 to 100 degrees Fahrenheit (°F). Average annual precipitation is 6 inches. Precipitation is fairly evenly distributed throughout the year. Snowfall is usually light. Mexican Hat received an annual average of 3.3 inches of snow from 1951 through 1980.

Strong winds are not common in the Colorado Plateau. Average wind speeds have been recorded at 9 miles per hour at Blanding, Utah, approximately 70 air miles northeast of the Mexican Hat site (*Figure 13-9*).

SITE HISTORY AND OWNERSHIP

Approximately 2.2 million tons of ore were processed from 1957 to 1965 at the Mexican Hat site. Much of the ore processed at the Mexican Hat mill contained large quantities of sulfides, some of which were consumed in a sulfuric acid plant at the site. Two separate piles covered most of the site. The upper pile covered approximately 25 acres and the lower pile covered approximately 43 acres.

The U.S. Department of Energy (DOE) and the Navajo Nation entered into a cooperative agreement pursuant to the provisions of Uranium Mill Tailings Radiation Control Act (UMTRCA) (42 USC §7901 *et seq.*) to provide for the planning, expenditure of funds, remediation, and long-term surveillance and maintenance of the disposal site. This agreement calls for custody of the disposal site to be transferred by the Navajo Nation to the DOE until ground water remediation under congressional extensions of UMTRCA is completed.

Figure 13-8
Mexican Hat Site Location

ASER94/HAT/SITELOC

Figure 13-9
Wind Rose

Ref: DOE, 1989.
Cumulative data 1977 through 1978.

ASER94/HAT/WINDHAT

Ownership and control of the site will comply with a custody agreement between the DOE and the Navajo Nation.

SITE CHARACTERIZATION AND CLEANUP

In remedial action, the tailings will be stabilized at the present location. The tailings and associated windblown contaminated soils will be consolidated into a contoured pile and covered with a radon barrier of compacted soil.

Remedial action was suspended during 1990, but began again in August 1992. At the end of 1992, approximately 90 percent of the construction at the Mexican Hat site was complete, with the upper part of the tailings pile relocated to the lower pile in preparation for stabilization. Most windblown materials surrounding the mill site had been remediated. The primary 1993 construction activity was placement of Monument Valley contaminated materials in the Mexican Hat disposal cell.

After the contaminated material is placed and compacted, a radon barrier of silty sand amended with bentonite clay will be placed over the pile to reduce radon flux. Layers of rock will be placed on the pile for erosion protection.

**ENVIRONMENTAL
COMPLIANCE
STATUS**

In accordance with DOE policy, the UMTRA Project at Mexican Hat complies with federal and state environmental regulations. Remedial action activities are continuously evaluated for their environmental impact and to ensure they meet all regulatory requirements. Mexican Hat site environmental activities include compliance with the Clean Water Act (33 USC §1251 *et seq.*) for monitoring liquid effluent discharge to surface waters; the Clean Air Act (42 USC §7401 *et seq.*) for controlling fugitive dust emissions; the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC §9601 *et seq.*) for reporting certain quantities of hazardous materials used or stored at the site; and community right-to-know, Spill Prevention Control and Countermeasures Plan regulations, transportation, and local (conditional use and highway access permits) regulations in 1993.

**Superfund Amendments
and Reauthorization Act**

Under the Superfund Amendments and Reauthorization Act (SARA) (Public Law 99-499), an amendment to CERCLA, the Mexican Hat site must comply with the SARA Title III emergency planning and community right-to-know requirements, including notifications for threshold planning quantities of hazardous materials and notifications for spills of reportable quantities of extremely hazardous materials.

In 1993, the site was in compliance with the requirements of SARA Title III, Section 311, because the site had been inventoried for all materials stored on the site in excess of 10,000 pounds or in excess of the threshold planning quantities for extremely hazardous materials. The inventory included diesel fuel, oil, sulfuric acid, automotive maintenance fluids, and uranium mill tailings. The inventory was submitted to the state Emergency Response Commission, the local emergency planning committee, and the local fire department.

In 1993, the site was in compliance with the requirements of SARA Title III, Section 312; Tier II reporting forms for the materials inventoried in 1992 had been developed and submitted to the state Emergency Response Commission, the local emergency planning committee, and the local fire department on March 1, 1993.

The toxic release reporting requirements of SARA Title III, Section 313, do not apply to the Mexican Hat site because it is not listed in the Standard Industrial Classification Codes 20 to 39. However, no materials were released into the environment that would fall under these reporting requirements.

Clean Water Act***National Pollutant Discharge Elimination System***

A National Pollutant Discharge Elimination System (NPDES) permit (No. UT-0024945) was issued by the U.S. Environmental Protection Agency (EPA), November 1, 1990, as a no-discharge permit for the retention basin at the Mexican Hat site. A general storm water permit application for the site was submitted to the EPA in November 1993. The site applied for an individual storm water permit from EPA Region VIII in February 1993. There were no storm water releases in 1993.

Spill Prevention Control and Countermeasures Plan

This plan addresses requirements for spill response and reporting and for secondary spill containment systems for bulk chemical storage areas. In 1993, earthen berms were designed and constructed around existing aboveground storage tanks and around drum storage areas. These secondary containment systems are designed to provide adequate spill control. In addition, berm inspection plans for spill detection, emergency spill response, and spill cleanup were developed for fuel, oil, and other storage areas.

Septic/Holding Tanks

The Mexican Hat site has one septic tank and drainfield. It is emptied at least yearly, or as necessary. The Navajo Office of Environmental Health has regulatory jurisdiction for septic/holding tanks.

Clean Air Act

The EPA determined that the Mexican Hat site is not a major source as defined under regulations for the prevention of significant deterioration. The major pollutant is fugitive emissions (total suspended particulates) from nonpoint sources; therefore, the Mexican Hat site does not require a permit from the EPA and fugitive dust monitoring was not conducted. Visible emissions of fugitive dusts were strictly controlled during 1993 using water and proper work practices, as required by the Navajo Nation Environmental Protection Agency.

National Environmental Policy Act

In compliance with the National Environmental Policy Act (42 USC §4321 *et seq.*), public scoping meetings were held at Mexican Hat to gather input for the ground water programmatic environmental impact statement (in preparation).

Hazardous Materials Transportation Act

All materials transported at the Mexican Hat site were in full compliance with all applicable requirements of the Hazardous Materials Transportation Act (49 USC §1801 *et seq.*).

Environmental Permit Compliance Status

The Mexican Hat site obtained and operated under all required permits in 1993. All active permits under which the site operated from January 1, 1993, to April 1994 are listed in *Table 13-4*.

Table 13-4 Active permits

Permit description	Submittal date	Preliminary approval date	Final approval date	Permit number	Expiration date
NPDES permits (EPA)					
Process site wastewater (state)	1/90	Final received ^a	6/92	UT-0024945	9/95
Process site storm water (EPA Region VIII) (individual)	1/93	Final received ^a	12/93	UTRIOA05F	11/98
Process site storm water (general)	10/93	Final received ^a	11/90	b	NA
Water rights					
Consigned water service	12/87	1/88	8/88	R1490	10/95
Water use permit (Navajo Nation)	2/93	Final received ^a	3/93	93030	3/94
Borrow permit (BIA)					
B4/RB7	3/89	Final received ^a	11/93	115-93	12/95
Revocable use permit (BIA)					
Expanded tailings site	5/87	Final received ^a	9/87	TC-87-902	7/93
Expanded tailings site (renewal request)	5/93	Pending		TC-87-902	09/94 ^c
Free use permit (BLM)					
Bluff Pit	2/89	Final received ^a	4/92	UTU66338	5/97
Sugarloaf Quarry	NA	Final received ^a	10/92	UTU66339	5/97
Sugarloaf Quarry - revision to material quantity	NA	Final received ^a	5/93	UTU66339 ^c	5/97
^a Not applicable in 1993. ^b Permit is overdue from agency. ^c Renewal request, see N-01-02738. ^d Additional 17,400 tons approved. NA - Not applicable. BIA - Bureau of Indian Affairs. BLM - Bureau of Land Management.					

