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Grand Junction Office
2597 B 3/4 Road
Grand Junction, CO 81503

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Site Environmental Report for Calendar Year 1996

June 1997

Work Performed Under DOE Contract No. DE-AC13-96GJ87460 for the U.S. Department of Energy

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**U.S. Department of Energy
Grand Junction Office**

**Site Environmental Report
for Calendar Year 1996**

June 1997

Prepared for
U.S. Department of Energy
Grand Junction Office
Albuquerque Operations Office

Prepared by
WASTREN-Grand Junction
2597 B 3/4 Road
Grand Junction, CO 81503

Work Performed Under DOE Contract No. DE-AC13-96GJ87460

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Acronyms

Ag	silver
Al	aluminum
AL	(U.S. Department of Energy) Albuquerque Operations Office
APEN	Air Pollution Emission Notification
As	arsenic
B	boron
Ba	barium
Be	beryllium
BOD	biochemical oxygen demand
Bq	Becquerel
Ca	calcium
Cd	cadmium
CDPHE	Colorado Department of Public Health and Environment
CDT	conductivity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CESQG	conditionally exempt small quantity generator
CFR	<i>Code of Federal Regulations</i>
Ci	curie
Cl	chlorine (chloride)
Co	cobalt
Cr	chromium
Cu	copper
DOE	U.S. Department of Energy
EA	Environmental Assessment
EDE	effective dose equivalent
EHS	extremely hazardous substance
EPA	U.S. Environmental Protection Agency
Fe	iron
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
g	gram
GJO	Grand Junction Office
GJORAP	Grand Junction Office Remedial Action Project
ha	hectare
Hg	mercury
H ₂ O	water
K	potassium
kg	kilogram
lb	pound
LLW	low-level waste
mg	milligram
mg/L	milligrams per liter
Mg	magnesium
Mn	manganese

Acronyms (continued)

$\mu\text{Bq/mL}$	microbequerel per milliliter
$\mu\text{Ci/mL}$	microcuries per milliliter
$\mu\text{g/L}$	micrograms per liter
Mo	molybdenum
mrem	millirem
mSv	milliseivert
N	nitrogen
Na	sodium
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
Ni	nickel
NiCad	nickel-cadmium
NO_3	nitrate
NPDES	National Pollutant Discharge Elimination System
ORNL	Oak Ridge National Laboratory
Pb	lead
PCB	polychlorinated biphenyl
pCi/L	picocuries per liter
PO_4	phosphate
QA	quality assurance
QAPP	quality assurance program plan
QC	quality control
Ra-226	radium-226
Ra-228	radium-228
RCRA	Resource Conservation and Recovery Act
RI/FS EA	remedial investigation/feasibility study environmental assessment
SARA	Superfund Amendments and Reauthorization Act
Sb	antimony
Se	selenium
Si	silicon
SO_4	sulfate
Sv	sievert
TDS	total dissolved solids
Tl	thallium
TSCA	Toxic Substances Control Act
TSS	total suspended solids
U	uranium
U-234	uranium-234
U-238	uranium-238
UMTRA	Uranium Mill Tailings Remedial Action (Project)
UMTRCA	Uranium Mill Tailings Radiation Control Act
USFWS	U.S. Fish and Wildlife Service

Acronyms (continued)

V	vanadium
WQCC	Water Quality Control Commission
yr	year
Zn	zinc
Zr	zirconium

Executive Summary

This *Annual Site Environmental Report* presents information pertaining to environmental activities conducted during calendar year 1996 at the U.S. Department of Energy (DOE) Grand Junction Office (GJO) facility in Grand Junction, Colorado. *WASTREN-Grand Junction*, the Facility Operations and Support contractor for the GJO, prepared this report in accordance with the requirements of DOE Order 5400.1, *General Environmental Protection Program*, and supplemental guidance from DOE Headquarters. This report applies specifically to the GJO facility; the *Monticello Mill Tailings Site Environmental Summary for Calendar Year 1996* was prepared as a separate document.

Primary GJO activities involve laboratory analysis of environmental samples from GJO and other DOE sites and site remediation of contamination caused by previous uranium mill operations. Activities at the GJO are conducted in compliance with applicable Federal, State, and local regulations and requirements and as directed by applicable DOE orders. Environmental monitoring is performed on air emissions, sewer effluent, surface water and groundwater, and wetlands restoration. Wastes are generated from the Analytical Laboratory, site remediation, and facility operation.

The site contractor conducted off-site dose modeling for the GJO to determine compliance with National Emission Standards for Hazardous Air Pollutants; DOE Order 5400.1; and DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. Modeling results indicated that the effective dose equivalent from all sources of radiation emanating from the facility was at least 9,000 times less than the applicable Federal standard.

Sewer effluent, sampled at the point of discharge to the city of Grand Junction sewer system, never exceeded discharge limits specified in the GJO industrial pretreatment permit and DOE Order 5400.5. However, contaminant concentrations exceeded Federal and State water-quality standards for surface water and groundwater in several samples from the North Pond, South Pond, and Wetland Area. The presence of uranium, lead, chloride, and sulfate were detected at levels above applicable State standards in several surface-water samples. Concentrations of uranium, molybdenum, arsenic, selenium, gross alpha, nitrate, and total dissolved solids were detected at levels above Federal and State standards in several groundwater samples. These analytes are associated with leachate from the uranium mill tailings formerly present on the facility. The on-site surface-water and alluvial groundwater are not currently used for any purpose.

Removal of uranium mill tailings was completed in 1994. Groundwater modeling of the alluvial aquifer predicts that passive remediation (natural flushing) will decrease contaminant concentrations in groundwater and surface water to levels below applicable standards within 50 to 80 years of tailings removal. This time frame is within the 100-year cleanup period required in groundwater regulations of the Uranium Mill Tailings Radiation Control Act and is addressed in the selected remediation alternative described in the Grand Junction Office Record of Decision (DOE 1990). Analyte concentrations that exceed Federal and State standards are documented

and reported annually in the GJO Site Environmental Report and provided to the appropriate regulatory agencies.

There were no major environmental issues in 1996 and there were no unplanned releases to the environment. The GJO has a program to audit activities that have environmental effect, assess environmental compliance, and implement corrective actions. The GJO effect on the environment was reduced in 1996 through an effective program of pollution prevention and decontamination/demolition of contaminated buildings.

1.0 Introduction

The U.S. Department of Energy (DOE) Grand Junction Office (GJO) facility is located in Mesa County, Colorado, immediately south and west of the Grand Junction city limits (Figure 1-1) at 2597 B 3/4 Road. The GJO is 1 kilometer (0.6 mile) from heavily populated areas of Grand Junction. The population of the city of Grand Junction and surrounding areas is approximately 105,000. Approximately 440 people work at the GJO facility. The facility encompasses 22.8 hectares (ha) (56.4 acres) in Sections 26 and 27, Township 1 South, Range 2 West, Ute Principal Meridian, at an elevation of approximately 1,390 meters (4,560 feet) above sea level (U.S. Geological Survey 1962).

The GJO facility lands were acquired by the U.S. War Department in August 1943 to refine uranium for the Manhattan Project. Uranium was milled, analyzed, and stored on the GJO facility from 1943 to 1975. All known environmental contamination is believed to be the result of these past activities. According to historical records (maintained by DOE and its predecessor agencies, the U.S. Atomic Energy Commission and the U.S. Energy Research and Development Administration), approximately 29,024 metric tons (32,000 short tons) of ore was processed between 1943 and 1958. The resulting tailings, consisting of approximately 136,100 cubic meters (178,000 cubic yards) of material, were stored or used at many locations at the site.

The GJO lies within the 1,000-year floodplain of the Gunnison River and is separated from the river by an earthen flood-control dike. The facility occupies an elongate, north-south-trending tract bounded on the west by the river and on the north, south, and east by agricultural, open-range, and railroad lands. Moderate, semiarid climatic conditions prevail in the Grand Junction area. Average daily temperatures range from an average maximum of 33 °C (92 °F) in the summer to an average minimum winter temperature of -9 °C (16 °F). Average annual precipitation in Grand Junction for the period 1962 to 1995 measured 22.4 centimeters (8.82 inches).

Groundwater within the alluvial aquifer beneath the site has been contaminated by the leached products of on-site uranium mill tailings. Water from the aquifer is not used for any purpose. All domestic surface-water sources for the Grand Junction area are located upstream of the GJO facility or are obtained from the Colorado River drainage system. The Gunnison River, which converges with the Colorado River about 0.8 kilometer (0.5 mile) downstream of the facility, is used for seasonal recreation activities such as boating, fishing, and swimming.

Site characterization and remedial action studies to assess the radiological hazards at the facility began in 1984 (Henwood and Ridolfi 1986) when the facility was accepted into the DOE Surplus Facilities Management Program. Facility oversight was transferred to the Defense Programs Decontamination and Decommissioning Program in 1988. In 1990, oversight of the GJO was transferred to the newly formed Office of Environmental Management.

In planning for cleanup of the facility, DOE-GJO complied with the National Environmental Policy Act (NEPA) process and also elected to comply with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) even though the site did not qualify for

Figure 1-1. Location of DOE-GJO Facility

placement on the National Priorities List. A Final Remedial Investigation/Feasibility Study-Environmental Assessment (RI/FS-EA) that addressed remediation of the facility was completed in 1989 (DOE 1989a). Removal of contaminated soils from open-land areas began in 1989 and was completed in June 1994 (Figure 1-2). Cleanup of contamination in and beneath on-site buildings is ongoing.

The current GJO mission is to provide project management, engineering, and scientific support to the Federal Government's environmental restoration programs. These programs include cleanup of the GJO site through the Grand Junction Remedial Action Project (GJORAP), the Uranium Mill Tailings Remedial Action (UMTRA) Project, and the UMTRA Groundwater Project. Housed on the facility are fully equipped laboratories for analytical chemistry, petrology, radon, and electronics. Several technical projects with other DOE facilities and Federal agencies are conducted at the GJO facility.

This annual Site Environmental Report for 1996 was prepared by *WASTREN-Grand Junction* (*WASTREN-GJ*), the Facility Operations and Support contractor for DOE-GJO. The purpose of this report is to provide DOE, State officials, the people of Colorado, and other interested parties current information on GJO activities and the effects of these activities on the environment. The 1996 Site Environmental Report follows the format described in the "Supplemental Guidance for the Preparation of the 1995 Annual Site Environmental Reports," provided by the DOE Office of Environmental Policy and Assistance.

Figure 1-2. DOE-GJO Facility Showing Areas of Radiological Contamination and Remediation

2.0 Compliance Summary

This section describes the GJO compliance status with applicable Federal environmental regulations, describes current issues and actions such as environmental audits, and contains a summary of the permits held by the DOE-GJO for management of the GJO site.

2.1 Compliance Status

In September 1996, a new contractor took over management of the site. The new contractor, *WASTREN-GJ*, conducted an independent environmental baseline audit in September and October 1996 to identify any environmental issues that might adversely affect the functioning of the site. The DOE-GJO site operated during calendar year 1996 without receiving any notices of violation and did not have any reportable occurrences that required reporting to outside agencies.

2.1.1 Comprehensive Environmental Response, Compensation, and Liability Act

Although the GJO facility was not placed on the National Priorities List by the U.S. Environmental Protection Agency (EPA), DOE-GJO elected to follow the CERCLA process for environmental cleanup of the facility. The GJORAP was initiated to remove contaminated materials associated with past uranium-milling activities on the site. An RI/FS-EA (DOE 1989a) was completed in 1989, and a Record of Decision (DOE 1990) was finalized and approved by the DOE Idaho Operations Office in April 1990.

GJORAP activities in 1996 included removing radioactively contaminated materials from Buildings 1, 34, and 36. During the year, 1,524 metric tons (1,680 short tons) of contaminated material was removed and transported to the UMTRA Cheney Disposal Cell, located 17 miles southeast of Grand Junction.

The GJORAP Information Repositories are located at the Mesa County Library in Grand Junction and in the Technical Library at the GJO. The repositories were updated in March 1996. In future years, the repositories will be updated semiannually (in January and June).

2.1.2 Superfund Amendments and Reauthorization Act, Title III, Executive Order 12856

DOE-GJO developed a Chemical Tracking System in 1995 to comply with the reporting and notification requirements of the Superfund Amendments and Reauthorization Act of 1986 (SARA), Emergency Planning and Community Right-To-Know Act of 1986 (Sections 311, 312, and 313), and Executive Order 12856, "Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements."

During 1996, extremely hazardous substances (EHS) or hazardous chemicals were not stored at the GJO facility in amounts exceeding the threshold planning quantities established in Sections 311 and 312 of SARA Title III. In addition, toxic chemicals were not used at the GJO in excess of applicable threshold quantities established in Section 313 of SARA Title III, and no reportable releases of hazardous substances (as defined by Section 304 of SARA Title III)

occurred at the GJO facility; therefore, the applicability of SARA Title III reporting requirements for calendar year 1996 is as follows:

- Sections 302–303: Planning Notification—not required.
- Section 304: EHS Release Notification—not required.
- Sections 311–312: Material Data Safety Sheets/Chemical Inventory—not required.
- Section 313: Toxic Chemical Release Inventory Reporting—not required.

On March 1, 1997, DOE–GJO informed the Colorado Emergency Response Commission, the Mesa County Emergency Planning Committee, and the Grand Junction Fire Department by letter that no chemicals were stored in excess of the applicable thresholds during 1996.

2.1.3 Resource Conservation and Recovery Act

DOE–GJO operates under the special requirements (codified at Title 40, Section 261.5, of the *U.S. Code of Federal Regulations* [CFR]) for conditionally exempt small-quantity generators (CESQGs) of hazardous and mixed waste. GJO maintains its CESQG status providing the facility generates no more than 100 kilograms (kg) (220 pounds [lb]) of hazardous and mixed waste in a calendar month and stores no more than 1,000 kg (2,200 lb) before shipment for treatment and disposal. CESQG wastes are not subject to full regulation under 40 CFR 124, 262 through 266, 268, and 270; however, the generator must comply with certain requirements. CESQGs can accumulate waste on site and remain exempt from full regulation as long as generation and storage requirements are not exceeded. If on-site waste accumulation exceeds 1,000 kg, all the accumulated wastes become subject to small-quantity generator requirements, including the land disposal restrictions codified at 40 CFR 268. DOE–GJO maintained CESQG status during 1996 for all months except May. During that month, the GJO generated approximately 418.5 kg (923 lb) of nonacutely hazardous waste and was therefore classified as a small quantity generator for that month only. Because DOE–GJO routinely operates under the criteria for a small-quantity generator as a best management practice, the waste generated during the month of May was managed appropriately.

2.1.4 National Environmental Policy Act

During 1996, the *Environmental Assessment of Facility Operations at the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado* (DOE 1996a) was completed. This environmental assessment (EA) described the potential environmental and human health effects associated with operations at the GJO facility. Completion of the EA and issuance of the accompanying Finding of No Significant Impact reduced the number of activity reviews required under NEPA at the site.