Site-Specific Requirements

Because the site is on Navajo Nation land, it is under the jurisdiction of both the Navajo Nation Environmental Protection Agency and the federal EPA, Region VIII. Because potential water discharges from the site would eventually migrate to the San Juan River, the federal EPA has regulatory authority over activities associated with the NPDES.

ENVIRONMENTAL MONITORING

The DOE implements a detailed environmental monitoring program for radiological and nonradiological materials at the Mexican Hat site, including environmental gamma-dose equivalent and radionuclide/nonradionuclide concentrations in air and ground water. This program monitors quantities of radioactive material and nonradiological hazardous constituents that may be released into the environment, demonstrates compliance with applicable guidelines, and indicates the efficiency of environmental protection measures.

Due to the lack of available surface water at the site, surface water samples were not collected during 1993.

Air Monitoring

Nonradiological Air Particulate Monitoring

Because the major pollutant is fugitive emissions (total suspended particulates) from nonpoint sources, the Mexican Hat site does not require an EPA permit and fugitive dust monitoring was not performed. Visible emissions of fugitive dust are strictly controlled using water and proper work practices.

Radiological Air Particulate Monitoring

Radiological air particulate monitoring at the Mexican Hat site was conducted at Stations 1 through 5. Background measurements were made at Station 1 (*Figure 13-10*).

None of the stations reported an annual average concentration statistically different from background (36.6×10^{-16} microcuries per milliliter [$\mu\text{Ci/mL}$]). The estimated annual average thorium-230 concentration at all stations was well below the thorium-230 average annual guideline of $500 \times 10^{-16} \mu\text{Ci/mL}$ above background. This reading indicates radioactive particulate releases from remedial action were not significant.

Radon Monitoring

Real-Time Radon Monitoring. Real-time radon monitoring was conducted at Stations 1, 4, and 5. Background radon concentrations were measured at Station 1, upwind (southwest) of the site (*Figure 13-10*).

Figure 13-11 presents the quarterly average radon concentrations for all locations statistically above background at the Mexican Hat site in 1993. The annual average background radon concentration measured at Station 1 was $0.47 \times 10^{-9} \mu\text{Ci/mL}$. Although radon concentrations were greater than background levels ($0.63 \times 10^{-9} \mu\text{Ci/mL}$) for Station 4, they were much lower than the DOE guideline of $3 \times 10^{-9} \mu\text{Ci/mL}$ above background. The elevated concentrations at the Mexican Hat site should return to background levels when remedial action is complete.

Figure 13-10
Environmental Air and Gamma Radiation Monitoring Stations

Figure 13-11
Real-Time Radon Concentrations

ASER94/HAT/TAB2

Passive Radon Monitoring. Nine stations were established around the site (Stations 1 to 9). Background monitoring was again performed upwind, at Station 1 (*Figure 13-10*).

The annual average background radon concentration measured at Station 1 was 0.5×10^{-9} $\mu\text{Ci/mL}$. No concentrations were statistically greater than background, and all were much lower than the DOE guideline.

Air Monitoring Conclusions

All concentrations of thorium-230 particulates and radon-222 were lower than the applicable guidelines. No significant releases occurred from the site during 1993.

Environmental Gamma Radiation Monitoring

A network of thermoluminescent dosimeters measured exposure to penetrating gamma radiation in the environment around the Mexican Hat site. Monitors were placed at the site perimeter as well as near adjacent communities. Stations 1, 5, and 9 were placed near local communities (*Figure 13-10*). Nine dosimetry monitoring stations were active in 1993.

The annual background dose equivalent was 147.4 ± 11.8 millirems (mrem) at Station 1, southwest (upwind) of the site. None of the

stations recorded dose equivalents statistically different from background.

Environmental Gamma Radiation Monitoring Conclusions

No stations recorded environmental gamma radiation levels greater than the applicable guidelines, indicating no significant releases occurred.

Ground Water Monitoring

Ground water was sampled in June 1993 to monitor the effects of surface remediation activities and to provide data to support the site baseline risk assessment. Surface remediation involves the stabilization of all mill tailings and contaminated soils from both the Mexican Hat and Monument Valley sites. Completion is planned for 1994.

Water is present in two units beneath the site, the Halgaito Shale formation and the Honaker Trail formation. The ground water in the shallower zone, the Halgaito Shale, occurs over a limited area and is a result of milling operations. Water within the Halgaito Shale is contained in fractures and flows east at an approximate rate of 30 ft per year. *Figure 13-12* shows ground water sampling locations in the Halgaito Shale Formation. Ground water within the Honaker Trail Formation flows northeast at an approximate rate of 4 ft per year. *Figure 13-13* shows a 1985 estimate of the potentiometric surface map and ground water flow direction in the Honaker Trail Formation.

Although the Halgaito Shale was dry or only partially saturated prior to milling operations, it now contains water from the milling operations. Therefore, the Halgaito Shale is not considered the uppermost aquifer. Ground water within the uppermost aquifer, the Honaker Trail Formation, has not been developed due to its naturally poor quality, which is characterized by high concentrations of total dissolved solids, hydrogen sulfide, and naturally occurring organic compounds. The nearby San Juan River provides good-quality water for the area.

Because only one Halgaito Shale well exists at the site (location 909), a ground water contamination map cannot be constructed. However, the eight ground water seeps that were sampled indicate contaminated ground water is traveling downgradient (east) of the site. Nitrate, sulfate, and uranium are good indicators of ground water contamination (*Table 13-5*) because they travel at about the same rate as ground water flow and they are by-products of the milling operation.

Ground water and ground water seeps were sampled on one occasion during 1993 (*Figure 13-12*). All locations were sampled in June, except location 251 which was sampled during February.

Figure 13-12
Seep and Ground Water Monitoring Well Locations

Figure 13-13
Potentiometric Surface, Honaker Trail Formation

Table 13-5 Seep water quality results, June 1993

Indicator parameter	Guideline	Monitoring well/seep location								
		248	251 ^a	253	254	255 ^a	256 ^a	909	922	923
Nitrate	44 ^b	61	676	36	381	405	<1.0	8	51	NM
Sulfate	250 ^c	3080	2250	2980	NM	3060	2780	2250	3420	3180
Uranium	0.044	0.434	0.771	0.276	0.75	0.801	0.01	0.047	0.353	0.039

^aFiltered samples.
^bMaximum concentration limit.
^cSecondary Drinking Water Standard.
 NM - Not measured.

Notes: 1. All results are from June 1993 except location 251, which was sampled February 1993.
 2. All monitoring locations are downgradient seeps, except location 909, an upgradient well, and seep 256, a background seep.
 3. < symbol indicates actual is less than the detection limit (number shown).
 4. Results are reported in milligrams per liter.

Ground Water Results

Ground water samples were analyzed for a variety of constituents, including the main contaminant indicator parameters, nitrate, sulfate, and uranium (*Table 13-5*).

The water quality of the seeps, with the exception of the background seep (256), indicates the former mill operations have affected the ground water.

Ground Water Conclusions

Ground water downgradient from the site is affected by the former milling operations, which included mill tailings disposal. The extent of contamination in ground water is shown by the locations of the seeps. Contaminated ground water is moving east through fractures in the Halgaito Shale at a rate of approximately 30 ft per year.

Contaminated water from the seeps apparently does not reach the San Juan River. Because the amount of water discharged from the seeps is so small, the water probably evaporates before reaching the river.

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SITE DESCRIPTION AND LOCATION

The Vitro Uranium Mill Tailings Remedial Action (UMTRA) processing site is a 128-acre property 4 miles south-southwest of the center of Salt Lake City, Utah (*Figure 13-14*). The processing site is bounded on the north by Mill Creek, on the east by the tracks of the Denver & Rio Grande Western Railroad, on the south by 3300 South Street, and on the west by 900 West Street. An industrial area faces the processing site on 900 West Street.

The Salt Lake City disposal site (the South Clive disposal site) is in Tooele County, Utah, approximately 81 miles due west of Salt Lake City (*Figure 13-14*). The disposal site is in a relatively flat area along the eastern edge of the Great Salt Lake desert. The desert extends approximately 60 miles from the Nevada-Utah border on the west to a series of north-south trending mountain ranges on the east. In the disposal site vicinity, the eastern border of the desert is formed by the Cedar Mountains that rise to elevations of approximately 7700 feet (ft) above mean sea level (MSL). The proximity of this mountain range results in a westerly surficial drainage pattern at the disposal site.

Some 437,000 people live within 6 miles of the Vitro processing site. The estimated population of South Salt Lake City is 10,129. The population of Salt Lake County is 725,956 (DOC, 1990).

An estimated 25,526 people lived within 50 miles of the South Clive disposal site at the time of the 1980 census; near the disposal site, most of the land is uninhabited.

The Vitro processing site area is semiarid. Temperatures range from 28 degrees Fahrenheit (°F) in January to 77°F in July. The average rainfall is about 15 inches per year. Prevailing winds are south through southeast with a mean speed of 8.7 miles per hour; strong winds tend to come from the west or northwest. The area receives summer thunderstorms and winter snowfall.

The South Clive disposal site area is arid. Normal monthly temperatures range from 27°F in January to 79°F in July. The annual precipitation is only 5 inches.

SITE HISTORY AND OWNERSHIP

In 1951, Vitro Chemical acquired a plant originally built during World War II to produce alumina from alunite. Vitro converted the plant to process uranium ore; from 1951 to 1964 it sold uranium ore to the U.S. Atomic Energy Commission. In 1964, the mill was converted to produce vanadium from Idaho Ferrophosphorous (resulting from elemental phosphorous production). Vanadium production ceased in July 1968. Plant demolition began in 1968 and was complete in 1970.

The state of Utah holds title to the South Clive disposal site and the Vitro processing site is owned by the Central Valley Water

Figure 13-14
Vitro Processing Site and South Clive Disposal Site Locations

MAC: ASER94/SLC/CLIVE&VITRO-SITELOC

Reclamation Facility Board. The state must transfer title for the disposal site to the federal government before the U.S. Nuclear Regulatory Commission (NRC) will license the disposal site under provisions of 10 CFR Part 40. This title transfer is required under Section 104(f)(b) of the Uranium Mill Tailings Radiation Control Act (42 USC §7901 *et seq.*).

SITE CHARACTERIZATION AND CLEANUP

When the plant was dismantled in 1970, the radioactively contaminated materials from the processing operations (approximately 1.6 million cubic yards of uranium mill tailings and over 850,000 cubic yards of other contaminated material) remained on the site. Surface remedial action, conducted by the state of Utah under the direction of the UMTRA Project Office, began in 1984 and was completed in 1988. A total of 2,798,000 cubic yards of residual radioactive materials were removed from the former Vitro processing site and surrounding vicinity properties and transported and stabilized in the South Clive disposal site.

ENVIRONMENTAL COMPLIANCE STATUS

With the surface remedial action at the Vitro processing site complete, the compliance issues remaining for surface remediation are NRC licensing under provisions of 10 CFR Part 40. Before licensing, the NRC must concur with the completion reports for the South Clive disposal site and the South Salt Lake City Vitro processing site. Under the UMTRA Ground Water Project, ground water, surface water, and sediment samples are collected at the Vitro processing site and analyzed to further evaluate ground water contamination from the former uranium processing activities. Two UMTRA documents will address the evaluation and sampling requirements in detail: a baseline risk assessment (in preparation) and the site water sampling and analysis plan (in preparation).

In compliance with the National Environmental Policy Act (42 USC §4321 *et seq.*), a public scoping meeting was held in Salt Lake City to gather input for the ground water programmatic environmental impact statement (in preparation).

ENVIRONMENTAL MONITORING

The U.S. Department of Energy (DOE) conducts a detailed environmental monitoring program for radiological and nonradiological materials at the Vitro processing site, including radionuclide and nonradionuclide concentrations in surface water and ground water. This program monitors quantities of radioactive material and nonradiological hazardous constituents released into the environment, demonstrates compliance with the applicable guidelines, and indicates the efficiency of environmental protection measures.

With the surface remedial action complete, air and environmental gamma radiation monitoring data are no longer collected for the

UMTRA environmental monitoring program at the Vitro processing site and South Clive disposal cell.

Surface Water Monitoring

Surface water and sediment samples were collected at the Vitro site in December 1993 at upstream and downstream locations along the Jordan River, Mill Creek, and the south Vitro ditch (*Figure 13-15*). This is the first set of surface water samples collected from the site. Results do not indicate that surface water quality is impacted by seepage from the former tailings piles (*Table 13-6*).

Ground Water Monitoring

Ground water in the vicinity of the Vitro processing site is generally characterized by two aquifer systems: a shallow, unconfined system and a deeper, confined system. The two aquifers are separated by interbedded layers of low-permeability clays and silts. Wells at depths from 70 to 330 ft below the ground surface are under substantial artesian pressure, with ground water flowing from several wells. Near the site, ground water flow in both aquifers is predominantly west-northwest, or toward Great Salt Lake.

Ground water levels in the unconfined aquifer range from 5 to 15 ft or more below the ground surface. Topographic lows in the vicinity of the site are perennially marshy. The ground water flows primarily from southeast to northwest. *Figure 13-16* shows a water table map of the shallow unconfined aquifer.

No potentiometric isopleth map of the deeper confined aquifer was constructed because there were too few data available.

The ground water monitoring network at the site consists of nine wells screened in the shallow unconfined aquifer and two wells screened in the deeper confined aquifer. The shallow unconfined aquifer monitoring wells are upgradient of the contamination, within the contamination, and downgradient. The deeper confined aquifer monitoring wells are located downgradient of the site boundary (*Figure 13-16*).

Ground water was sampled in October 1993 and in February 1994. The next water quality sampling round is scheduled for October 1994.