Prior to the approval of the EA in 1996, five proposed actions on the GJO facility were reviewed for compliance with NEPA requirements in accordance with 10 CFR 1021; DOE Supplemental

Directive 5440.1D, *U.S. Department of Energy Albuquerque Operations Office NEPA Compliance Program*; and DOE Order 451.1, *NEPA Compliance Program*. Environmental checklists were prepared for all these proposed actions, which are described in the list of categorical exclusions in 10 CFR 1021, Subpart D, Appendix B. The DOE Albuquerque Operations Office (AL) determined that the proposed actions were categorically excluded from further NEPA review.

NEPA determinations, reviews, and approvals were tracked and updated monthly in 1996. In addition, a NEPA Annual Planning Summary, which lists EAs and environmental impact statements to be prepared during the year, was submitted to DOE-AL in January 1996.

2.1.5 Uranium Mill Tailings Radiation Control Act

The Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) authorized remedial action at certain inactive uranium milling sites that were not owned by the Federal government. Because the GJO facility is owned by DOE, this is not an applicable requirement; however, UMTRCA is considered a relevant and appropriate requirement for remedial action at the facility. Cleanup of radioactive contamination is conducted in compliance with the standards specified in UMTRCA, which are codified at 40 CFR 192.

2.1.6 Clean Air Act/National Emission Standards for Hazardous Air Pollutants

In 1991, the Colorado Department of Public Health and Environment (CDPHE) granted DOE-GJO an air emission permit for the Analytical Laboratory. The permit established limitations on (1) the annual emissions of particulate matter, volatile organic compounds, and benzene; (2) the annual consumption of acids, volatile organic compounds, and benzene; and (3) the opacity of emissions. As in previous years, no limits were exceeded in 1996.

Off-site dose modeling using CAP88PC dose assessment software was conducted for the facility to determine compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP), Subpart H; DOE Order 5400.1, *General Environmental Protection Program*; and DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. The calculated effective dose equivalents for radiological emissions from the GJO point and diffuse sources are 2.46×10^{-4} and 8.42×10^{-4} millirem per year (mrem/yr), respectively, which are at least 11,000 times below the DOE and EPA standard of 10 mrem/yr.

2.1.7 Clean Water Act/National Pretreatment Program

Sewer effluent from the facility is routed to the publicly owned treatment works operated by the city of Grand Junction. A Class II Industrial Pretreatment Permit (No. 023) was reissued to DOE-GJO by the city of Grand Junction in April 1996 in accordance with provisions of the Federal Water Pollution Control Act as amended by the Clean Water Act and Article 10 of Chapter 25 of the Code of Ordinance for the city of Grand Junction. The permit requires that the sewer effluent be sampled and measured for biochemical oxygen demand (BOD), oil and grease, polychlorinated biphenyls (PCBs), pH, silver, total suspended solids (TSS), total dissolved solids

(TDS), ammonia, temperature, and flow. Threshold limits were assigned to oil and grease, PCBs, pH, silver, and temperature. DOE-GJO sampled its sewer effluent quarterly in accordance with the permit and reported the results to the city. None of the reported results exceeded established threshold limits (Table 5-2).

The GJO facility has no wastewater or storm-water discharges that are regulated by the National Pollutant Discharge Elimination System (NPDES) and, therefore, is not required to have NPDES discharge permits for its current activities and operations. As a best management practice, however, DOE-GJO monitors storm water when possible.

2.1.8 Clean Water Act/Executive Order 11990, "Protection of Wetlands"

Through the U.S. Army Corps of Engineers, DOE obtained a 404 permit for excavation of tailings-contaminated materials in riparian areas along the Gunnison River and in wetland areas. Restoration was completed in spring 1995, and monitoring was initiated in August 1995. Results of the monitoring were documented in the *Second Annual Monitoring Report for the U.S. Department of Energy Grand Junction Office Wetland Mitigation Project* (DOE 1996b). The permit was officially terminated in 1996 because restoration activities were completed. Monitoring activities will continue and a monitoring report will be completed annually through 1999.

2.1.9 Safe Drinking Water Act

The provisions of the Safe Drinking Water Act are not relevant to the GJO facility because neither groundwater nor surface water at or near the site is used for public consumption.

2.1.10 Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) was enacted in 1976 to fill the significant gap left by other Federal regulations. The Clean Air Act, the Federal Water Pollution Control Act, and other laws dealt with chemical substances only when they entered the environment as wastes (emissions to air and discharges to water). TSCA was created to regulate the manufacturing of chemical substances. TSCA provides EPA with authority to require testing of chemical substances, both new and old, entering the environment and to regulate them where necessary.

TSCA specifically addresses the use of PCBs and asbestos. The rate of generation of TSCA-related wastes at GJO is low and is generated primarily from replacement and removal of PCB-containing light ballasts. Asbestos waste is generated from the removal of asbestos-containing materials such as ceiling insulation, damper material, and linoleum. The PCB waste generated in 1996 was stored on site for later disposal (within the 9-month time period), and the asbestos waste was disposed of in the Mesa County Landfill.

Because the GJO was the site of uranium processing, residual radioactive material still exists on the site, and both asbestos and PCB waste present on the GJO may be contaminated with residual radioactive material. There are no commercial disposal facilities at this time that accept radioactive PCB waste. The GJO stores radioactive PCB wastes in compliance with 40 CFR 761.65 and in accordance with the *Federal Facilities Compliance Agreement on the Storage of Polychlorinated Biphenyls* (August 1996).

Asbestos was removed from Buildings 1, 12, and 46 and was disposed of at the Mesa County Landfill in compliance with local, State, and Federal regulations. Radioactively contaminated, asbestos-containing material was removed from Buildings 1, 34, and 36 and was disposed of at the Cheney Disposal Cell. In addition, three radiologically contaminated trailers that contained nonfriable asbestos linoleum were demolished and shipped to the Cheney Disposal Cell for disposal. Work performed before September 5, 1996, was conducted under General Contractor Abatement Certificate No. 84-1034010, issued to Rust Geotech Inc. by the Air Pollution Control Division of CDPHE on February 22, 1993. After September 5, 1996, work requiring a general contractor abatement certificate was performed by an outside subcontractor.

2.1.11 Federal Insecticide, Fungicide, and Rodenticide Act

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) governs the use, storage, registration, and disposal of pesticides. FIFRA categorizes pesticides as either "restricted use" or "general use." EPA may classify a pesticide as a restricted-use pesticide (1) if it is determined that substantial adverse effects to the applicator or environment may occur without additional regulatory restrictions or (2) if unreasonable harm to humans or the environment may occur, even if the pesticide is used as directed by the label instructions. FIFRA regulations require that restricted-use pesticides be used or applied only by a certified private or commercial applicator or under the direct supervision of a certified applicator. No restricted-use pesticides were used or stored at the GJO during 1996.

2.1.12 Endangered Species Act

Section 7 of the Endangered Species Act requires DOE to ensure that any actions authorized, funded, or performed at the facility do not "jeopardize the continued existence of threatened or endangered species and do not destroy or adversely modify critical habitat required for the continued existence of that species." The Gunnison River adjacent to the facility provides habitat for four endangered fish: the Colorado squawfish, humpback chub, bonytail chub, and razorback sucker. Withdrawals of water from the river were needed for dust abatement and irrigation at the facility during site remediation and revegetation from 1992 through 1995. A biological assessment addressing the effects of the proposed withdrawals on fish habitat was prepared and submitted to the U.S. Fish and Wildlife Service (USFWS) in 1991. The USFWS released a biological opinion and approved the withdrawals with a stipulation that DOE mitigate the effects of its actions on the endangered fish by making payment to the Colorado River recovery fund each year that water is withdrawn. The GJO has not withdrawn water from the Gunnison River since 1995 and has no plans for withdrawing water in the future. However, arrangements with the USFWS will be made in the event that withdrawals are deemed necessary in the future.

2.1.13 National Historic Preservation Act

The National Historic Preservation Act requires DOE to assess the effects of federally assisted actions on a structure or object that is included on or eligible to the National Register of Historic Places. During 1996, no actions affecting such structures or objects occurred on the facility.

2.1.14 Executive Order 11988, "Floodplain Management"

The U.S. Corps of Engineers (1976) determined that the GJO facility was not in the 100-year or the 500-year floodplain of the Gunnison River. The Mesa County Housing and Urban Design Flood Insurance Rate Map (July 1978) places the GJO facility within the 1,000-year floodplain. In accordance with Executive Order 11988, "Floodplain Management," the *Mesa County Floodplain Permit Application* (DOE 1989b) was prepared, and a permit was obtained in 1989 for the facility and GJORAP operations.

2.2 Current Issues and Actions

There were no major ongoing environmental issues at GJO and there were no nonroutine or unplanned releases to the environment. GJO utilizes external environmental audits, internal environmental audits, and management compliance assessments to evaluate environmental compliance and to implement corrective actions.

2.2.1 Environmental Audits

During 1996, 22 external audits and appraisals were performed at GJO. Included in these audits were six audits of the Analytical Laboratory (including a certification audit by the State of Utah); three audits related to Industrial Hygiene, Occupational Safety, and Health Physics environmental work; one audit on suspected hazardous waste; and one audit on the industrial pretreatment permit. Only minor findings were identified in any of these audits and all findings were closed at the end of 1996. In addition, representatives from *WASTREN Technical Services* conducted an environmental baseline audit in September and October of 1996; 21 findings were identified, and corrective actions were developed and implemented for each. All findings from the environmental baseline audit were resolved within 30 days of issuance of the audit report.

Two internal environmental audits of GJO facility operations were conducted by the contractor in 1996 relating to the Instrument Calibration System and Engineering Document Controls. Contractor Quality Assurance (QA) coordinators completed 26 compliance surveillances during 1996 that were related to environmental compliance, measurement, waste handling and storage, and sampling and monitoring activities.

The Analytical Laboratory continued to maintain its certifications and proficiency program, participating in the DOE Environmental Measurements Laboratory and other proficiency programs related to waste analytical methods and data.

2.2.2 Management Compliance Assessments

Management compliance assessments were initiated in March 1991 at the GJO facility to provide a comprehensive review of activities associated with environmental protection, safety and health, management systems, and organizational structure. The objectives of the assessments were to achieve the highest level of safety for the public and for facility employees, to protect the environment, and to provide feedback to management for the improvement of compliance and operations at the facility.

During 1996, 32 management compliance assessments were conducted for a variety of programs and activities. The assessments focused on management and organizational structure, health and safety, and environmental concerns. No conditions imminently hazardous to the environment or to health and safety were identified, although corrective actions were implemented as a result of the assessments.

2.3 Summary of Facility Permits

Table 2-1 contains the types of permits that were active at the DOE-GJO site during 1996.

Table 2-1. Types of DOE-GJO Permits Active in 1996

Type of Permit	Issuing Agency	Number of Permits
Industrial Pretreatment Permit	City of Grand Junction, Colorado	1
General Abatement Certificate (asbestos)	State of Colorado	1
RCRA Hazardous Waste Storage Permit Application, Part A	State of Colorado	1
Air Pollution Emission Notice	State of Colorado	4
Gravel Pit Permit	State of Colorado	1
Pond Permit	State of Colorado	1
Floodplain Permit	Mesa County, Colorado	1
Section 401 Water Quality Certification	State of Colorado	1
Section 404 Permit	U.S. Army Corps of Engineers	1
Well Permit	State of Colorado	48

3.0 Environmental Program Information

Environmental programs at the GJO facility include air monitoring, water monitoring, environmental remediation, waste management, and pollution prevention. This section provides descriptions of all program elements except the groundwater program, which is presented in Section 6.0, "Groundwater Monitoring and Protection Program." Air and water monitoring results, excluding groundwater, are presented in Section 4.0, "Environmental Radiological Program Information" and Section 5.0, "Environmental Nonradiological Program Information." This section presents brief discussions of data associated with environmental remediation, waste management, and pollution prevention.

In addition to the environmental programs, GJO has a comprehensive Health and Safety Program and Radiological Control Program to minimize workplace hazards and to ensure protection to employees and the public. These programs are described in the *GJO Health and Safety Policy Manual* (DOE 1996c) and the *GJO Site Radiological Control Manual* (DOE 1997a).

3.1 Air Monitoring

Three air monitoring programs, designed to monitor the effect of GJORAP contamination on the facility's ambient air quality, were discontinued in July 1994 after the removal of residual radioactive material from open-land areas of the facility. The discontinued programs monitored atmospheric radon, ambient-air particulates, and direct gamma radiation. GJO continues site-specific meteorological monitoring, radiological airborne emissions monitoring and estimation, and nonradiological airborne emissions monitoring (opacity and chemical consumption).

3.1.1 Meteorology

Meteorological monitoring was conducted in 1996 at the GJO facility to support off-site dose calculations. The meteorological monitoring station is located in the northern portion of the facility (Figure 3-1); monitoring was initiated in November 1993. Parameters measured consisted of wind speed, wind direction, temperature, barometric pressure, precipitation, and relative humidity. Hourly standard deviation of wind direction was calculated and used to determine atmospheric stability. Wind data collected during 1996 were processed to create a stability array file, which served as an input parameter for the EPA-approved model CAP88PC, to calculate the 1996 off-site effective dose equivalent. Detail on the model and input parameters is provided in Section 4.1, "Radiological Air Emissions," and Section 4.2, "Radiological Dose Modeling."

3.1.2 Air Emissions Monitoring and Estimation for Radiological Constituents

Radiological air-emissions monitoring and estimation is conducted on the GJO facility to assess the potential radiation dose to members of the public that could result from site operations and to demonstrate compliance with the dose standards established by NESHAP, 40 CFR Part 61, Subpart H; and DOE Order 5400.5. Sources of radioactive air emissions on the GJO facility during 1996 included the Sample Preparation Facility (Baghouse), Oak Ridge National

Figure 3-1. Air Emission Sources, Baghouse Sampling, and Meteorological Monitoring Locations at the DOE-GJO Facility

Laboratory (ORNL) sample preparation trailer, Analytical Laboratory, Radon Laboratory, Calibration Test Pits, and contaminated-soil excavation areas. Radioactive air emissions are generated during environmental sample preparation, such as grinding, blending, and digestion and during instrument calibration and soil excavation.

Point Source Particulates

Three point sources (the Baghouse, ORNL sample preparation trailer, and Analytical Laboratory) contributed to radioparticulate air emissions from the GJO facility during 1996 (Figure 3-1). EPA granted an indefinite waiver of sampling requirements for the ORNL sample preparation trailer and the Analytical Laboratory, but required that the Baghouse emissions be sampled. The ORNL sample preparation trailer and Analytical Laboratory radionuclide emissions were estimated according to guidelines in 40 CFR Part 61, Appendix D. Radiological emissions from the Baghouse were continuously sampled during operation with an isokinetic sampling system. The point source information is presented in Table 3-1. The radionuclides released from these point sources and estimated total emission levels during 1996 are presented in Section 4.1.1. Point-source dose modeling results are provided in Section 4.2.