Ground Water Results and Conclusions

Indicator parameters reflect the sharp contrast between background ground water quality conditions and tailings-contaminated ground water. These indicator parameters easily distinguish between natural and contaminated ground water conditions. The indicator parameters selected for the Vitro processing site are chloride, sulfate, and uranium (*Table 13-7*). These parameters are contaminants derived from processing activities and tailings piles that have migrated into the shallow unconfined aquifer. *Figure 13-17* shows sulfate distributions

Figure 13-15
Surface Water Sampling and Ground Water Monitoring Well Locations,
Vitro Processing Site

ASER94/SLC/LOCMONWELLS

Table 13-6 Surface water and sediment quality results

Sampling location	Indicator parameter		
	Chloride ^a	Sulfate ^b	Uranium ^c
Jordan River upstream			
Surface water location 185	278	339	0.015
Sediment location 185	304	91	2.5
Jordan River downstream			
Surface water location 184	288	340	0.015
Sediment location 184	57	<14	0.65
Mill Creek downstream			
Surface water location 182	197	141	0.004
Sediment location 182	165	67	1.2
Mill Creek downstream			
Surface water location 180	66	173	0.002
Sediment location 180	110	60	1.3
South Vitro ditch			
Surface water location 186	102	115	0.007
Sediment location 186	250	77	3.9

^aNo guideline available.
^bSecondary Drinking Water Standard (250 mg/L).
^cMaximum concentration limit (0.044 mg/L).

Note: 1. Results are reported in milligrams per liter.
2. < symbol indicates result is less than the detection limit (number shown).

in the shallow aquifer at the site. Maximum concentration limits were not exceeded in ground water in the deeper confined aquifer.

Results from the first-quarter 1994 sampling round showed that concentrations of molybdenum, nitrate, selenium, and uranium and activities of net gross alpha and radium-226 and radium-228 exceeded maximum concentration limits in ground water in the shallow unconfined aquifer beneath the site.

Ground water is still contaminated as a result of the uranium processing activities. Contaminant migration in ground water in the unconfined aquifer west and northwest of the Vitro processing site may be occurring, but the extent of contamination is not known because no monitoring wells were established at downgradient, off-site locations. The deeper confined aquifer does not appear to be contaminated.

Figure 13-16
Ground Water Table Contours of the Unconfined Aquifer, Vitro Processing Site

ASER94/SLC/WATTAB

Table 13-7 Shallow unconfined aquifer ground water quality results, processing site

Indicator parameter	Guideline ^a	Monitoring well location		
		006 (background)	135 (contamination)	134 (downgradient)
Chloride	250 ^a	318	2,540	215
Sulfate	250 ^a	137	4,970	412
Total dissolved solids	500 ^a	1290	12,200	1400
Uranium	0.044 ^b	0.004	0.089	0.089

^aSecondary Drinking Water Standard.

^bMaximum concentration limit (0.044 mg/L) is the mass equivalent of 30 pCi/L, assuming uranium-234 and uranium-238 are in equilibrium.

Note: Concentrations are reported in milligrams per liter.

Figure 13-17
Sulfate Concentrations in the Unconfined Aquifer, Vitro Processing Site

Note: Monitoring wells 011 and 109 last sampled in October 1993 before being destroyed.
 Monitoring well 008 last sampled October 1993.

200 0 200 400 Feet

ASER94/SLC/SULCON

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United States Codes

33 USC §1251 *et seq.*, *Clean Water Act*, October 18, 1972.

42 USC §4321 *et seq.*, *National Environmental Policy Act*, January 3, 1975.

42 USC §7401 *et seq.*, *Clean Air Act*, December 27, 1963.

42 USC §7901 *et seq.*, *Uranium Mill Tailings Radiation Control Act of 1978*, November 8, 1978.

42 USC §9601 *et seq.*, *Comprehensive Environmental Response, Compensation, and Liability Act*, December 11, 1990.

49 USC §1801 *et seq.*, *Hazardous Materials Transportation Act*, January 3, 1975.

CHAPTER 14 WYOMING SITES

WYOMING SITES

This chapter provides detailed Uranium Mill Tailings Remedial Action (UMTRA) Project data on environmental monitoring activities conducted at Riverton and Spook, Wyoming, during 1993 and the first quarter of 1994.

Numerous documents describe the existing environmental and construction conditions at UMTRA Project sites. These documents, including environmental impact statements, environmental assessments, and remedial action plans, are available at the U.S. Department of Energy (DOE) UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Riverton

The Riverton site is in Fremont County in western Wyoming. Site remediation was completed in November 1989. Because surface remedial action is complete, air monitoring and environmental gamma radiation monitoring were not conducted in 1993. However, during 1993, surface water and ground water were monitored for radiological and nonradiological constituents. Only the constituents defined as indicator parameters for this site are discussed here.

Spook

The Spook site is in Converse County in eastern Wyoming. The DOE completed site remediation in May 1990. The U.S. Nuclear Regulatory Commission (NRC) licensed the disposal cell in 1993. The Spook site was not sampled in 1993, pursuant to the approved NRC ground water compliance strategy. The NRC agreed no postremedial action ground water monitoring would be required as part of the implementation of supplemental standards. Therefore, no data are presented in this report.

CHAPTER 14 — WYOMING

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SITE DESCRIPTION AND LOCATION

The Riverton Uranium Mill Tailings Remedial Action (UMTRA) Project site is in Fremont County, Wyoming, 2.5 miles southwest of the city of Riverton, on private land within the boundaries of the Wind River Indian Reservation (Northern Arapaho and Shoshone Indian tribes).

The Riverton site is on a nearly level alluvial terrace in the Wind River Basin, approximately 13,000 feet (ft) upstream of the confluence of the Wind and Little Wind rivers. The Wind River is approximately 4000 ft north of the site and the Little Wind River is approximately 3000 ft southeast of the site (*Figure 14-1*).

The estimated populations of Fremont County, Wyoming, and the city of Riverton are 33,662 and 9202, respectively (DOC, 1990). The Riverton area is primarily agricultural, with several residences in the immediate site vicinity. Much of the area also is used as pasture for cattle and horses. A privately-owned sulfuric acid plant is adjacent to the west boundary of the site.

The Riverton area is semiarid to arid (the Wind River mountain range hinders the passage of moisture). The average annual precipitation is 8 inches. Most of this precipitation occurs from April through June.

The Riverton area is influenced by cold air masses from Canada and prevailing warm, westerly winds. From 1951 to 1980, 207 days per year averaged minimum temperatures of 32 degrees Fahrenheit (°F) or less, and 37 days per year averaged maximum temperatures of 90°F or more (DOE, 1987).

SITE HISTORY AND OWNERSHIP

The mill at the Riverton tailings site was constructed in 1958. Fremont Minerals, Inc., initially operated the mill to treat uranium ores from the surrounding area. A sulfuric acid plant was also part of the mill facilities. The uranium mill closed in 1963. Koch Sulfur Products Company still operates the sulfuric acid plant.

The mill used both sulfuric acid and carbonate circuits. Clarified solutions from the acid leaching process were fed to a solvent extraction circuit and subsequently stripped with caustic soda to precipitate the uranium. During its 4 years of operation, the mill processed approximately 900,000 tons of ore. Waste solids from the uranium ores were transferred to a tailings pile adjacent to and southeast of the mill.

The tailings pile covered approximately 70 acres and contained approximately 1 million cubic yards of tailings. Approximately 140 acres within the designated area, including the pile site, were contaminated. Wind dispersed the tailings, contaminating approximately 50 additional acres outside the site boundaries.

Figure 14-1
Riverton Site Location

ASER94/RVT/SITELOC

Between 1988 and 1990, the uranium mill was demolished and the tailings pile and contaminated soils were removed from the site and surrounding area. The soils were excavated until the radium concentrations met UMTRA Project guidelines (40 CFR §192.12).

Approximately 1.8 million cubic yards of residual radioactive material were removed from the site and disposed of at the Gas Hills site (*Figure 14-1*). This site is licensed by the U.S. Nuclear Regulatory Commission (NRC) and operated by Umetco. The excavation was backfilled with clean fill, graded to form a crown, and planted with rye grass. Surface remediation was completed in November 1989.

The state of Wyoming purchased the Riverton site from Lome Drilling & Well Service, Inc., in July 1987. In November 1987, the state of Wyoming, the U.S. Department of Energy (DOE), and Chemical Marketing Services, Inc. (now Koch Sulfur Products Co.), entered into a remedial action and land purchase agreement for the 218-acre processing site. This agreement is recorded in the Fremont County Courthouse in Book 296, page 501, dated November 3, 1987. Under the agreement, Chemical Marketing Services made partial payment for the deed to approximately 5 acres that had contained a water well, a water tank and overhead tower, and a truck weigh scale. When the NRC certifies the site meets the surface cleanup standards in 40 CFR Part 192, Subpart B, the agreement requires Chemical Marketing Services to pay the state the balance of the purchase price and to obtain title to the remaining 213 acres of the processing site. The title transfer, which imposes certain land use restrictions, will guarantee access to the site (with certain land-use restrictions) for UMTRA Ground Water Project activities.

ENVIRONMENTAL COMPLIANCE STATUS

With surface remedial action at the Riverton site complete, the remaining compliance issue is ground water monitoring.

National Environmental Policy Act

In compliance with the National Environmental Policy Act (42 USC §4321 *et seq.*), public scoping meetings were held at the city of Riverton and at St. Stephens Mission to gather information for the ground water programmatic environmental impact statement (in preparation).

ENVIRONMENTAL MONITORING

At the Riverton site, the DOE conducts an environmental monitoring program for radiological and nonradiological materials in surface water and ground water. This program monitors the amount of radioactive material and nonradiological hazardous constituents released into the environment, demonstrates compliance with applicable guidelines, and indicates the efficiency of environment protection measures.

With surface remedial action at the Riverton site complete, air and environmental gamma radiation monitoring data were not collected for the UMTRA environmental monitoring program in 1993.

Surface Water Monitoring

As part of the ground water program baseline risk assessment, surface water and sediment samples were collected in June 1993 from the Little Wind River and from wetlands and streams in the site area to determine the impact of uranium milling activities on surface water. *Figure 14-2* shows surface water sampling locations. *Table 14-1* gives the analytical results for indicator parameters (lead, molybdenum, and uranium) along the Little Wind River.

Table 14-1 Surface water quality results

Indicator parameter	Guideline	794 (background)	742 (near plume)	796 (downstream)
Lead	0.05	0.004	0.004	0.004
Molybdenum	0.1	ND	ND	ND
Uranium	0.044	0.002	0.025	0.002

ND - Not detected.

Notes: 1. Nonfiltered samples collected in 1993.
2. Guideline is maximum concentration limit. Measurements are in milligrams per liter.

Surface Water Results

The samples collected from the wetland areas west (745) and east (746) of the Riverton site, from the drainage ditch along the eastern edge (744), from the unnamed tributary of the Little Wind River (741), and along the Little Wind River (742, 743, 794, and 796) were analyzed for calcium, iron, magnesium, manganese, molybdenum, lead, and uranium. None of the hazardous constituents analyzed exceeded the maximum concentration limits in surface water samples. Lead concentrations were 1 order of magnitude below the primary drinking water maximum concentration limit and were unchanged between the downstream background locations along the Little Wind River. Molybdenum was not detected or equaled the detection limit in all sampling locations. Uranium concentrations were well below the maximum concentration limit at all sample locations, except for sample location 742 (*Table 14-1*). Uranium concentrations at this location exceeded background but were still approximately one-half the maximum concentration limit for drinking water. Further downstream, at sampling location 796, the concentrations of uranium declined to background levels. Two other locations (743 and 744) also registered uranium concentrations above background but below the maximum concentration limit.

Figure 14-2
Surface Water Sampling Locations

ASER94/RVT/SURF&SAMPLCS

**Surface Water
Conclusions**

Contaminant concentrations in samples from locations 742, 743, and 744 indicate contaminated ground water probably discharges to the Little Wind River southeast of the site, into the wetland southwest of the site, into a drainage ditch along the eastern site boundary, and then into the wetland to the east. None of the concentrations are near the maximum concentration limits nor are they likely to affect aquatic life.

Ground Water Monitoring

Five hydrogeologic units of interest underlie the Riverton site. They are, in descending order: a surficial, unconfined alluvial and sandstone aquifer; a leaky shale layer that limits ground water movement (aquitard); a semiconfined sandstone aquifer; a second, more impermeable shale aquitard; and a confined sandstone aquifer.

The unconfined aquifer is 15 to 20 ft thick and consists of alluvial sand and gravel underlain by a discontinuous layer of sandstone. The water table ranges from approximately 6 to 10 ft below land surface across the site. Ground water flows east-southeast, with a gradient of approximately 0.002 (*Figure 14-3*). The average hydraulic conductivity is approximately 56 ft per day and the approximate ground water flow velocity is 160 ft per year. The leaky underlying shale aquitard is from 5 to 10 ft thick.

The semiconfined sandstone aquifer underlies the leaky shale aquitard. This unit is from 15 to 30 ft thick. In this aquifer, ground water flows in a more easterly direction than the unconfined aquifer (*Figure 14-4*). The semiconfined sandstone has an approximate hydraulic conductivity of 40 ft per day and an approximate ground water velocity of 140 ft per year. Water level data from a monitoring well cluster just north of the former tailings area indicate a downward gradient from the higher unconfined aquifer to the semiconfined aquifer. However, water level data from monitoring well clusters south and east of the former tailings area indicate equilibrium conditions between the two aquifers. The reason for the apparent downward gradient in the north is not known. The contours on *Figure 14-4* do not reflect the inconsistency.

The main effect of the leaky aquitard is to limit downward contaminant migration. Sulfate is the only constituent of concern detected in the semiconfined aquifer, except for molybdenum in well 108.

Beneath the semiconfined sandstone aquifer is about 40 ft of shale with discontinuous sandstone lenses. The confined sandstone aquifer underlies this shale aquitard. Water level data from monitoring wells near the site show ground water flows south in the confined sandstone (*Figure 14-5*). An upward gradient from the confined sandstone aquifer into the semiconfined sandstone aquifer in the site area prevents contaminant movement from the upper aquifers downward

Figure 14-3
Ground Water Table Contours in the Surficial Aquifer

Figure 14-4
Potentiometric Surface of the Semiconfined Sandstone Aquifer

Figure 14-5
Potentiometric Surface of the Confined Sandstone Aquifer

into the confined sandstone aquifer or deeper aquifers that supply area domestic and municipal wells.

Twenty-three domestic wells have been identified in the site area (*Figure 14-6*). All these wells are completed at depths greater than 100 ft in the confined sandstone aquifer or deeper aquifers except for two shallow (less than 35 ft deep) stock wells completed in the surficial aquifer (431 and 442). The Riverton well field is more than 7000 ft north of the site. Riverton's municipal water supply is obtained from this well field between October and April. During the remainder of the year, water is taken from the Wind River.