Table 3-1. GJO Point Source Information

Point Source	Type of Control	Efficiency (%)	Distance to Nearest Receptor
Baghouse	Cloth bag filtration	90	500 meters (1,640 feet)
ORNL sample preparation trailer ^a	None	NA	500 meters (1,640 feet)
Analytical Laboratory ^a	Wet scrubbers	50 - 75	500 meters (1,640 feet)

^aEmissions were estimated according to guidelines in 40 CFR Part 61, Appendix D.

Nonpoint Source Particulates

Nonpoint sources of radioactive air emissions from the GJO facility during 1996 involved fugitive emissions from the excavation, stockpile, and hauling of soil contaminated with uranium mill tailings. The contaminated soils were excavated adjacent to and beneath four buildings on the GJO facility. The radionuclides released from these sources and estimated total emission levels during 1996 are presented in Section 4.1.2. Nonpoint source dose modeling results are presented in Section 4.2.

Atmospheric Radon

Sources of radon emissions from the GJO facility include the Calibration Test Pits and Radon Laboratory (Figure 3-1). Radon air emissions were generated during instrument calibration. Estimates of radon emissions from the Calibration Test Pits are based on radon flux measurements from selected pads. Estimates of radiological emissions from the Radon Laboratory are based on source inventories.

3.1.3 Air Emissions Monitoring and Estimation for Nonradiological Constituents

Air emissions monitoring and estimation for nonradiological constituents is conducted on the GJO facility to demonstrate compliance with specific permit and Air Pollution Emission Notification (APEN) exemption requirements. The permit specifies visible emission (opacity) requirements; sets limitations on particulate matter (as acids), volatile organic compounds, and benzene emissions; and sets maximum consumption rates on acids, volatile organics, and benzene. Air emission sources at the GJO facility include the Analytical Laboratory, Petrology Laboratory, and Baghouse. These sources are regulated by the Colorado Air Quality Control Commission Regulation No. 3.

The Analytical Laboratory is subject to the requirements of an Air Emission Permit No. 90ME402-1 issued by the Air Pollution Control Division of CDPHE, and granted final approval in January 1994. Emission sources at the Petrology Laboratory and Baghouse have been granted APEN and permit exemptions by the Air Pollution Control Division.

Opacity

The requirement that visible emissions not exceed 20-percent opacity is a specific term of Air Emission Permit No. 90ME402-1 and the APEN/permit exemptions granted to the Baghouse and Petrology Laboratory. Monthly observations of visible emissions from these sources were conducted by a qualified observer to ensure that compliance with the opacity limit was maintained.

Permitted Releases

In addition to the opacity requirement, Air Emission Permit No. 90ME402-1 for the Analytical Laboratory establishes limitations on (1) the annual emissions of particulate matter, volatile organic compounds, and benzene and (2) the annual consumption of acids, volatile organic compounds, and benzene. Consumption rates are monitored annually to demonstrate compliance with this permit condition.

The APEN exemption granted to the Baghouse establishes limitations on the quantity of soil processed annually. Soil processing is monitored to demonstrate compliance with this APEN exemption requirement. Section 5.0 provides a comparison of the 1996 chemical consumption and quantity of soil processed with permit limitations.

3.2 Water Monitoring

The GJO monitors the sewer effluent entering the city sewer system, surface water and groundwater on and adjacent to the GJO facility, and storm-water discharges. This section presents descriptions of monitoring activities performed in 1996 associated with the sewer, surface water, and storm water. Section 6.0 presents descriptions of groundwater monitoring activities and results.

3.2.1 Sewer Effluent

The GJO sewer effluent consists of domestic sewage and wastewater discharges from the Analytical Laboratory, Radon Laboratory, cafeteria, maintenance shop, and microfiche processing center. The GJO sewer system discharges to the city sewer system, which is routed to the City of Grand Junction Publicly Owned Treatment Works. The GJO sewer effluent is monitored to demonstrate compliance with the standards and requirements established by DOE Order 5400.5 and the Class II Industrial Pretreatment Permit issued to the GJO facility by the city.

Sewer Effluent Monitoring for Radioactive Constituents

Sources of radioactive liquid discharges to the GJO sewer system are the Analytical Laboratory and the Radon Laboratory. Radioactive liquids are generated in the course of environmental sample preparation and analysis and are discharged directly to the GJO sewer system. Administrative controls are in place to ensure that the level of radioactivity does not exceed levels established in DOE Order 5400.5, conservatively set at 1.5×10^{-7} microcuries per milliliter ($\mu\text{Ci/mL}$) (5,550 microbecquerels per milliliter [$\mu\text{Bq/mL}$]) at the sewer outfall.

Flow-proportioned composite sewer effluent samples are collected and analyzed monthly for gross alpha, gross beta, and tritium activity to demonstrate compliance with the standard established in DOE Order 5400.5. Isotopic analysis is performed if the sum of gross alpha and gross beta activities exceeds $1.5 \times 10^{-7} \mu\text{Ci/mL}$ (5,550 $\mu\text{Bq/mL}$). In the past, uranium concentrations that exceeded the standard were determined to be from natural uranium, a common groundwater constituent in Mesa County, Colorado. No radionuclide concentrations exceeded the standard in 1996. The maximum gross alpha and gross beta activities are provided in Section 4.3.

Sewer Effluent Monitoring for Nonradioactive Constituents

The GJO sewer effluent Class II Industrial Pretreatment Permit was issued to DOE-GJO under the authority of the City of Grand Junction's Industrial Pretreatment Program, Section 38 of the Code of Ordinance; the Colorado Water Quality Control Act; and the Federal Water Pollution Control Act as amended by the Clean Water Act of 1977. The original GJO Industrial Pretreatment Permit issued in March 1989 has been renewed twice. The current permit (No. 023) is effective from July 1, 1996, through June 30, 1999, and requires quarterly sampling of the GJO sewer effluent at the discharge point to the city of Grand Junction sewer system (Outfall 001). The location of Outfall 001 is shown in Figure 3-2.

Sampling was conducted at Outfall 001 in March, May, August, and December 1996. Sewer effluent samples were analyzed for BOD, TSS, TDS, ammonia, temperature, pH, oil and grease, silver, and PCBs, as required by the permit. The current permit provides threshold limits for temperature, pH, silver, and PCBs. A summary of the 1996 sampling results and comparison with established threshold limits is provided in Section 5.2, Table 5-2.

Figure 3-2. Sewer Effluent and Storm-Water Sampling Locations at the DOE-GJO Facility

3.2.2 Surface Water

Surface-water monitoring is conducted to verify compliance with State water-quality standards and to detect changes in water quality resulting from remedial actions. Surface-water sources at or near the GJO facility consist of the North Pond, South Pond, Wetland Area, and Gunnison River, all of which contain water year-round. The North Pond, South Pond, and Wetland Area are located on the GJO facility, and the Gunnison River is contiguous to the facility's west and north boundaries (Figure 3-3). The wetlands were created in spring 1994 from the excavation of contaminated soils during GJORAP operations. This area was not backfilled after excavation, which resulted in a depression that is recharged by groundwater. Although the majority of the wetlands are dry during low groundwater periods (September through March), a portion of the area was designed to contain water year-round for monitoring purposes; this area forms the sampling location called the Wetland Area.

In accordance with the CDPHE Water Quality Control Commission (WQCC) "Basic Standards and Methodologies for Surface Water" (5 CCR 1002-8), the State has designated four use classifications for the segment of the Gunnison River near the GJO facility:

(1) Recreation—Class I, (2) Cold Water Aquatic Life—Class I, (3) Domestic Water Supply, and (4) Agriculture. Table 5-3 lists the State water-quality standards associated with these classifications and lists the more stringent standard if more than one exists. Where table value standards were adopted by CDPHE WQCC, the numerical criteria provided were used to determine the standard. The North Pond and South Pond are subject to the WQCC's general narrative water-quality standards and specific water-quality standards for radioactive materials and organic pollutants. The Wetland Area is subject only to the WQCC's narrative water-quality standards for created wetlands.

The surface-water sampling locations are near the shore of the Gunnison River upstream of the facility (Upper Gunnison), adjacent to the facility (Upper Middle Gunnison and Middle Gunnison), downstream of the facility (Lower Gunnison), near the western shores of the North and South Ponds, and at the Wetland Area (Figure 3-3).

Surface-water samples were initially collected quarterly during the removal of tailings and contaminated soil from the facility (1990 through 1994). A 9-month sampling frequency was phased in as completion of the remediation was approached. Sample collection from the North Pond, South Pond, and Wetland Area was changed to the 9-month frequency following the December 1993 sampling event, and the Gunnison River locations were changed to the 9-month frequency following the September 1994 sampling event. The 9-month sampling frequency was implemented to allow for an annual assessment of compliance with State water-quality standards and to observe seasonal fluctuations in contaminant concentrations. The 9-month frequency results in four rounds of sampling over a 3-year period. Surface-water samples were collected in March and December of 1996.

Surface-water alkalinity, turbidity, pH, conductivity, and temperature were determined in the field; surface-water samples were collected and analyzed in the laboratory for metals (arsenic, barium, cadmium, chromium, iron, lead, manganese, molybdenum, selenium, and vanadium),

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major cations (calcium, magnesium, potassium, and sodium), major anions (chloride, nitrate, and sulfate), radionuclides (gross alpha, radium-226, and total uranium), and TDS. These analytes are used to characterize general water quality and to monitor the effects of alluvial groundwater under the GJO facility on surface-water quality. Historical and 1996 maximum analyte concentrations in samples from the Gunnison River are compared with applicable State standards in Table 5-3.

3.2.3 Storm Water

The GJO facility storm water is routed through a series of drain lines and discharged into the South Pond. The storm water consists of runoff from the facility parking lots, other paved areas, and office buildings. Sampling of storm-water effluent began in 1994 in response to an environmental baseline audit finding (DOE 1991) (Figure 3-2). The storm-water discharge was sampled as a best management practice in 1994 and 1995, although the GJO's storm-water effluent is not subject to EPA's NPDES permitting requirements. Storm water was not sampled in 1996, and the benefit of continuing the sample collection is currently under consideration for 1997.

3.3 Environmental Remediation

GJORAP encompasses activities associated with the removal of uranium mill tailings and mill-related contamination from early GJO operations. All known on-site radiological contamination of groundwater, surface water, and soils is believed to be a result of those past activities. Remedial action site investigations formally began in 1984 when the facility was accepted into the DOE Surplus Facilities Management Program. The *GJORAP Final Remedial Investigation/Feasibility Study Report for the U.S. Department of Energy Grand Junction Projects Office* (DOE/ID/12584-16) (DOE 1989a) was issued in July 1989 and the *Declaration for the Record of Decision and Record of Decision Summary* (DOE 1990) was issued in April 1990.

The total volume of uranium tailings and tailings-contaminated material at the GJO was estimated at 191,000 cubic meters (m^3) (250,000 cubic yards [yd^3]). The tailings and related materials occupied approximately 8 ha (20 acres). Areas of contamination included the North Pond area, the leased U.S. Army Reserve areas, the South Pond area, the dike area along the Gunnison River, and a number of smaller, scattered locations (Figure 1-2). Removal of uranium mill tailings and contaminated soil began in late 1989, and the majority of the contaminants were removed by 1994. Current environmental remediation activities include limited GJORAP activities and monitoring of the wetlands that were established after tailings removal.

3.3.1 GJORAP Activities

Remediation under GJORAP continues as old buildings are decontaminated and remodeled or demolished. Radiologically contaminated soil, building debris (including asbestos), and other radiologically contaminated waste are handled as residual radioactive material and disposed of

accordingly (Sections 3.4.2 and 3.4.3). In addition, release surveys are performed and closeout reports prepared to release the buildings for unrestricted use.

Buildings 1, 34 and 36, which were contaminated with residual radioactive material, were demolished and disposed of during 1996. Contaminated soils were removed from underneath Building 46 and adjacent to Building 2. A risk analysis was performed and a report prepared showing that minor amounts of residual radioactive material in Building 2 will pose no significant threat to the public or environment if the building is released for unrestricted use without further remediation. Approximately 1,500 metric tons (1,650 short tons) of radiologically contaminated materials from GJORAP activities were shipped off site for disposal during 1996.

3.3.2 Wetlands Restoration and Monitoring

As required under Section 404 of the Clean Water Act, approximately 0.61 ha (1.5 acres) of wetland habitat, 3.0 ha (7.4 acres) of riparian habitat (1.3 ha [3.1 acres] of jurisdictional and 1.7 ha [4.2 acres] of nonjurisdictional), and 4.3 ha (10.7 acres) of upland (nonjurisdictional) habitat were revegetated in 1994 and 1995 (Figure 3-4). Efforts consisted of applying 10 to 15 cm (4 to 6 inches) of topsoil, seeding native and adapted grass species, transplanting trees and shrubs, irrigating the revegetated areas, and applying fertilizer as needed to promote seedling growth.

Special conditions of the Section 404 permit (No. 10040) require a 5-year monitoring program to evaluate the effectiveness of wetland revegetation. Monitoring began in 1995, when flood waters created erosion problems and prevented the wetland vegetation from becoming established. In spring 1996, the Wetland Area was revegetated with containerized willow, sedge, and rush plants and live rootstocks of creeping spike rush and hardstem bulrush. A riparian seed mix was broadcast seeded throughout the area.

The total vegetative cover in the Wetland Area increased from essentially no cover in 1995 to 25 percent in August 1996. The vegetation is all herbaceous, as no willows have survived in the jurisdictional wetland area. The established vegetation is healthy and nonweedy, and the plants are expected to continue filling the interior portions of the wetlands in 1997. No additional revegetation is recommended at this time.

Revegetation of the riparian area is progressing well. Survival rates for silver buffaloberry, skunkbush sumac, willow, and cottonwood were 72, 85, 12 and 47 percent, respectively. The plants were well established, and the majority were growing well despite some browsing by deer. Growth rates of the woody vegetation, as measured by the sum of the height and canopy dripline, was 34 percent for skunkbush sumac, 28 percent for silver buffaloberry, 87 percent for cottonwood, and 39 percent for willow. Ground cover of all herbaceous species was 49 percent.

3.4 Waste Management

The GJO routinely generates small volumes of Resource Conservation and Recovery Act (RCRA) hazardous waste, TSCA waste, radioactive waste, and RCRA-radioactive mixed waste.

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Occasionally, the GJO generates TSCA-radioactive mixed waste. The GJO stores waste prior to shipment off site for treatment and disposal. Programs, policies, and procedures are in place to minimize waste generation and manage wastes that cannot be minimized in compliance with applicable Federal and State regulations and DOE directives.

3.4.1 RCRA Hazardous-and Mixed-Waste Management

Hazardous and mixed wastes are generated primarily from analysis of environmental samples by the Analytical Laboratory and from co-mingled hazardous and residual radioactive material from site remediation. The GJO accumulates hazardous and mixed waste in satellite accumulation areas and commercially manufactured storage modules (Buildings 61A and 61C). Hazardous wastes are shipped off site to commercial treatment and disposal facilities approximately one or two times each calendar year. The GJO maintains a RCRA Part A interim-status storage facility (Building 42) for storage of mixed waste that currently has no route for treatment. The GJO has prepared a closure plan for this facility in accordance with the requirements for closure established at 40 CFR Part 265, Subpart G.

The GJO maintained its status as a CESQG by generating less than 100 kg (220 lb) per month and storing less than 1,000 kg (2,200 lb) of hazardous or mixed waste throughout most of 1996. However, in May 1996, the GJO waste-generation rate was 418.5 kg (923 lb), primarily from increased work scope at the Analytical Laboratory and the transfer and bulking of mixed-waste scintillation cocktails. A total of 678.42 kg (1,496 lb) of hazardous and mixed waste was generated in 1996.

In April, approximately 209 kg (461 lb) of hazardous waste was shipped to Aptus in Argonite, Utah, for treatment and disposal. In July, approximately 150 kg (331 lb) of mixed waste was shipped to Diversified Scientific Services, Inc., in Kingston, Tennessee, for incineration. In December, approximately 207 kg (456 lb) of mercury waste was shipped to Recyclights in Bloomington, Minnesota, for recycling.

During 1996 the GJO treated approximately 563 kg (1,241 lb) of hazardous waste contaminated with residual radioactive material during site remediation. Much of this mixed waste was generated before 1996. Treatment to remove the hazardous component was performed in July 1996 on wastes, including lead-contaminated excess sample material (soil and uranium mill tailings), mercury-contaminated debris, lead-contaminated paint, trichloroethylene-contaminated oily debris, and miscellaneous lead- and asbestos-contaminated demolition debris. Treatment of the mixed waste rendered this waste non-RCRA regulated and solely contaminated with residual radioactive material. All treated material is scheduled for disposal at the Cheney Disposal Cell (Section 3.4.3).

3.4.2 TSCA and Mixed TSCA Waste Management

Most of TSCA relates to the manufacturing and distribution of chemicals and therefore does not affect the GJO; however, TSCA specifically addresses the use of asbestos and PCBs, both of which are present at the GJO. Asbestos and PCB-contaminated wastes are generated during

building maintenance, renovation, or demolition. Although all PCB-containing transformers at the site were retrofilled in the late 1980s, many of the ballasts in older fluorescent light fixtures contain PCBs, and when these ballasts fail they become TSCA-regulated waste. In addition, the Analytical Laboratory occasionally uses very small quantities of PCBs as reference standards for PCB testing.

As asbestos or PCB waste is generated, process knowledge or radiation surveys are used to determine whether the material is also contaminated with residual radioactive material and must be managed as a mixed waste. Nonradioactive asbestos waste such as ceiling insulation, damper material, and linoleum is disposed of in the Mesa County Landfill. Nonradioactive PCB wastes are accumulated for a period of less than 9 months, and then are shipped off site for treatment and disposal. All radioactive asbestos is disposed of in the Cheney Disposal Cell. Radiologically contaminated PCB wastes are stored on site because currently there are no Federal or commercial disposal facilities that accept solid radioactive PCB waste.

The GJO generated 14.1 m³ (18.4 yd³) of asbestos and 55.8 kg (123 lb) of PCB wastes in 1996. Asbestos waste was disposed of at the Mesa County Landfill as it was generated, and the PCB wastes were scheduled for shipment off site in January 1997. Additionally, 2.3 m³ (3.0 yd³) of radioactive asbestos and 17.1 kg (37.7 lb) of radioactive or suspected radioactive PCBs were generated. Radioactive asbestos was disposed of at the Cheney Disposal Cell and the radioactive PCB wastes were stored at the GJO in compliance with TSCA and the *Federal Facility Compliance Agreement* (1996).

Since 1991, the GJO has stored 58.3 metric tons (64.2 short tons) of soil that contains residual radioactive material mixed with PCB material as the result of a spill. The volume of this soil is 46.6 m³ (61 yd³). Although the resulting concentration of PCBs in the soil is less than the concentration regulated in 40 CFR 761, the concentration of PCBs in the original material (before the spill) was above regulatory limits, and the entire soil volume must therefore be managed as if it were above the regulatory limit (40 CFR 761.123). The GJO continues to evaluate and negotiate disposal options for this material. Additionally, there are approximately 90.4 kg (199.3 lb) of soil containing residual radioactive material contaminated with PCBs and 33.2 kg (73.2 lb) of radioactive and PCB-contaminated light ballasts, light fixtures, and personal protective equipment in storage pending determination of disposal option.

3.4.3 Residual Radioactive Material

Residual radioactive material is defined by 40 CFR Part 192, Section 192.01, as "(1) Waste (which the Secretary determines to be radioactive) in the form of tailings resulting from the processing of ores for the extraction of uranium and other valuable constituents of the ores; and (2) Other wastes (which the Secretary determines to be radioactive) at a processing site which relate to such processing, including any residual stock of unprocessed ores or low-grade materials." During remediation of the GJO facility, the GJO generates residual radioactive material in the form of excavated soil, facility demolition/remodeling debris, equipment, investigation-derived waste, and residue from laboratory analysis of residual radioactive material.

Material is not classified as residual radioactive unless it is determined to be radioactive through process knowledge and radiation survey.

The Cheney Disposal Cell, located approximately 17 miles from the GJO in Mesa County, Colorado, receives residual radioactive material from GJO remediation activities and from UMTRA Project vicinity properties in Grand Junction.

Remediation in 1996 involved removing radiologically contaminated materials associated with the demolition of Buildings 1, 34, and 36; and contaminated soil associated with an excavation near Building 46. Approximately 1,500 metric tons (1,650 short tons) of residual radioactive material was removed and transported to the Cheney Disposal Cell.

3.4.4 Low-Level Waste Management

Radioactive wastes that are clearly not residual radioactive material do not qualify for disposal at the UMTRA Cheney Disposal Cell and must be managed as low-level waste (LLW) in compliance with DOE Order 5820.2A, *Radioactive Waste Management*. The GJO generates LLW from analysis of environmental samples received from other DOE sites. Typical LLW includes soil sample residues, excess samples and sample reject, contaminated sand derived from the cleaning of sample grinders and blenders, baghouse fines, counting filters, planchettes, latex gloves, paper wipes, glassware, and resins used for radionuclide separation. Nontypical LLW includes fluids generated from decontamination of treatability study equipment, a mixture of ethylene glycol and water used for shielding in calibration test pits, and excess sealed radioactive sources.

The GJO has implemented strict radiological characterization and segregation requirements to reduce the amount of waste classified and managed as LLW (DOE 1995c). Administrative controls such as the establishment of Radioactive Materials Management Areas, limiting the use of materials in those areas, and surveying wastes for segregation as contaminated or noncontaminated further reduces the volume of LLW generated at the GJO.

The GJO generated 458 kg (1,010 lb), approximately 0.8 m³ (1.0 yd³), of LLW in 1996. The GJO had 4.05 metric tons (4.46 short tons), or approximately 7.6 m³ (10.0 yd³), of LLW in storage before 1996, resulting in a current inventory of 4.51 metric tons (5.0 short tons), or approximately 8.4 m³ (11 yd³). The LLW is stored in Building 61B, Building 7 Sample Preparation Plant, and in drums with secondary containment in the drum storage area at the northwest corner of Building 33.

Although the facility has no on-site disposal capability, GJO has pursued a variety of LLW disposal avenues both commercially and within the DOE complex, but has had difficulty establishing a contract because of the small volume of LLW generated at the site. The DOE Programmatic Environmental Impact Statement indicates that GJO will ship waste to the Nevada Test Site. However, GJO did not become an approved waste generator for the Nevada Test Site because of cost under the previous waste acceptance criteria (NVO-325). Although GJO could cost-effectively comply with the reduced requirements for low-volume generators under the

Nevada Test Site Waste Acceptance Criteria issued in September 1996, the Nevada Test Site Environmental Impact Statement considers only currently approved waste generators. Thus, the GJO is unable to dispose of LLW within the DOE complex until issues between the Programmatic Environmental Impact Statement and site Environmental Impact Statements are resolved. The only short-term option available to the GJO is commercial disposal, an option described in the *Environmental Assessment of Facility Operations at the U.S. Department of Energy Grand Junction Projects Office, Grand Junction, Colorado* (DOE 1996a). The GJO is actively pursuing disposal of its LLW through an existing DOE, interagency, or commercial contract with Envirocare of Utah.

3.5 Pollution Prevention

As indicated, the GJO generates small amounts of hazardous and radioactive waste. Although the potential volume of waste reduced is small, the GJO actively incorporates pollution prevention as part of a larger goal of wise environmental management. Wastes generated from GJO operations are reduced at the source wherever technically and economically feasible. Recycling options are explored for wastes that cannot be prevented through source reduction. Treatment options are considered for wastes that cannot be prevented or recycled. Disposal is the final option after all others have been considered.

3.5.1 Source Reduction

Source reduction at the GJO is achieved primarily through material substitution and waste segregation. Substitution involves replacing a hazardous material with a less hazardous or nonhazardous material. Examples include replacing hazardous solvents and scintillation fluids with nonhazardous substitutes. However, the GJO uses relatively few hazardous materials, most of which are required for laboratory analytical procedures, and thus the potential for reduction through substitution is small. Waste segregation involves separating hazardous materials from nonhazardous, and separating radiologically contaminated materials from noncontaminated materials. Examples include use of Radioactive Materials Management Area principles to keep materials from becoming radiologically contaminated, and use of radiological surveys to segregate radioactive from nonradioactive waste.

The GJO actively attempts to reduce wasteful practices and to replace inefficient equipment. For example, the landscaping is watered during the hours of midnight to 6 a.m. to reduce water use. Grass clippings and weeds are composted for use as fertilizer and mulch. The GJO is replacing older, less efficient fluorescent light tubes and fixtures with newer, more energy-efficient ones, many of which have automatic shutoff switches. Employees are encouraged to use their computers to ~~reduce the amount of paper waste, and many manuals and administrative documents are available on-line rather than on paper copies.~~

3.5.2 Reuse and Recycling

The GJO generates several types of hazardous and nonhazardous waste on a regular basis that are suitable for recycling or reuse. These materials include spent fluorescent tubes, spent batteries, scrap metal, office paper, cardboard, aluminum cans, and lead.

All spent fluorescent tubes are sent to a recycler that recovers the glass, metal, and mercury. Other waste mercury is also shipped for recycling. In 1996, the GJO shipped approximately 206 kg (454 lb) of spent fluorescent tubes and 0.8 kg (1.8 lb) of waste mercury off site for recycling.

Normal operations such as replacing batteries in electric vehicles and radios generate spent batteries at the GJO. The site routinely recharges nickel-cadmium (NiCad) batteries, and then reconditions the batteries to increase the number of possible recharges. NiCad batteries are sent to a recycling facility when the batteries can no longer be recharged. Lead-acid batteries from vehicles are sent to a local recycler. Approximately 64 spent lead-acid batteries were recycled in 1996.

The GJO generates used oil from equipment maintenance and ships the used oil to an appropriate processing, re-refining, or burning facility on a regular basis. The GJO generated over 3,785 liters (1,000 gallons) of used oil in 1996.

The GJO has purchased reusable rags and personal protective equipment such as coveralls and booties, which are sent off site to Interstate Nuclear Service Laundry, a laundry permitted to launder radiologically contaminated material. The GJO diverts about 1 m³ (1.3 yd³) each of radioactive and nonradioactive waste per year from disposal through use of the laundry.

The GJO regularly recycles office paper, cardboard, glass, plastics, magazines, and newspaper through a local recycling service. In 1996, the site recycled over 300 m³ (392 yd³) of these materials, along with 2 metric tons (2.2 short tons) of scrap metal.

Many materials at GJO are not wastes because they are still useable for their original intended purpose without reprocessing. Such materials may include office furniture, construction materials, paints and solvents, and nonradiologically contaminated lead bricks used for shielding. Reuse or recycling may include resale to the public or transfer to another DOE site.

3.5.3 Affirmative Procurement

The GJO purchases materials with recycled content whenever practical. These efforts are coordinated under the Contracts and Procurement group as part of their affirmative procurement program. The affirmative procurement program favors the acquisition of environmentally preferable and energy-efficient products and services.

The Contracts and Procurement group routinely adds language to contracts that specifies a preference for the use of recycled or otherwise recovered materials (five contracts in 1996), and

removes language that prohibits the use of recycled materials (five contracts in 1996). The Contracts and Procurement group is reevaluating several older policies that do not allow recovered materials to be used in certain items, such as fly ash in cement and retreaded tires on forklifts, with the goal of reducing restrictions wherever possible. The group recently designated a recycling coordinator to promote, educate, and monitor Affirmative Procurement Program activities.

Purchase orders for hazardous materials not already used at the GJO are reviewed before commitment of funds. This review allows the GJO to track hazardous materials kept on site, and includes a discussion with the requestor to determine whether alternate compounds could be substituted for the hazardous materials and could thus reduce or eliminate the generation of hazardous waste.

4.0 Environmental Radiological Program Information

Environmental radiological monitoring programs at the GJO facility include sampling and estimation of air emissions, and sampling sewer effluent, surface water, and groundwater. Detailed descriptions of the monitoring programs, except groundwater, were provided in section 3.0. Results of air emissions, sewer, and surface-water monitoring are described in this section, and groundwater program description and monitoring results are described in Section 6.0. Assumptions are described and radiological dose estimates are presented, along with details on the specific models used in performing calculations, where appropriate.

All radiological emissions and releases from the GJO in 1996 were within the limits provided in NESHAP, 40 CFR 61 Subpart H, and DOE Order 5400.5. Air-emission dose assessments and comparison to applicable Federal and DOE standards are provided in Section 4.2. A comparison of radionuclide concentrations in sewer effluent and surface water to applicable DOE orders and State standards is provided in Sections 4.3 and 4.4, respectively. No unplanned releases of radioactivity occurred at GJO in 1996.

4.1 Radiological Air Emissions

Three types of radiological air emissions were monitored or estimated on the GJO facility in 1996: point source radioparticulates, nonpoint source radioparticulates, and radon. The radionuclides and annual release rates for each type of radiological air emission are provided in the following sections.

4.1.1 Point Source Radionuclides

The radionuclides that contributed to more than 10 percent of the 1996 potential effective dose equivalent (EDE) from the monitored release point (Baghouse) are presented in Table 4-1. Radiological emissions from the ORNL sample preparation trailer and Analytical Laboratory were estimated according to guidelines in 40 CFR Part 61, Appendix D. Release rates represent the total emission level in curies per year (Ci/yr) and becquerels per year (Bq/yr) for these radionuclides from all point sources. Total uranium in grams is provided, as calculated from the uranium-238 activity. The half-life for each isotope is also reported.

The GJO point source emission data listed in Table 4-1 are entered into the EPA-approved dose assessment model, CAP88PC, to estimate the off-site dose from these radioparticulate emissions. Point source dose modeling results are provided in Section 4.2.