Ground water samples are collected at the Riverton site to monitor the effects of remedial action activities on the ground water quality. Ground water was sampled to support a site baseline risk assessment and to provide a historical data base of ground water quality before the ground water remediation phase of the UMTRA Project begins.

Ground water elevations were measured and samples were collected from 26 monitoring wells at the Riverton site during one sampling round in 1993 (*Figure 14-7*). Of the monitoring wells sampled, 13 are screened in the surficial aquifer, 9 are completed in the semiconfined aquifer, and 3 are completed in the confined aquifer. Fifteen new monitoring wells were drilled and installed in 1993 in support of the site baseline risk assessment (in preparation). Ground water samples were analyzed for constituents that have maximum concentration limits, and for other selected inorganic constituents.

Ten domestic wells in the site area were sampled in 1993 and another eight were sampled in January 1994 in accordance with a request by the state of Wyoming Department of Environmental Quality. The 15 new monitoring wells installed in 1993 also were sampled in 1994 to increase the analytical data base.

Ground Water Results

Background ground water quality in the surficial, semiconfined, and confined aquifers did not exceed maximum concentration limits. Indicator parameters for ground water contamination at the Riverton site are molybdenum, sulfate, and uranium.

The contamination downgradient of the site in the surficial aquifer is characterized by concentrations of uranium and molybdenum that exceed maximum concentration limits and sulfate above background concentrations (*Figures 14-8, 14-9, and 14-10*). Results of ground water quality data are compared with background levels and the proposed U.S. Environmental Protection Agency (EPA) maximum concentration limits in *Table 14-2*.

Figure 14-6
Domestic Well Locations

Figure 14-7
Ground Water Monitoring Well Locations

Figure 14-8
Uranium Concentrations in the Surficial Aquifer

Figure 14-9
Molybdenum Concentrations in the Surficial Aquifer

Figure 14-10
Sulfate Concentrations in the Surficial Aquifer

Table 14-2 Surficial aquifer ground water quality results

Indicator parameter	Guideline	710 (background)	707 (contaminated)	101 (on-site)
Molybdenum	0.1 ^a	<0.01	0.83	0.05
Sulfate	250 ^b	113 ^c	2970	380 ^a
Uranium	0.044 ^a	0.004	0.957	0.225

^aMaximum concentration limit.
^bSecondary Drinking Water Standard.
^cNot sampled for sulfate in 1993; this number is an average of 1992 data (two rounds).

Notes: 1. One sampling round, March 13 - April 2, 1993.
2. Measurements are in milligrams per liter.
3. < symbol indicates the value is less than the detection limit (number shown).

In the semiconfined aquifer, molybdenum exceeds the maximum concentration limit in one on-site monitoring well and sulfate is above background in downgradient wells near the southwest corner of the site. The upward gradient from the confined to the semiconfined aquifer prevents ground water contaminants from reaching the confined aquifer.

Figure 14-11
Uranium Concentrations Over Time in
Ground Water

ASER94/RVT/URNCON

Because most of the monitoring wells sampled in 1993 were installed in 1993, analytical results cannot be compared with historical data. *Figures 14-11 through 14-13* show the trends of uranium, molybdenum, and sulfate from three surficial aquifer monitoring wells sampled since 1987. The on-site and background monitoring wells show little variability over time and the 1993 data follow existing trends. Water quality from monitoring well 707 shows significant variability with time, possibly because of its proximity to the Little Wind River and the river's resulting seasonal influences.

No hazardous constituents exceeded maximum concentration limits in any ground water sample

collected from a domestic well. Ground water quality data are available from the DOE UMTRA Project office, Albuquerque, New Mexico.

Ground Water Conclusions

Operations at the former uranium mill have impacted ground water in the unconfined surficial aquifer (uppermost aquifer). The contamination extends no farther north than the northern site boundary. Contamination is constrained to the east and west by the natural wetland areas and does not extend under the Little Wind River to the south. Contamination of the semiconfined aquifer extends beyond the southeastern corner of the site. There is no evidence of contamination in the confined aquifer on or off the site.

The contaminated ground water in the surficial aquifer discharges to the Little Wind River, slightly affecting the water quality in a backwater area along the river's northern edge. Uranium exceeds its maximum concentration limit in river water collected upstream of the site, but is only just over one-half the maximum concentration limit. The uranium concentration in a sample collected downstream of the site was nearly identical to the unimpacted, upstream sample.

Figure 14-12
Molybdenum Concentrations Over Time in
Ground Water

ASER94/RVT/MOLYCON

Figure 14-13
Sulfate Concentrations Over Time in
Ground Water

ASER94/RVT/SULCON

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DOE (U.S. Department of Energy), 1987. *Environmental Assessment-Remedial Action at the Riverton Uranium Mill Tailings Site, Riverton, Wyoming*, final, UMTRA-DOE/EA-0254, prepared by the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Code of Federal Regulations

40 CFR Part 192, *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings*, U.S. Environmental Protection Agency (1994).

United States Code

42 USC §4321 *et seq.*, *National Environmental Policy Act*, January 1, 1970.

UWTPRA PROJECT

CHAPTER 15 GLOSSARY

ALARA	Phrase and acronym meaning as low as reasonably achievable. Used to describe a method of controlling and managing radiation exposure and emissions to the public as far below specified limits as economically, technically, and practically feasible.
Aliquot	Fraction of a field sample taken for complete processing through an analytical procedure (a laboratory sample of a field sample).
Alluvium	Detrital deposit of sediments resulting from surface water flows such as rivers, flood plains, lakes, estuaries, and alluvial fans at the foot of mountain slopes.
Alpha particle	Type of particulate radiation (identical to the nucleus of the helium atom) consisting of two protons and two neutrons.
Ambient air	Atmosphere surrounding people, plants, and structures. Does not include the air immediately adjacent to emission sources.
Amines	Class of organic compounds derived from ammonia by replacing one or more hydrogens with organic radicals used in uranium ore processing to concentrate uranium in the solvent extraction process.
Analytes	Element or constituent for which a sample may be analyzed.
Aquifer	Saturated layer of rock or soil below the ground surface that can supply usable quantities of ground water to wells and springs. Aquifers can be sources of water for domestic, agricultural, and industrial uses.
Atomic Energy Commission	Federal agency created in 1946 to manage the development, use, and control of nuclear energy for military and civilian applications. Abolished by the Energy Reorganization Act of 1974 and succeeded by the Energy Research and Development Administration (now part of the DOE and NRC).
Background radiation	Ionizing radiation from sources other than the laboratory. Background radiation may include cosmic radiation; radiation from naturally occurring radioactivity in the earth (terrestrial radiation), air, and water; internal radiation from naturally occurring radioactive elements in the human body; and radiation from medical diagnostic procedures.
Backlog	On-site waste awaiting permitted treatment, storage, or disposal options.
Baseline risk assessment	Site-specific assessment of demographic, geographic, physical, chemical, and biological factors influencing the extent of actual or potential harm to human health and the environment.