Table 4-1. GJO Point Source Radionuclides and Annual Release Rates

Radioisotope	Release Rate			Half-life (yr)
	Ci/yr ^a	Bq/yr	g/yr	
Lead-210	4.76×10^{-8}	1,761	-	22.3
Polonium-210	3.62×10^{-8}	1,338	-	0.379
Radium-226	3.64×10^{-8}	1,345	-	1,600
Thorium-230	5.19×10^{-8}	1,920	-	75,400
Uranium-234	2.28×10^{-7}	8,426	-	245,000
Uranium-238	2.31×10^{-7}	8,545	-	4.47×10^9
Uranium (Total)	-	-	0.69	-

^a1 Ci = 3.70×10^{10} Bq

4.1.2 Nonpoint Source Radionuclides

Fugitive particulate emissions from the four soil excavation projects completed in 1996 were estimated using acceptable methods pursuant to Colorado Air Quality Control Commission Regulation No. 3, Part A (II)(B)(1), and current industry practice. The total mass of fugitive emissions was converted to individual radionuclide source strength using an activity-per-unit-mass value for each radionuclide. The radionuclides released from these sources and estimated total emission levels during 1996 are presented in Table 4-2. Release rates represent the total emission level in curies per year and becquerels per year for these radionuclides from all nonpoint sources. Total uranium in grams is calculated from the uranium-238 activity. The half-life for each isotope is also reported.

The GJO nonpoint source emission data listed in Table 4-2 were entered into the EPA-approved dose assessment model, CAP88PC, to estimate the off-site dose from these radioparticulate emissions. Nonpoint source dose modeling results are provided in Section 4.2.

4.1.3 Atmospheric Radon

Atmospheric radon is estimated from selected radon flux measurements from the Calibration Test Pits and from the Radon Laboratory source inventory. The radon-emission release rate from the GJO is 0.52 Ci/yr.

4.2 Radiological Dose Modeling

Off-site dose modeling of the 1996 GJO radioactive air emissions was conducted to evaluate compliance with NESHAP, 40 CFR Part 61, Subpart H; and DOE Order 5400.5. Both regulations establish a "maximally exposed individual" dose limit of 10 mrem/yr for exposure to airborne radioparticulate emissions (excluding radon) from DOE facilities. Additionally, DOE Order 5400.5 requires that the EDE to the public from all sources of radiation (including radon) not exceed 100 mrem/yr, and requires calculation of a collective population dose (dose to

residents within an 80-kilometer radius of the facility). The collective population dose for point source dose assessments includes the radon source term. The DOE provides no standard of comparison for the collective population dose.

Table 4-2. GJO Nonpoint Source Radionuclides and Annual Release Rates

Radioisotope	Release Rate			Half-life (yr)
	Ci/yr ^a	Bq/yr	g/yr	
Actinium-227	3.60×10^{-8}	1,330	—	21.8
Bismuth-210	2.40×10^{-8}	886	—	0.0137
Bismuth-211	3.60×10^{-8}	1,330	—	4.07×10^{-6}
Bismuth-214	2.40×10^{-8}	886	—	3.79×10^{-5}
Protactinium-231	3.60×10^{-8}	1,330	—	32,800
Protactinium-234	6.41×10^{-8}	2,370	—	2.25×10^{-6}
Lead-210	2.40×10^{-8}	886	—	22.3
Lead-211	3.60×10^{-8}	1,330	—	6.87×10^{-5}
Lead-214	2.40×10^{-8}	886	—	5.10×10^{-5}
Polonium-210	2.40×10^{-8}	886	—	0.379
Polonium-214	2.40×10^{-8}	886	—	5.19×10^{-12}
Polonium-215	3.60×10^{-8}	1,330	—	5.64×10^{-11}
Polonium-218	2.40×10^{-8}	886	—	5.92×10^{-6}
Radium-223	3.60×10^{-8}	1,330	—	0.0313
Radium-226	2.40×10^{-8}	886	—	1,600
Thorium-227	3.60×10^{-8}	1,330	—	0.0513
Thorium-230	2.75×10^{-8}	1,020	—	75,400
Thorium-231	3.00×10^{-9}	111	—	0.00291
Thorium-234	6.41×10^{-8}	2,370	—	0.066
Thallium-207	3.60×10^{-8}	1,330	—	9.08×10^{-6}
Uranium-234	6.48×10^{-8}	2,400	—	2.45×10^5
Uranium-235	3.00×10^{-9}	111	—	7.04×10^8
Uranium-238	6.41×10^{-8}	2,370	—	4.47×10^9
Uranium-Total	—	—	0.19	—

^a1 Ci = 3.70×10^{10} Bq

The CAP88PC model was used to calculate the EDE for the maximally exposed individual from all point sources. The EDE represents potential doses rather than actual doses because these doses were calculated rather than measured. User-supplied variables include the distance for individual assessment, radionuclide list and release rates, stack height, stack diameter, plume rise type, and meteorological information. The annual ambient temperature, annual precipitation, and atmospheric lid height were obtained from the Grand Junction Airport. The wind data were collected on site.

The population within 80 kilometers of the GJO is 117,483, according to the 1990 U.S. Bureau of the Census. Population centers in the assessment area include Cedaredge, Clifton, Collbran, DeBeque, Delta, Fruita, Gateway, Grand Junction, Mesa, Olathe, Palisade, and Whitewater. The receptor used is the nearest off-site residence located 500 meters north-northwest of the GJO facility.

4.2.1 Point Source Dose Assessments

The EDEs for the GJO point source radiological air emissions in units of millirem per year and millisieverts per year (mSv/yr) are presented in Table 4-3. Calculation of the nonradon EDE to the maximally exposed individual resulted in a value of 2.46×10^{-4} mrem/yr, or more than 40,000 times below the DOE and EPA standard of 10 mrem/yr. The public EDE includes the radon source term of 0.52 Ci/yr, and was derived by summing the individual EDEs calculated for radioparticulates and radon. The resulting total EDE was 0.00486 mrem/yr, which is more than 20,000 times below the DOE standard of 100 mrem/yr. Calculation of the collective population dose resulted in a value of 0.00909 person-rem/yr.

Table 4-3. Effective Dose Equivalent Attributable to Point Source Airborne Radiological Emissions From the GJO Facility During 1996

EDE Type	Standard	Effective Dose Equivalent	Effective Dose Equivalent
EDE from Airborne Radioparticulates	10 mrem/yr ^a	2.46×10^{-4} mrem/yr	2.46×10^{-6} mSv/yr ^b
Public EDE (including radon)	100 mrem/yr ^c	0.00486 mrem/yr	4.86×10^{-5} mSv/yr
Collective Population Dose (including radon)	No Standard	0.00909 person-rem/yr	9.09×10^{-5} person-Sv/yr ^d

^aDOE and EPA standard (40 CFR 61.92); excludes radon

^b1 mrem/yr = 0.01 mSv/yr

^cDOE standard

^d1 person-rem/yr = 0.01 person-Sv per year

4.2.2 Nonpoint Source Dose Assessments

The EDEs for the GJO nonpoint source radiological air emissions are presented in Table 4-4. Calculation of the nonradon EDE to the maximally exposed individual resulted in a value of 8.42×10^{-4} mrem/yr, or more than 10,000 times below the DOE and EPA standard of

10 mrem/yr. The collective population dose was calculated at 3.13×10^{-4} person-rem/yr. The nonpoint source radon contribution to the public EDE is accounted for in the point source calculation.

Table 4-4. Effective Dose Equivalent Attributable to Nonpoint Source Airborne Radiological Emissions From the GJO Facility During 1996

EDE Type	Standard	Effective Dose Equivalent	Effective Dose Equivalent
EDE from Airborne Radioparticulates	10 mrem/yr ^a	8.42×10^{-4} mrem/yr	8.42×10^{-6} mSv/yr ^b
Collective Population Dose (excluding radon)	No Standard	3.13×10^{-4} person-rem/yr	3.13×10^{-6} person-Sv/yr ^c

^aDOE and EPA standard (40 CFR 61.92); excludes radon

^b1 mrem/yr = 0.01 mSv/yr

^c1 person-rem/yr = 0.01 person-Sv per year

4.3 Radiological Sewer Effluent

Table 4-5 contains the maximum gross alpha and gross beta activities and maximum total gross alpha and gross beta activity measured in the sewer effluent in 1996. Total gross alpha and gross beta activity never exceeded the DOE Order 5400.5 action level of 1.5×10^{-7} microcuries per milliliter ($\mu\text{Ci/mL}$) ($5,550 \mu\text{Bq/mL}$) during 1996. The maximum gross alpha activity of $4.10 \times 10^{-8} \mu\text{Ci/mL}$ was measured in June 1996, and the maximum gross beta activity of $2.72 \times 10^{-8} \mu\text{Ci/mL}$ was measured in February 1996. Isotopic analysis was not performed in 1996 because total gross alpha and gross beta activity of the sewer effluent never exceeded the action limit. Table A-1 in Appendix A contains all GJO sewer effluent analytical results.

Table 4-5. Sewer Effluent Radiological Discharges from the GJO During 1996

Parameter	Standard		Activity	
	$\mu\text{Ci/mL}$	$\mu\text{Bq/mL}^a$	$\mu\text{Ci/mL}$	$\mu\text{Bq/mL}$
Gross Alpha Maximum (June)	—	—	4.10×10^{-8}	1,520
Gross Beta Maximum (February)	—	—	2.72×10^{-8}	1,010
Total Maximum (June)	1.5×10^{-7}	5,500	5.88×10^{-8}	2,180

^a1 $\mu\text{Ci} = 3.70 \times 10^{10} \mu\text{Bq}$

4.4 Surface Water

Radionuclide concentrations in samples collected from the Gunnison River in 1996 were below applicable standards in CDPHE WQCC "Classifications and Numeric Standards for Gunnison and Lower Dolores River Basins" (5 CCR 1002-8) (surface-water-quality standards). Historical

and 1996 maximum radionuclide concentrations in the Gunnison River are presented and compared with applicable surface-water-quality standards in Section 5.3, Table 5-3. Table A-2 in Appendix A presents the Gunnison River surface-water sampling results for 1996.

In 1996, total uranium concentrations were relatively constant in the Gunnison River samples with respect to sampling location. No trend in total uranium concentration was observed when the analytical results of upstream samples were compared to results from downstream samples. Figures B-1a and B-1b in Appendix B show measured total uranium concentrations from January 1989 through December 1996 at the four sampling locations on the Gunnison River. Surface-water concentrations of uranium will continue to be monitored for changes that may occur in response to passive remediation (natural flushing) of groundwater at the GJO facility.

The Gunnison River surface-water samples were also analyzed for gross alpha, gross beta, and radium-226 activity. Although no surface-water-quality standards specific to the Gunnison River segment adjacent to the GJO facility currently exist for these constituents, analytical results indicate that gross alpha, gross beta, and radium-226 activities were near or below analytical instrument detection limits.

Water from the North Pond, South Pond, and the Wetland Area is recharged by the shallow alluvial aquifer underlying the facility and shows the same radiological characteristics as the groundwater. Table A-2 in Appendix A presents the North Pond, South Pond, and the Wetland Area surface-water sampling results for 1996. The surface-water-quality standard used for the Gunnison River samples (Gunnison River standard) (40 picocuries per liter [pCi/L]) (58 micrograms per liter [$\mu\text{g/L}$]) was used to evaluate total uranium concentrations in samples from the North Pond, South Pond, and the Wetland Area because the State basic standards for surface waters do not address total uranium. Concentrations of total uranium in all samples from those locations exceeded the Gunnison River standard in 1996. The maximum total uranium concentration (406 pCi/L) was detected in the September 1996 sample from the Wetland Area. Figures B-2a and B-2b in Appendix B show measured total uranium concentrations in the North and South Pond and the Wetland Area sample locations.

The North Pond, South Pond, and Wetland Area samples were also analyzed for gross alpha, gross beta, and radium-226 activity. Although gross alpha and gross beta activities in these samples were above instrument detection limits, no surface-water-quality standards currently exist for these constituents for comparison. The State surface-water standard for radium 226+228 (5 pCi/L) was not exceeded in the samples collected from the North Pond, South Pond, and Wetland Area.

To date, a determination of changes in on-site surface-water quality resulting from remedial actions is premature; only four surface-water sampling rounds have been conducted since remediation of open-land areas was completed in June 1994. Surface-water remediation is expected to mirror groundwater remediation because the on-site surface-water sources are recharged by alluvial groundwater. Surface-water quality should improve over time as passive remediation (natural flushing) of the alluvial aquifer continues. Groundwater modeling of the alluvial aquifer predicts that groundwater and water in the on-site ponds will be remediated to

below applicable standards within 50 to 80 years after mill tailings removal. This 50- to 80-year time-frame is within the 100-year cleanup period required under UMTRCA groundwater regulations (40 CFR 192) as indicated in the GJORAP Record of Decision (DOE 1990).

4.5 Storm Water

No storm water was analyzed in 1996. However, analytical results from the 1994 and 1995 storm-water samples indicate that the GJO storm-water discharge quality is similar to an average residential or commercial site. Average residential and commercial storm-water discharge data were obtained from an EPA study that included sampling data from several sites around the nation (EPA 1983). No radiological data from the EPA study were available for comparison; however, the GJO storm-water radionuclide concentrations were near or below detection limits in 1994 and 1995.

5.0 Environmental Nonradiological Program Information

The GJO monitors and estimates nonradiological air emissions from the Analytical Laboratory and samples nonradiological analytes in the GJO sewer effluent and surface water. Results of nonradiological air emissions monitoring and sewer effluent and surface-water sample analysis are presented in this section. There were no releases of nonpermitted hazardous substances or other unplanned releases at the GJO in 1996.

5.1 Nonradiological Air Emissions

An assessment of nonradiological air emissions at the GJO facility includes monitoring of opacity, annual chemical consumption, and annual quantity of soil processed by the GJO.

5.1.1 Opacity

Monthly observations of visible emissions from the permitted and APEN/permit-exempt stationary sources were conducted by a qualified observer in accordance with the requirements of 40 CFR Part 60, Appendix A, Method 9, "Visual Determination of the Opacity of Emissions from Stationary Sources." Visible emissions in 1996 never exceeded the permit-specified limit of 20 percent opacity.

5.1.2 Permitted Releases

The annual record of chemical consumption by the Analytical Laboratory, required by Air Emission Permit No. 90ME402-1, is summarized in Table 5-1. Chemical consumption was calculated from 1996 purchase records. The annual quantity of soil processed by the Sample Preparation Laboratory was 1.22 short tons (1.11 metric tons), which is 1.8 percent of the permitted annual quantity of 66 short tons (60 metric tons) stated in the APEN/permit exemption. The records of chemical consumption and quantity of soil processed demonstrate that no limits were exceeded in 1996.

Table 5-1. Annual Record of Chemical Consumption by the Analytical Laboratory

Chemical	Permitted Annual Consumption	Annual Consumption	Percent of Permitted Annual Consumption
Acids	900 gallons (3,804 liters)	153.4 gallons (648.4 liters)	17
Volatile Organic Compounds	2,000 gallons (8,454 liters)	147.6 gallons (623.9 liters)	7
Benzene	13 gallons (55 liters)	0.4 gallon (1.6 liters)	3

5.2 Nonradiological Sewer Effluent

The 1996 GJO sewer-effluent samples were analyzed for BOD, TSS, TDS, ammonia, temperature, pH, oil and grease, silver, and PCBs as required by the GJO Industrial Pretreatment Permit. Table 5-2 summarizes the 1996 sampling results and provides a comparison of the maximum concentration of each constituent with the appropriate threshold limits. All analyte concentrations were below or within the respective threshold limits established in the permit. A complete list of the GJO sewer-effluent sampling results is provided in Table A-1 in Appendix A.

Table 5-2. Comparison of Sewer-Effluent Threshold Limits to 1996 Maximum Concentrations^a

Constituent or Parameter	Threshold Limit	1996 Maximum Concentration ^b
Ammonia (NH ₃)	Report Only	33.2 mg/L
Biochemical Oxygen Demand	Report Only	193 mg/L
Oil and Grease	Report Only	41.0 mg/L
pH	>5.5	8.96
PCBs ^c	0.002 mg/L	<0.002 mg/L
Silver	0.43 mg/L	0.0052 mg/L
Temperature	66 °C	23.4 °C
Total Dissolved Solids	Report Only	532 mg/L
Total Suspended Solids	Report Only	416 mg/L

^a"<" indicates that the maximum concentration was below the detection limit (number shown); "Report Only" indicates no discharge limits were assigned by the City of Grand Junction.

^bThis represents the maximum value of all GJO sewer-effluent samples collected in 1996.

^cPCBs include Aroclor 1016, 1221, 1232, 1242, 1248, 1254, and 1260.

5.3 Nonradiological Surface-Water Sampling and Analysis

Nonradionuclide concentrations detected in surface-water samples from the Gunnison River in 1996 were below or within acceptable ranges of applicable State standards, with the exception of lead in the sample taken from the Middle Gunnison River sampling location in December 1996. Historical and 1996 maximum analyte concentrations in the Gunnison River are presented and compared with applicable State standards in Table 5-3. Several constituents listed in the table (such as copper, mercury, nickel, silver, zinc, nitrite, dissolved oxygen, and fecal coliform bacteria) were not measured in 1996 because either the standards were not exceeded historically or a relationship could not be established between alluvial groundwater contamination and concentrations in the Gunnison River. Table A-2 in Appendix A presents the Gunnison River surface-water sampling results for 1996. This table contains analytical results for several constituents that are not presented in Table 5-3 because either no surface-water-quality standards

currently exist for these constituents, or the measured concentrations were below applicable State standards.

Table 5-3. Comparison of State Surface-Water-Quality Standards to 1996 and Historical Maximum Concentrations in the Gunnison River^{a,b}

		1996 Maximum Concentrations ^c			Historical Maximum Concentrations ^d		
Constituent	State Standard	Upgradient	Adjacent to Site	Down-gradient	Upgradient	Adjacent to Site	Down-gradient
Common Ions							
Chloride	250.0 mg/L	5.61	5.72	6.09	12.4	12.6	80
Nitrate (as N) ^e	10.0 mg/L	0.714	0.709	0.709	6	6	6
Nitrite (as N) ^f	0.05 mg/L	–	–	–	<0.304	–	<0.304
Sulfate	250.0 mg/L	233	233	236	513	512	584
Field Measurements							
Dissolved Oxygen ^g	7.0 mg/L	–	–	–	9.5	9.3	9.5
pH	6.5–9.0	8.04–8.68	8.33–8.85	8.01–8.70	7.20 – 9.04	7.29–9.19	7.33–9.01
Inorganics							
Fecal Coliform ^h	200	–	–	–	1500	300	1300
Metals ⁱ							
Arsenic	0.05 mg/L	0.0087	0.0086	0.0103	0.011	~0.0051	0.011
Cadmium	0.001 mg/L	<0.001	~0.00063	~0.00032	0.002	<0.002	<0.002
Chromium+6	0.011 mg/L	<0.004	<0.004	<0.004	~0.0036	~0.0045	~0.0034
Copper	0.013 mg/L	–	–	–	0.056	0.013	0.05
Iron	0.300 mg/L	~0.0238	~0.0114	<0.005	0.44	0.1	0.32
Lead	0.005 mg/L	0.0046	0.0193	<0.001	0.059	0.0118	0.027
Manganese	0.050 mg/L	0.02	0.02	0.0238	0.2	0.0766	0.122
Mercury	0.0001 mg/L	–	–	–	<0.002	<0.002	<0.002
Nickel	0.106 mg/L	–	–	–	0.005	<0.025	0.021

Table 5-3 (continued). Comparison of State Surface-Water-Quality Standards to 1996 and Historical Maximum Concentrations in the Gunnison River^{a,b}

		1996 Maximum Concentrations ^c			Historical Maximum Concentrations ^d		
Constituent	State Standard	Upgradient	Adjacent to Site	Down-gradient	Upgradient	Adjacent to Site	Down-gradient
Metals ⁱ							
Selenium	0.017 mg/L	<0.004	~0.0043	<0.004	0.0096	0.014	0.0148
Silver	0.003 mg/L	–	–		<0.0005	<0.0005	0.0005
Zinc	0.118 mg/L	–	–		1.07	0.86	1.72
Radionuclides							
Uranium ^j	40 pCi/L	3.8472	3.9159	4.122	10.42	14.39	23.358

^aCDPHE Water Quality Control Division standards for the Gunnison River segment, effective August 30, 1995.

^b"—" indicates no data available; "<" indicates that the maximum concentration was below the detection limit (number shown is detection limit); "~" indicates an approximate value (the value was outside the limits for which the instrument was calibrated).

^cThe units are indicated in the "State Standard" column.

^dBased on maximum concentrations observed from 1984 through 1995.

^eNitrate (as N) was derived for measured nitrate using the conversion $N = NO_3 \div 4.427$.

^fNitrite (as N) was derived for measured nitrite using the conversion $N = NO_2 \div 3.285$.

^gThe standard value for dissolved oxygen represents a minimum concentration. Measured values must be greater than 7.0 mg/L to comply with this standard. Listed values represent the minimum measurements observed.

^hNumber of colonies per 100 mL

ⁱAll values given are for dissolved constituents.

^jUranium concentrations that were measured in milligrams per liter were converted to picocuries per liter for comparison. The conversion assumes equilibrium and an activity of 0.687 pCi/μg.

The concentration of lead (19.3 μg/L) in the sample taken from the Middle Gunnison River sampling location exceeded the applicable surface-water standard (5 μg/L) in December 1996 (Figures B-3a and B3-b). A relationship between this concentration and the concentration of lead in the alluvial groundwater is not apparent. The highest lead concentration detected in any groundwater sample from the December 1996 sampling event was 4.6 μg/L. The Gunnison River will continue to be sampled for this analyte in the future.

For comparison, Figures B-4a through B-6b in Appendix B show measured concentrations of analytes in Gunnison River surface-water samples that were contaminants in 1996 alluvial groundwater samples. No concentrations exceeded the applicable Gunnison River surface-water-quality standards for these analytes in samples from the Gunnison River sampling locations. Historically, manganese (Figures B-7a and B-7b) and sulfate (Figures B-8a and B-8b) concentrations routinely exceeded State standards in samples from all Gunnison River sampling locations; however, there is no evidence that discharge from the alluvial aquifer is contributing to elevated concentrations in the river. None of the analyte concentrations exceeded State standards in 1996.

The North Pond, South Pond, and Wetland Area contain elevated quantities of chemical constituents typically associated with uranium mill tailings (e.g., arsenic, manganese, molybdenum, sulfate, and vanadium). As with the radionuclides, Gunnison River surface-water-quality standards were used to evaluate measured concentrations of nonradiological analytes in the North Pond, South Pond, and Wetland Area. Table A-2 in Appendix A presents the 1996 sampling results for these surface-water analytes.

Chloride and sulfate concentrations in samples collected from the North Pond, South Pond, and Wetland Area in 1996 exceeded Gunnison River surface-water-quality standards for those analytes. Table 5-4 compares 1996 maximum chloride and sulfate concentrations in samples from these surface-water areas with applicable State standards.

Table 5-4. Comparison of Maximum Chloride and Sulfate Concentrations in Samples From the North Pond, South Pond, and Wetland Area With State Standards

Constituent	State Standard (mg/L)	North Pond (mg/L)	South Pond (mg/L)	Wetland Area (mg/L)
Chloride	250	338	145	1,690
Sulfate	250	2,250	2,010	13,100

6.0 Groundwater Monitoring and Protection Program

Groundwater in the alluvial aquifer beneath the GJO facility was contaminated from leached products of uranium mill tailings generated during mill operations. Uranium mill tailings removal from open-land areas on the facility began in late 1989, and the majority of the tailings and contaminated soil were removed by 1994. Modeling of the alluvial aquifer predicts that groundwater will be cleaned to below applicable standards within 50 to 80 years after removal of the contamination source (DOE 1990).

The objective of the groundwater monitoring and protection program is to verify improvement in groundwater quality and to verify the effectiveness of passive remediation (natural flushing) of the alluvial aquifer. This section characterizes the GJO hydrogeology, describes the 1996 groundwater sampling and analysis activities, provides groundwater analytical results, and interprets trends in groundwater remediation to date.

6.1 Hydrogeology

Two hydrogeologic units are of importance at the GJO facility: the unconsolidated alluvial aquifer along the Gunnison River and the underlying Morrison Formation aquitard. These two units and the Gunnison River itself influence groundwater flow and discharge into the river.

The alluvial aquifer consists of two facies: a poorly sorted, unconsolidated basal gravel unit with a silt and sand matrix and an overlying unit of silty sand (Figure 6-1). Drill-hole logs from 1984 well installations indicate that both units are laterally continuous throughout the GJO site. The portion of the alluvial aquifer underlying the GJO facility occupies about 22.8 ha (56.4 acres) of the Gunnison River floodplain; its thickness ranges from 6 to 21 meters (20 to 70 feet) but averages between 6 and 8 meters (20 and 25 feet). Bounded on the west and north by the river and on the east by the shales and sandstones of the Morrison Formation, the aquifer is open to the south where the alluvium continues along the east boundary of the river. Aquifer pump tests show the hydraulic conductivity of the alluvium to be approximately 9 meters (30 feet) per day and the specific yield to be on the order of 0.05. Generally, depth to groundwater ranges from 1.5 to 3 meters (5 to 10 feet). Currently, the alluvial groundwater is not used for any purpose.

Field observations suggest that a simple depositional model is adequate to represent the alluvial aquifer. The basal portion was deposited as the Gunnison River migrated from the east to its present position. During this migration, older alluvial sediments to the west were eroded, and a new layer of sediment was left behind. This deposition resulted in a continuous layer of gravel, sand, and silt. Periodic flood events deposited sand and silt on top of the gravel to produce the alluvial stratigraphy shown in Figure 6-1. Such a depositional model is similar to the alluvial-floodplain facies model of Allen (1970); the primary difference between the two is that the alluvium at the GJO facility was deposited in an area that was more restricted laterally, and where, as a result, the water flowed more swiftly. The result is a thicker and more consistent basal gravel unit than the Allen model would indicate. Figure 6-2 presents a typical stratigraphic column at the GJO facility.

Figure 6-1. Typical Geologic Cross Section of the Alluvial Aquifer Underneath the DOE-GJO Facility

Figure 6-2. Typical Stratigraphic Column at the DOE-GJO Facility (compiled from well GJ84-18)

Upgradient groundwater (southeast of the facility) has water quality characteristics similar to those of the Gunnison River, although major ion concentrations increase slightly as the groundwater-residence time increases. Before uranium mill tailings were removed from the facility, groundwater flowing beneath the facility became contaminated with the leached products of uranium mill tailings—uranium, arsenic, radium, selenium, and molybdenum. Only uranium and molybdenum, however, were mobile enough to migrate throughout the downgradient portion of the aquifer.

Underlying the alluvial aquifer at the GJO facility is the Morrison Formation which, in the Grand Junction area, consists of the Brushy Basin and Salt Wash Members. The formation is composed primarily of shale, although minor lenticular sandstones are present in the upper Brushy Basin Member and increasing sandstone facies occur in the Salt Wash Member. The Morrison Formation serves as an aquitard beneath the facility, inhibiting downward groundwater flow and preventing communication between the overlying alluvial aquifer and the underlying Entrada Sandstone aquifer.

At the GJO facility, the Gunnison River incises only the upper part of the Brushy Basin Member. Brushy Basin shales are exposed along the valley margins and underlie the alluvium. This framework results in free-flowing groundwater in the alluvial aquifer because Brushy Basin shales act as a relatively impermeable boundary beneath the aquifer and along the valley margins.

Recharge of the alluvial aquifer occurs mainly through fluctuations in the Gunnison River and, to a much lesser extent, precipitation. During normal flows of the Gunnison River, groundwater enters the alluvial aquifer from the river along the southern perimeter of the GJO facility and flows to the north. Groundwater is discharged into the river along the north and west boundaries of the facility. During periods of high river flow, Gunnison River water recharges the alluvial aquifer and groundwater flow is toward the middle of the aquifer.

6.2 Groundwater Sampling and Analysis

In 1996, GJO groundwater monitoring involved two separate sampling schemes implemented by the GJO contractor and by ORNL. The GJO contractor continued groundwater sampling under a long-term monitoring strategy that was designed to verify the completion of passive remediation of the alluvial aquifer in the 50- to 80-year time frame predicted in the Record of Decision. This strategy involves sampling 12 monitoring wells every 9 months. The 9-month sampling frequency was implemented to allow an annual assessment of compliance with groundwater standards and to allow for seasonal fluctuations in contaminant concentrations. This schedule results in four sampling rounds over a 3-year period. The 1996 groundwater samples were collected in March and December. Sampling procedures and protocol are described in the *Grand Junction Projects Office Facility, Grand Junction Projects Office Remedial Action Project, and Monticello Mill Tailings Site Sampling and Analysis Plan for Environmental Monitoring* (DOE 1995a), which incorporates the standard procedures published by EPA (1985, 1987) and DOE (1987). The groundwater monitoring program is detailed in the *Grand Junction Projects Office*

Facility, Grand Junction Projects Office Remedial Action Project, and Monticello Mill Tailings Site Environmental Monitoring Plan (DOE 1995b) (Environmental Monitoring Plan).

Groundwater monitoring was also conducted by ORNL as part of an ongoing independent verification of GJORAP. Verification involves an independent analysis of the GJO groundwater monitoring program and examination of the passive remediation (natural flushing) of the alluvial aquifer. Verification will be accomplished by independent groundwater sampling and analysis and by developing a new groundwater transport model to predict cleanup of the alluvial aquifer and discharges of alluvial groundwater into the Gunnison River. A 2-year intensive study initiated in 1995 continued in 1996 with quarterly groundwater sampling. Independent verification activities are detailed in the *Addendum to the Work Plan for Independent Verification of the Grand Junction Projects Office Remedial Action Project* (ORNL 1994). Sampling procedures and protocol are described in the *Environmental Technology Section Procedures Manual Volume II: Health and Safety and Technical Procedures* (ORNL 1993).