CHAPTER 15 — GLOSSARY

Beta particle	Negatively charged particle (identical to the electron) emitted during decay of certain radioactive atoms. Most beta particles are blocked by an 0.6-centimeter aluminum barrier.
Blank	Sample of the carrying agent (gas, liquid, or solid) normally used to selectively measure a material of interest; this sample is subjected to the usual analytical process to establish a baseline or background value. This value is then used to adjust or correct the routine analytical results.
Calibration	Adjustment of system flow, temperature, humidity, and pressure gauges and determination of system accuracy using known sources and instrument measurements. Conducted using standard operating procedures and sources traceable to the NIST.
Chain of custody	Method for documenting the history and possession of a sample from the time of collection (through analysis and data reporting) to its final disposition.
Class W Th-230	Derived air concentration as specified in DOE Order 5480.11, <i>Radiation Protection for Occupational Workers</i> . Class W refers the range of half-times for retention in the pulmonary region of the lung as being between 10 to 100 days.
Cleanup	Removal or stabilization of contaminants to eliminate or reduce the risk to human health and the environment.
Code of Federal Regulations	Codification of all regulations developed and finalized by federal government agencies in the <i>Federal Register</i> .
Confined aquifer (conditions)	Aquifer under greater than atmospheric pressure, banded above and below by layers with distinctly lower permeabilities than the aquifer itself.
Constituent	Substance found in ground water or soil pores that may or may not be naturally occurring or desirable.
Contaminant	Undesirable substance from uranium processing activities that may affect human health and the environment.
Contaminated plume	Ground water area portion of the naturally occurring ground water by impacted contaminants from uranium processing activities.
Contamination	Deposition of unwanted radioactive material on the surfaces of structures, areas, objects, and personnel including infiltration into ground water.

CHAPTER 15 — GLOSSARY

Cooperating agency	Federal, state, local, or tribal agency participating in scoping and document preparation for an environmental impact statement.
Cooperative agreement	Agreement between the DOE and an affected state or Indian tribe that defines the roles and responsibilities of the parties in implementing the UMTRA Project.
Curie	One Curie equals 3.70×10^{10} nuclear transformations per second.
Data validation	Systematic review of sampling, custody, and analysis documentation to verify compliance with established procedures and to assess data quality.
Derived concentration guideline	Concentration of a radionuclide in air or water that, under 1-year continuous exposure by one exposure mode (for example, drinking water or breathing the air), results in either an effective dose equivalent of 0.1 rem (1 mSv) or a dose equivalent of 5 rem (50 mSv) to any tissue, including skin and the lens of the eye.
Detection limit	Lowest concentration at which an analyte in a given sample medium can be unambiguously distinguished for a given confidence level using a particular combination of sampling and measurement procedures, sample volume, analytical detection limit, and processing procedure.
Disposal cell	Engineered embankment designed to isolate residual radioactive materials from the environment.
Dose	Term denoting the quantity of radiation energy absorbed.
Downgradient	Areas of an aquifer that are located in the same direction as ground water flow from a specified location.
Effluent	Liquid or gaseous waste discharge to the environment.
Effluent monitoring	Collection and analysis of samples or measurements of liquid, gaseous, or airborne effluent to characterize and quantify contaminants and process stream characteristics, assess radiation exposure to members of the public, and demonstrate compliance with applicable standards.
Environmental assessment	Document determining the potential for significant impact to the environment from an action.
Environmental impact statement	Document describing and evaluating the potential significant impact on the environment from several alternative actions, including no action.

CHAPTER 15 — GLOSSARY

Environmental surveillance	Collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media to determine the environmental quality of an industry or community. Commonly performed at sites containing nuclear facilities.
Eolian	Sediments deposited as a result of the transporting action of the wind.
Ephemeral stream	Stream or a portion of a stream flowing only in direct response to precipitation.
Exposure pathway	Route by which materials could travel between the point of release and the point of delivery of a radiation or chemical dose to a person.
Facies	Part or layer of a rock body as differentiated from other parts by appearance or composition.
Facies sequence	Succession of vertically related facies of sediments or rocks.
Filtered ground water sample	Water sample filtered through a 0.45-micron filter to remove micron-size colloidal particles suspended and floating in the water.
Fugitive dust	Dust and dust-like materials generated from waste storage areas and administration areas and originating from construction activities.
Gamma-dose equivalent	Dose equivalent derived from external radiation at a depth of 1 centimeter in tissue.
Gamma radiation	Short-wavelength electromagnetic radiation of nuclear origin with no mass or charge. Because of its short wavelength (high energy), gamma radiation can cause ionization. Other forms of electromagnetic radiation (such as microwave, visible light, and radio waves) have longer wavelengths (lower energy) and cannot cause ionization.
Gross alpha	Total amount of measured alpha activity without identification of specific radionuclides.
Gross beta	Total amount of measured beta activity without identification of specific radionuclides.
Ground water	Supply of water under the earth's surface that fills spaces between materials such as sand, soil, or gravel. In aquifers, ground water occurs in sufficient quantities that it can be pumped for drinking water, irrigation, and other purposes.
Ground water monitoring	Periodic sampling and analysis of ground water to measure water levels and detect the possible presence of chemicals.
Ground water plume	Defined area of ground water contamination.

Ground water remediation	Treatment of ground water to decrease the amount or mobility of contaminants.
Hazardous and Solid Waste Amendments	HSWA of 1984 to RCRA that greatly expanded the scope of hazardous waste regulation. Through the HWSA, Congress directed the EPA to take measures to further reduce the risks to human health and the environment caused by hazardous wastes.
Hazardous waste	Waste exhibiting any of the following characteristics: ignitability, corrosivity, reactivity, or extraction procedure toxicity (yielding toxic constituents in a leaching test). In addition, the EPA has listed as hazardous other wastes that do not necessarily exhibit these characteristics. Although the legal definition of hazardous waste is complex, the term generally refers to any waste that the EPA believes could pose a threat to human health and the environment if managed improperly. RCRA regulations set strict controls on managing hazardous waste.
Heap-leaching	Placing crushed ore in a pile underlain by an impermeable membrane to collect water and dissolved minerals removed from the ore by the process water.
Hydraulic conductivity	Ratio of flow velocity to driving force (head) for ground water flow in a porous medium (saturated sediments or rock).
Hydraulic gradient	In an aquifer, the rate of change of pressure head (usually in 0.01 ft of water) per unit distance of flow at a given direction (down the gradient).
Hydrology	Study of the properties, distribution, and circulation of water through the local environment.
Indicator parameter	A constituent introduced into the ground water by milling operations. These constituents are above background ground water concentrations and do not necessarily impact public health and the environment. Indicator parameters are selected based on their mobility and/or risk potential so as to provide early information on contamination zone movement.
Intercomparison program	Program that prepares, distributes for analysis, and compiles results for samples of known composition to assess analytical proficiency.
Ionization	Removal of electrons from an atom by means of interaction with radiation.
Isopleth	Line on a map or chart drawn through points of equal size or concentration.

CHAPTER 15 — GLOSSARY

Isotope	Atom with the same atomic number but different mass number. Isotopes usually have the same chemical properties, but could have very different radiological properties (such as half-life and type of radiation emitted).
Leachate	Water percolating through the bottom of a dump, landfill, or disposal cell.
Less than detectable	Measurement or calculated concentration that is not statistically different from the associated background or control value at a selected confidence level.
Level C	Quality control measure that provides low detection limits, a wide range of calibrated analytes, matrix recovery information, laboratory process control information, and known precision and accuracy.
Liquor	Process water that has dissolved the minerals from the ore.
Maximum concentration limit	Greatest amount of a contaminant present in water that will not produce adverse health effects after either short- or long-term consumption.
Mill site	See processing site.
Millirem	mrem. Dose equivalent that is one-thousandth of a rem.
Minimum detection level	Minimum amount of the constituent or species of interest that can be observed by an analytical instrument and distinguished from background and instrument noise with a specified degree of probability.
Mixed waste	Hazardous waste contaminated with low-level radioactive materials.
Monitor	Process of measuring certain constituents or parameters in an effluent stream continuously or at a frequency that permits a representative estimate of the amount to be taken over a specified interval of time.
National Emission Standards for Hazardous Air Pollutants	Standards found in the Clean Air Act that set limits for such pollutants as beryllium and radionuclides.
National Environmental Policy Act	Federal legislation, passed in 1969, regulating the issuance of permits for constructing and operating facilities that have the potential to impact the environment or public health. NEPA requires federal agencies to prepare an EIS when major actions are taken.