Six groundwater sampling events at the GJO were conducted in 1996; two sampling events were conducted by the GJO contractor and four were conducted by ORNL. Monitoring wells sampled during each event and the constituents analyzed are summarized in Appendix C. Well GJ84-09 is located upgradient of formerly contaminated areas and provides background water-quality data. The remaining wells are located in or downgradient of formerly contaminated areas of the facility and represent on-site and downgradient conditions. Well locations sampled in 1996 are shown in Figure 6-3.

6.3 Groundwater Analytical Results and Trends

During 1996, concentrations of uranium, molybdenum, arsenic, selenium, nitrate, TDS, and gross alpha in samples from the alluvial aquifer exceeded groundwater-quality standards (Figure 6-4). Table 6-1 lists 1996 and historical maximum analyte concentrations compared with Federal and State groundwater-quality standards. Table 6-1 combines Federal and State standards for comparison and lists the more stringent standard if more than one exists.

Analytical results of samples collected from groundwater monitoring wells in 1996 are presented in Tables A-3 through A-7 in Appendix A. The tables contain analytical results for several constituents that are not presented in Table 6-1 because either no groundwater quality standard currently exists for these constituents or the measured concentration was below applicable State standards. Figures D-1 through D-6 in Appendix D identify the analytes that exceeded applicable standards in samples with respect to the 1996 sampling.

To date, 12 groundwater-sampling events have been conducted since remediation of open-land areas was completed. Time-concentration plots in Appendix B, as well as a statistical study of uranium and molybdenum values from well GJ84-04, indicate aquifer cleanup is progressing. Uranium concentrations from March 1985 (pre-remediation) and March 1996 (post-remediation) are shown in Figures 6-5 and 6-6, respectively. These figures provide a visual indication that passive remediation (natural flushing) of the alluvial aquifer is progressing.

S0011800

Figure 6-3. Groundwater Sampling Locations at the DOE-GJO Facility

S0012000

Figure 6-4. Maximum Concentrations of Groundwater Analytes Exceeding Federal or State Standards in Alluvial Well Samples at the DOE-GJO Facility

Table 6-1. Comparison of Federal and State Groundwater-Quality Standards to 1996 and Historical Maximum Concentrations in the Alluvial Aquifer^{a,b}

		1996 Maximum ^{c,d}			Historical Maximum ^{d,e}		
Constituent	Federal/ State Standard	Up- gradient	On Site	Down- gradient	Up- gradient	On Site	Down- gradient
Common Ions							
Nitrate (as N) ^f	10.0 mg/L	0.007	38.4 ^g	0.94	1.6	69.6	33.8
Total Dissolved Solids ^h	2,290 mg/L	1,830	6,090	3,530	2,180	10,200	8,620
Metals							
Arsenic	0.05 mg/L	0.011	0.37	0.019	0.01	0.68	~0.031
Barium	1.0 mg/L	~0.018	0.078	0.029	~0.019	0.4	0.038
Cadmium	0.01 mg/L	<0.001	~0.00074	<0.005	<0.002	0.055	<0.005
Chromium (total)	0.05 mg/L	<0.004	<0.004	<0.004	0.010	0.039	0.112
Lead	0.05 mg/L	~0.0026	~0.0024	0.0046	<0.01	0.057	~0.0015
Mercury	0.002 mg/L	–	0.00023	<0.0002	0.0002	0.0002	0.0002
Molybdenum	0.1 mg/L	~0.0068	0.52	0.204	0.023	19	0.413
Selenium	0.01 mg/L	<0.004	0.136	0.018	~0.0025	0.685	0.073
Silver	0.05 mg/L	–	<0.005	<0.005	<0.01	0.006	0.0056
Radionuclides							
Gross Alpha (excluding radon and uranium) ⁱ	15 pCi/L	<24.25	342	59	71	1070	621
Radium-226+228	5.0 pCi/L	0.13	2.4	2.7	1	36	2.1
Thorium-230+232	60 pCi/L	–	–	–	0.2	18	4.3
Uranium-234+238 ^j	30.0 pCi/L	6.71	1140	336	23 ^k	6040	1010

^aStandards from the Uranium Mill Tailings Radiation Control Act, revised in 1986.

^bColorado Department of Health Water Quality Control Division, *Basic Standards for Ground Water*, effective April 30, 1996. Standards in the "Potentially Usable Quality" classification were used for GJO groundwater.

^c"—" indicates no data available; "<" indicates that the maximum concentration was below the detection limit (number shown is detection limit); "~" indicates an approximate value (the value was outside the limits for which the instrument was calibrated).

^dThe units are indicated in the "Federal/State Standard" column.

^eBased on maximum concentrations observed from 1984 through 1995.

^fNitrate (as N) was derived for measured nitrate using the conversion $N = NO_3 \div 4.427$.

^gThe maximum on-site nitrate (as nitrogen) result for 1996 (226 mg/L) was probably an outlier; it was more than 5 times higher than any other well value for 1996 and more than 4 orders of magnitude higher than the value obtained from the same well in 1995; that value was not included in the table.

^hThis is a site-specific standard calculated as background x 1.25. The background value is based on the December 1996 sampling event.

ⁱMeasured values represent total gross alpha minus uranium activity. Uranium concentrations that were measured in grams were converted to pCi/L. The conversion assumes equilibrium and an activity of 0.687 pCi/μg.

^jTotal uranium concentrations that were measured in grams were converted to uranium-234+238 in pCi/L for comparison. The conversion assumes equilibrium and an activity of 0.671 pCi/μg.

^kExtreme-values testing of uranium results from samples collected in 1985 and 1989 indicated that two values (201 pCi/L and 84 pCi/L) were outliers; these values from upgradient wells were not included in this table.

Table 6-1 (continued). Comparison of Federal and State Groundwater-Quality Standards to 1996 and Historical Maximum Concentrations in the Alluvial Aquifer

		1996 Maximum			Historical Maximum		
Constituent	Federal/ State Standard	Up- gradient	On Site	Down- gradient	Up- gradient	On Site	Down- gradient
Herbicides							
2,4,5-TP (Silvex)	10 µg/L	–	–	–	<0.2	<10	<0.2
2,4-D	70 µg/L	–	–	–	<1.2	<20	<1.2
Pesticides and PCBs							
4,4'-DDT	0.1 µg/L	–	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	0.1 µg/L	–	<0.05	<0.05	<0.05	<0.052	<0.05
Dieldrin	0.1 µg/L	–	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin	0.2 µg/L	–	<0.1	<0.1	<0.12	<0.12	<0.1
Heptachlor	0.05 µg/L	–	<0.05	<0.05	<0.05	<0.052	<0.05
Heptachlor Epoxide	0.05 µg/L	–	<0.05	<0.05	<0.05	<0.052	<0.05
Methoxychlor	40 µg/L	–	<0.5	<0.5	<0.5	<5	<0.5
PCBs ¹	1.0 µg/L	–	<1	<1	<2	<2.1	<2
Toxaphene	3 µg/L	–	<1	<1	<5	<48	<5
gamma-BHC (Lindane)	0.2 µg/L	–	<0.05	<0.05	<0.05	<0.8	<0.05
Semivolatile Organics							
1,2-Dichlorobenzene	600 µg/L	–	<11	<11	<10	<11	<11
1,3-Dichlorobenzene	620 µg/L	–	<11	<11	<10	<11	<11
1,4-Dichlorobenzene	75 µg/L	–	2	<11	<10	2	<11
2,4,5-Trichlorophenol	700 µg/L	–	<28	<28	<50	<50	<50
2,4,6-Trichlorophenol	50 µg/L	–	<11	<11	<10	<11	<11
2,4-Dichlorophenol	21 µg/L	–	<11	<11	<10	<11	<11
Hexachlorobenzene	1 µg/L	–	<11	<11	<10	<11	<11
Hexachlorobutadiene	10 µg/L	–	<11	<11	<10	<11	<11
Hexachlorocyclopenta- diene	50 µg/L	–	<11	<11	<10	<11	<11
Isophorone	40 µg/L	–	<11	<11	<10	<11	<11
Nitrobenzene	10 µg/L	–	<11	<11	<10	<11	<11
Pentachlorophenol	1 µg/L	–	<28	<28	<50	<50	<50
Bis(2-Chloroethyl) Ether	1 µg/L	–	<11	<11	<10	<11	<11

¹Polychlorinated biphenyls include Aroclor 1016, 1221, 1232, 1242, 1248, 1254, and 1260.

Table 6-1 (continued). Comparison of Federal and State Groundwater-Quality Standards to 1996 and Historical Maximum Concentrations in the Alluvial Aquifer

		1996 Maximum			Historical Maximum		
Constituent	Federal/ State Standard	Up- gradient	On Site	Down- gradient	Up- gradient	On Site	Down- gradient
Volatile Organics							
1,1,1-Trichloroethane	200 µg/L	–	<5	<5	<5	<5	<5
1,1,2-Trichloroethane	5 µg/L	–	<5	<5	<5	<5	<5
1,1-Dichloroethene	7 µg/L	–	<5	<5	<5	<5	<5
1,2-Dichloroethane	1 µg/L	–	<5	<5	<5	<5	<5
1,2-Dichloropropane	1 µg/L	–	<5	<5	<5	<5	<5
Benzene	5 µg/L	–	<5	<5	<5	<5	<5
Carbon Tetrachloride	1 µg/L	–	<5	<5	<5	<5	<5
Chlorobenzene	100 µg/L	–	<5	<5	<5	<5	<5
Ethyl benzene	680 µg/L	–	<5	<5	<5	<5	<5
Tetrachloroethene	5 µg/L	–	<5	<5	<5	<5	<5
Toluene	1000 µg/L	–	<5	<5	<5	<5	<5
Trichloroethene	5 µg/L	–	<5	<5	<5	<5	<5
Trihalomethanes	100 µg/L	–	<5	<5	<5	<5	<5
Vinyl Chloride	2 µg/L	–	<10	<10	<10	<10	<10
cis-1,2-Dichloroethene	70 µg/L	–	<5	<5	<5	<5	<5
trans-1,2-Dichloroethene	100 µg/L	–	<5	<5	<5	<5	<5

Figure 6-5. Uranium Concentrations in Groundwater at the DOE-GJO Facility in March 1985

Figure 6-6. Uranium Concentrations in Groundwater at the DOE-GJO Facility in March 1996

6.3.1 Radionuclide Groundwater Sampling Results

Uranium contamination is widespread throughout the alluvial aquifer beneath the facility. Uranium activities above the UMTRCA standard of 30 pCi/L (combined uranium-234 and uranium-238 activity; approximately equal to 0.045 mg/L) were recorded in samples from all alluvial wells analyzed for uranium during 1996, except the background well (GJ84-09) and on-site well GJ94-06, which is adjacent to the South Pond. The highest uranium concentration recorded in 1996, 1,141 pCi/L (1.7 mg/L), was measured in a sample from well GJ94-07, located near the dike in the central portion of the facility. Uranium concentrations in samples from downgradient well GJ84-04 and on-site well 11-1S have consistently exceeded the UMTRCA uranium standard. Figures B-9a and B-9b in Appendix B show uranium concentrations in samples collected from wells GJ84-04 and 11-1S from approximately 1990 to December 1996. For comparison, Figure B-9c shows background uranium concentrations in samples from well GJ84-09 for the same time period.

Gross alpha activities exceeding the UMTRCA standard of 15 pCi/L were recorded in samples from alluvial wells 10-19N, 10-2NA, 11-12NA, 11-1S, 14-13NA, 14-6NA, 5-12NA, 6-2N, 8-4S, and GJ87-15. Gross alpha measurements were compared with the standard, which excludes uranium and radon, by subtracting uranium activities from the reported gross alpha activities; the analytical process for determining gross alpha eliminates radon from the sample. The highest gross alpha activity recorded in 1996 was 341 pCi/L in a sample from well 10-2NA.

Historically, radium-226 contamination appeared to be localized in areas of buried tailings, which are now remediated. In 1996, the UMTRCA /State standard for radium-226 and radium-228 of 5 pCi/L was not exceeded in any well. Figure B-10a shows radium-226 and radium-228 concentrations with respect to time in samples from well 8-4S. Radium concentrations in samples from this well exceeded the UMTRCA radium standard before remediation of the southwest portion of the facility in 1992. Downgradient well GJ84-04 and background well GJ84-09 radium-226 and radium-228 concentrations are shown in Figures B-10b and B-10c for comparison.

6.3.2 Nonradionuclide Groundwater Sampling Results

As with uranium, molybdenum contamination is also widespread in the alluvial aquifer. Samples from 11 of 21 on-site and 1 of 5 downgradient wells sampled in 1996 contained concentrations of molybdenum in excess of the UMTRCA groundwater standard of 0.1 mg/L (Figure 6-4). The highest concentration (0.52 mg/L) was measured in a sample from on-site well GJ94-07. This well also yielded the highest molybdenum concentration in 1995. There is no consistent trend in elevated molybdenum concentrations with respect to time. For example, the concentration of molybdenum in samples collected from on-site well 10-19N has decreased since 1989 (Figure B-11a), whereas the concentration of molybdenum in samples collected from on-site well 14-13NA has consistently exceeded the UMTRCA groundwater standard (Figure B-11b). Molybdenum concentrations in samples from downgradient and background wells GJ84-04 and GJ84-09 are illustrated in Figures B-11c and B-11d, respectively.

Arsenic contamination is localized in the area formerly occupied by a large tailings pile. Four of the 21 on-site wells sampled in 1996 demonstrate arsenic concentrations above the UMTRCA/State standard of 0.05 mg/L. No downgradient wells contained arsenic in excess of the standard in 1996. A sample from well GJ94-05 yielded the highest arsenic concentration in 1996 (0.37 mg/L). This well also yielded the highest arsenic concentration in 1995. The UMTRCA and State groundwater standard of 0.05 mg/L was also exceeded in samples from wells 14-6NA, GJ87-15, and GJ84-03 (Figure 6-4). As shown in Figure B-12a, arsenic concentrations have consistently exceeded the UMTRCA standard in samples from well 14-6NA. Background arsenic concentrations in samples from well GJ84-09 are shown in Figure B-12b for comparison.

Selenium contamination in excess of the UMTRCA groundwater standard of 0.01 mg/L appeared in samples collected from 10 of 21 on-site wells in 1996 (Figure 6-4). No downgradient wells contained selenium in excess of the standard in 1996. The highest selenium concentration, 0.136 mg/L, was detected in a sample from on-site well 6-2N. As with molybdenum, no consistent trend in elevated selenium concentration with respect to time was observed. For example, the concentration of selenium in samples collected from on-site well 8-4S has decreased since 1990 (Figure B-13a), whereas the concentration of selenium in samples collected from on-site well 11-12NA has consistently exceeded the UMTRCA groundwater standard (Figure B-13b). Samples from background well GJ84-09 have always contained concentrations below the standard (Figure B-13c).