CHAPTER 15 — GLOSSARY

National Pollutant Discharge Elimination System	Federal program under the Clean Water Act, requiring permits for discharges into surface waterways.
NIST-traceable source	Particular source calibrated using the NIST that has traceable documentation.
Nonpoint source	Nonconfined area from which pollutants are discharged into a body of water, air, or soil.
Occurrence	Sudden release or sustained deviation from a regulated or planned operation that has environmental protection and compliance significance.
On-site	Area within the boundaries of a facility or site where public access is or can be controlled.
Operable unit	Discrete action comprising an incremental step toward comprehensively addressing site problems. Operable units may address specific areas of a site, specific site problems, or initial phases of an action performed over time or any actions that are concurrent but located in different parts of the site.
Perched	Ground water separated from an underlying body of ground water (usually the first aquifer) by unsaturated rock or sediments.
Permeability	Capacity of a rock or sediment to transport a fluid (usually water) as a rate of flow for a given distance through a given interval of time.
Piezometer	Well point used to measure the level to which water from a given aquifer will rise under its full head.
Point source	Single defined point (origin) of release such as stack, vent, pipe, or other discernable conveyance in water, air, or soil.
Pore fluid	Fluids within the pores of sediment, rock, or tailings (usually referring to the liquids contained in the porosity).
Potable water	Water suitable for consumption.
Potentiometric surface	Surface or level to which ground water in an aquifer would rise by hydrostatic pressure.
Processing site	Location where uranium ore was milled to remove the uranium.
Quality assurance	Action in environmental monitoring to ensure the reliability of monitoring and measurement data. Aspects include procedures, interlaboratory comparison studies, evaluations, and documentation.

CHAPTER 15 — GLOSSARY

Quality control	Routine application of procedures within environmental monitoring to obtain required standards of performance in monitoring and measurement processes. Procedures include instrument calibration, control chart development, and replicate and duplicate sample analysis.
Radioactive emissions	Release of radioactive material to the environment.
Radionuclide	Radioactive nuclide. There are several hundred known radionuclides, both artificially produced and naturally occurring. Characterized by the number of neutrons and protons in an atom's nucleus and their characteristic decay process.
Raffinate pond	Pond receiving the process water after removal of the uranium. Some uranium and other unwanted dissolved minerals remain in this raffinate water.
Random sample	Sample obtained in such a manner that all items or members of the lot or population have an equal chance of being selected.
Release	Unintentional discharge to the environment. Environment is broadly defined as any water, land, or ambient air.
Rem	Unit of radiation dose equivalent that takes into account different kinds of ionizing radiation and permits them to be expressed on a common basis. The dose equivalent in rems is numerically equal to the absorbed dose in rads multiplied by the necessary modifying factors.
Remedial action	Action consistent with the final remedy following a formal examination of the nature and extent or threat of a release, assessment of the risk, and selection of the final remedy based on an evaluation of possible alternatives.
Representative sample	Sample taken to depict the characteristics of a lot or population as accurately and precisely as possible. Representative sample may be a "random sample" or a "stratified sample," depending upon the objective of the sampling and the characteristics of the conceptual population.
Residual radioactive material	Uranium mill tailings determined by the DOE to be radioactive due to processing uranium ore and other waste at a processing site that the DOE determines to be radioactive and that relates to such processing.
Resource Conservation and Recovery Act	Amendment to the first federal solid waste legislation (the Solid Waste Disposal Act of 1965). In RCRA, Congress established initial directives and guidelines for the EPA to regulate hazardous wastes.

CHAPTER 15 — GLOSSARY

Riprap	Layer of large rock placed over a disposal cell as the final cover or cap.
Sample	1) Subset or group of objects selected from a larger set called the population; 2) extracted portion of a subset of an effluent stream or environmental medium.
Sampling	Extracting a prescribed portion of an effluent stream or an environmental medium for inspection and/or analysis.
Secondary Drinking Water Standards	Nonenforceable taste, odor, or appearance guidelines. When the taste, odor, and color of drinking water are below these guideline values, user complainants about water quality decline.
Site characterization	Provides the information needed to identify site hazards and select worker protection methods.
Solid Waste Management Unit	Any discernible unit at which solid waste has been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at or around a facility at which solid waste has been routinely and systematically released. Potential release sites include waste tanks, septic tanks, firing sites, burn pits, sumps, landfills (material disposal areas), outfall areas, LANL canyons, and contaminated areas resulting from leaking product storage tanks (including petroleum).
Static ground water elevation	Level to which ground water in a given aquifer will rise under its hydrostatic head under static well conditions (i.e., the well has not been pumped recently and the level is stabilized).
Superfund Amendments and Reauthorization Act	Act modifying and reauthorizing CERCLA. Title III of this act is also known as the Emergency Planning and Community Right-to-Know Act of 1986.
Supplemental standard	Standard that may be applied when contaminant concentration limits are greater than maximum concentration limits. The UMTRA Project may apply for supplemental standards when 1) ground water is not a current or potential source of drinking water due to poor quality or limited quantity; 2) ground water cleanup would create more environmental harm than benefit; or, 3) cleanup is not technically feasible.
Thermoluminescent dosimeter	Used to monitor the amount of radiation exposure.
Tolerance limit	Confidence limit frequently used in quality control work that applies to a percentage of the individual values of the population.

CHAPTER 15 — GLOSSARY

Total dissolved solids	Total dissolved, suspended, and colloidal particles in the water.
Total suspended particulates	Concentration of particulates suspended in the air irrespective of their nature, source, or size.
Toxicity characteristic leaching procedure	Analytical method to determine the mobility of both organic and inorganic compounds in liquid, solid, and multiphase wastes and the applicability of land ban regulations to a waste.
Transmissivity	Description of an aquifer's capability to transport ground water in relation to the aquifer thickness.
Transuranic	Element with an atomic number greater than uranium.
Unfiltered surface water sample	Sample containing dissolved, suspended, and colloidal particles.
Upgradient	Point located up the hydraulic gradient from a given point in an aquifer.
Uranium mill tailings	The sand-like portion of a metal-bearing ore remaining after some or all of the uranium has been extracted.
Vicinity property	Property outside a designated site boundary that has been contaminated by tailings dispersed by wind or water erosion or by people before the potential hazards of tailings were known.
Volatile organic compound	Liquid or solid organic compound with a tendency to spontaneously pass into the vapor state.
Water table	Boundary between the underground unsaturated zone and the saturated zone. Level to which a well screened in the unconfined aquifer would fill with water.
Wetland	Lowland area, such as a marsh or swamp, inundated or saturated by surface water or ground water sufficient to support hydrophytic vegetation typically adapted for life in saturated soils.