Nitrate concentrations in excess of the UMTRCA and State groundwater standard of 10 mg/L (nitrate as nitrogen) were detected in samples from 6 of the 21 on-site wells sampled in 1996; nitrate concentrations were below the standard in all samples from downgradient wells. Samples containing concentrations in excess of the standard were obtained from wells 10-2NA, 6-2N, 8-4S, 10-2NB, GJ94-08, and GJ94-09 (Figure 6-4). The maximum nitrate (as nitrogen) concentration of 38.4 mg/L was measured in a sample from well GJ94-08.

TDS concentrations exceeded the aquifer-specific State standard of 2,287 mg/L (1.25 times background) in samples from 6 of 21 on-site wells in 1996 (Figure 6-4). Two downgradient well samples contained TDS in concentrations that exceeded the standard. The highest TDS concentration recorded in 1996 (6,090 mg/L) occurred in a sample from well 10-19N. Samples from well 10-19N have consistently contained TDS in concentrations that exceed the State standard.

Sampling for Target Compound List volatile organic compounds, semivolatile organic compounds, pesticides, and PCBs was conducted in January 1996. The State groundwater standards for organic compounds were not exceeded in any well samples (Table 6-4) in 1996. Generally, organic compounds were not detected or were detected in low concentrations (Table A-7). Detected volatile organic compounds (acetone, 2-butanone, and styrene) ranged in concentration from 1 to 7 $\mu\text{g/L}$, and detected semivolatile organic compounds (1,4-dichlorobenzene and di-n-butylphthalate) ranged in concentration from 1 to 2 $\mu\text{g/L}$. These concentrations were estimated (i.e., the compounds were identified, but the concentrations were below the quantification limit). Because these estimated results are at the

limitations of the analytical technique, the detected compounds are not considered actual groundwater contaminants. This 1996 organic compound investigation yielded results similar to an organic compound characterization conducted in 1991 and 1992.

7.0 Quality Assurance

The DOE-GJO has a QA program that adopts and implements the requirements of 10 CFR 830.120, *Quality Assurance Requirements*, and the cultural philosophy of DOE Order 5700.6C, *Quality Assurance*. The GJO QA Program provides a structured approach for the application of QA principles to work performed for DOE, and is implemented through the *GJO Quality Assurance Manual* (DOE 1997c). ORNL's QA program is implemented through *Requirements for Quality Control of Analytical Data for the Environmental Restoration Program* (ORNL 1992).

The Quality Assurance Program Plan (QAPP) was developed for specific environmental monitoring and surveillance needs at the GJO and is appended to the *Environmental Monitoring Plan* (DOE 1995b). The primary purposes of the QAPP are to ensure that environmental data are valid and traceable and that they fulfill the requirements of the QA program. In addition, the QAPP addresses organizational responsibility, QA procedures, records, and audits. Field and laboratory quality control (QC), chain-of-custody, performance reporting, and independent data verification are addressed by the organizations responsible for the work performed.

7.1 Sampling

Methods used for effluent monitoring and environmental sampling at the GJO are described in the *Environmental Procedures Catalog* (DOE 1997b) and follow *Test Methods for Evaluating Solid Waste* (EPA 1986). ORNL sampling procedures are detailed in the *Environmental Technology Section Procedures Manual Volume II: Health and Safety and Technical Procedures* (ORNL 1993). QA and QC measures are integrated into all sampling activities to ensure sample representativeness, sample accuracy, sample precision, data comparability, and data completeness. The *Environmental Monitoring Plan* (DOE 1995b) outlines the procedures used for documentation requirements, sample collection, and sampling protocol. The procedures used to ensure that the samples are representative, comparable, precise, and complete include collecting field duplicates, equipment blanks, and trip blanks; conducting frequent QA surveillances to ensure compliance with the sampling plan; and documenting and tracking sample custody with chain-of-custody procedures.

7.2 Laboratory Analysis

The Analytical Laboratory performs analyses in support of GJO environmental monitoring programs and implements QA requirements through the *Analytical Chemistry Laboratory Administrative Plan and Quality Control Procedures* (WASTREN-GJ 1997a). The Analytical Laboratory's objective is to provide high-quality analytical data that adequately meet environmental monitoring program requirements. This objective is met by implementing a laboratory protocol that ensures that each sample is properly labeled, that analytical results are obtained and reported correctly, and that a well-documented sample history is maintained. QA measures address organizational responsibility, training and qualification of personnel, laboratory records, records control, laboratory QC, data acceptance, sample analysis, data recording and

calculation, data deficiencies, chain of custody, procurement of services, and quality assessment. Analytical methods are presented in the *Analytical Chemistry Laboratory Handbook of Analytical and Sample-Preparation Procedures* (WASTREN-GJ 1997b) and *Requirements for Quality Control of Analytical Data* (ORNL 1990).

The Analytical Laboratory maintains an internal QA organization to provide independent data review and evaluation of QC data. The QA staff includes in its audit program an evaluation of the effectiveness of the Analytical Laboratory QA program. Subcontracted analytical laboratories are under the supervision of the Analytical Laboratory. The Analytical Laboratory is responsible for monitoring a subcontracted laboratory's methods and sample results and for ensuring that proper QC is maintained.

As mandated by DOE Order 5400.1, the Analytical Laboratory participates in the DOE interlaboratory QA program coordinated by the DOE Environmental Measurements Laboratory. This interlaboratory program is designed to test the quality of the environmental measurements being reported to DOE by its contractors. Real or synthetic environmental samples that have been prepared and thoroughly analyzed at the program laboratory are distributed to the contractors for analysis, and the results are compiled for comparison. The Analytical Laboratory also participates in two non-DOE interlaboratory QA programs: (1) EPA's Environmental Measurement Systems Laboratory Program for radioactive materials and (2) the National Institute for Occupational Safety and Health Proficiency Analytical Testing Program for airborne metals, silica, and asbestos.

7.3 Data and Records Management

Data and records management objectives for environmental monitoring are established to maximize active use, maintenance, disposition, and preservation of required program information in an efficient and cost-effective manner. These objectives have been achieved and are being maintained through the establishment and implementation of systematic and applied controls through all phases of a record's life cycle.

Records are created both on paper and electronically in a retrievable format and are protected against deterioration, damage, and inadvertent loss. Records generated in support of environmental monitoring activities are subject to the requirements of Title 36, Chapter 12, of the CFR Parts 1220 through 1234 and the applicable guidance specified in the *Environmental Monitoring Plan* (DOE 1995b).

Laboratory analytical results of environmental samples are received electronically into an Oracle database. These data are maintained, protected, and archived by the GJO Information Resource Group. The Information Resource Group develops data summary reports and other data displays such as the time-concentration graphs presented in Appendix B of this report.

8.0 References

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10 CFR 1021, U.S. Department of Energy, "National Environmental Policy Act Implementation Procedures," *U.S. Code of Federal Regulations*.

40 CFR 60, U.S. Environmental Protection Agency, "Standards of Performance for New Stationary Sources," *U.S. Code of Federal Regulations*.

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Appendix A Monitoring Data

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Table A-1. Sewer-Effluent Chemistry Data for the GJO Facility During 1996^a

Ticket Number	Sample Date	Radiological Data			Non-Radiological Data							
		3H ^b (pCi/mL)	Alpha (pCi/L) ^c	Beta (pCi/L)	Ag (µg/L)	BOD ^d (mg/L)	NH ₃ (µg/L)	Oil ^e (mg/L)	PCBs/ Pesticides (µg/L)	pH	TDS ^f (mg/L)	Temperature (°C)
NBF-130	02/01/1996	<0.24	29.25	18.54	-	-	-	-	-	-	-	-
NBF-131	03/06/1996	-	20.32	27.18	-	-	-	-	-	-	-	-
NBF-132	03/07/1996	-	16.53	<19.18	<1.0	47.0	23000	41.0	No Detect	7.74	510	11.9
NBF-133	03/07/1996	-	<15.32	27.35	<1.0	49.0	22600	40.0	-	-	503	-
NBF-134	04/22/1996	<0.27	<15.74	<19.23	-	-	-	-	-	-	-	-
NBF-135	05/22/1996	-	37.86	29.49	-5.2	71.0	33200	17.0	No Detect	-	515	-
NBF-136	05/29/1996	<0.21	22.23	<13.21	-	-	-	-	-	-	-	-
NBF-137	05/30/1996	-	39.18	<13.38	<4.0	43.6	14100	39.0	No Detect	7.87	532	19.0
NBF-138	06/27/1996	<0.26	41.03	17.76	-	-	-	-	-	-	-	-
NBF-139	08/02/1996	<0.30	29.63	15.17	-	-	-	-	-	-	-	-
NBF-140	08/28/1996	<0.23	13.8	<15.7	-	-	-	-	-	-	-	-
NBF-141	08/29/1996	-	<10.7	<15.6	<3.6	27.1	14600	11.0	No Detect	7.78	370	23.4
NBF-142	08/29/1996	-	<10.7	<15.5	<3.6	27.1	14900	8.0	No Detect	-	383	-
NBF-143	09/25/1996	<0.31	8.02	13.89	-	-	-	-	-	-	-	-
NBF-144	10/09/1996	-	-	-	-3.1	193	18100	20.0	No Detect	-	483	-
NBF-145	10/31/1996	<0.29	8.71	13.03	-	-	-	-	-	-	-	-
NBF-146	12/02/1996	0.29	8.54	11.48	-	-	-	-	-	-	-	-
NBF-147	12/03/1996	-	-	-	<3.0	38.7	13200	9.0	No Detect	8.96	455	13.9
NBF-148	12/27/1996	<0.30	8.82	10.64	-	-	-	-	-	-	-	-

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit). A "-" indicates an approximate value (the value was outside the limits for which the instrument was calibrated).

^b Tritium. Values with units of pCi/mL multiplied by 10⁻⁶ will yield values with units of µCi/mL for comparison with the Derived Concentration Guides listed in Chapter 3 of DOE Order 5400.5.

^c Values with units of pCi/L multiplied by 10⁻⁹ will yield values with units of µCi/mL for comparison with the Derived Concentration Guides listed in Chapter 3 of DOE Order 5400.5.

^d Biological oxygen demand.

^e Oil and grease.

^f Total dissolved solids.

Table A-1 (continued). Sewer-Effluent Chemistry Data for the GJO Facility During 1996^a

Ticket Number	Sample Date	Non-Radiological
		TSS ^a (mg/L)
NBF-130	02/01/1996	-
NBF-131	03/06/1996	-
NBF-132	03/07/1996	42.0
NBF-133	03/07/1996	38.0
NBF-134	04/22/1996	-
NBF-135	05/22/1996	66.0
NBF-136	05/29/1996	-
NBF-137	05/30/1996	40.0
NBF-138	06/27/1996	-
NBF-139	08/02/1996	-
NBF-140	08/28/1996	-
NBF-141	08/29/1996	32.0
NBF-142	08/29/1996	36.0
NBF-143	09/25/1996	-
NBF-144	10/09/1996	416
NBF-145	10/31/1996	-
NBF-146	12/02/1996	-
NBF-147	12/03/1996	50.0
NBF-148	12/27/1996	-

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit). A "-" indicates an approximate value (the value was outside the limits for which the instrument was calibrated).

^a Total suspended solids.

Table A-2. Surface-Water Chemistry Data Collected At and Near the GJO Facility During 1996^a

Sample Location	Ticket Number	Sample Date	Radiological Data			Non-Radiological Data					
			Alpha (pCi/L) ^b	Beta (pCi/L)	Ra-226 (pCi/L)	Alkalinity (as CaCO ₃) (ppm)	As (µg/L)	Ba (µg/L)	Ca (µg/L)	Cd (µg/L)	CDT ^c (µmhos/cm)
Lower Gunnison	NBD-446	03/28/1996	<7.90	-	0.41	154	<3.0	~43.3	56800	~0.32	545
	NDA-154	12/09/1996	7.13	<7.23	0.18	141	10.3	~43.9	75600	<1.0	790
Middle Gunnison	NBD-445	03/28/1996	8.96	-	0.09	115	<3.0	~41.4	55500	<0.30	568
	NDA-153	12/09/1996	<5.76	<7.66	0.19	125	8.6	~43.7	74600	<1.0	775
North Pond	NBD-437	03/27/1996	346.53	-	0.26	239	<3.0	~10.2	241000	<0.30	5520
	NDA-155	12/10/1996	103.54	66.08	<0.16	179	16.0	~9.4	206000	<1.0	4860
South Pond	NBD-433	03/26/1996	295.63	-	0.69	108	<3.0	~18.7	316000	<0.30	3510
	NBD-434	03/26/1996	341.43	-	0.42	-	<3.0	~17.6	325000	<0.30	-
	NDA-157	12/10/1996	246.15	<59.48	0.10	69	8.0	~16.7	364000	<1.0	4070
	NDA-158	12/10/1996	279.68	82.70	0.21	-	17.5	~19.1	360000	<1.0	-
Upper Gunnison	NBD-443	03/28/1996	<7.55	-	0.16	114	<3.0	~42.3	55300	<0.30	575
	NDA-151	12/09/1996	<5.53	8.86	<0.17	137	8.7	~42.6	76300	<1.0	776
Upper Mid Gunnison	NBD-444	03/28/1996	<7.59	-	0.26	156	<3.0	~42.3	56000	~0.63	575
	NDA-152	12/09/1996	6.22	<7.22	<0.18	121	8.1	~42.7	75500	<1.0	774
Wetland Area	NBD-436	03/27/1996	585.31	-	0.10	214	~9.1	<2.0	436000	<0.30	10050
	NDA-156	12/10/1996	395.25	<290.10	0.11	196	25.0	~8.5	404000	<1.0	20200

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit). A "~" indicates an approximate value (the value was outside the limits for which the instrument was calibrated).

^b Values with units of pCi/L multiplied by 10⁻⁹ will yield values with units of µCi/mL for comparison with the Derived Concentration Guides listed in Chapter 3 of DOE Order 5400.5.

^c Conductivity measured in micromhos per centimeter.

Table A-2 (continued). Surface-Water Chemistry Data Collected At and Near the GJO Facility During 1996^a

Sample Location	Ticket Number	Sample Date	Non-Radiological Data							
			Pb (µg/L)	pH	Se (µg/L)	SO ₄ (µg/L)	TDS ^d (mg/L)	Temperature (°C)	U (µg/L)	V (µg/L)
Lower Gunnison	NBD-446	03/28/1996	<0.20	8.01	<2.0	160000	353	9.0	~4.6	<6.0
	NDA-154	12/09/1996	<1.0	8.70	<4.0	236000	498	3.6	6.0	<6.0
Middle Gunnison	NBD-445	03/28/1996	<0.20	8.33	~3.9	149000	373	9.2	~3.6	<6.0
	NDA-153	12/09/1996	19.3	8.65	<4.0	232000	535	3.7	5.5	<6.0
North Pond	NBD-437	03/27/1996	<0.20	7.93	5.5	2250000	4160	12.6	309	<6.0
	NDA-155	12/10/1996	~2.2	8.50	<4.0	2190000	3947	3.8	227	~6.6
South Pond	NBD-433	03/26/1996	<0.20	7.01	<2.0	1700000	2820	13.3	417	<6.0
	NBD-434	03/26/1996	<0.20	-	~2.3	1660000	2820	-	426	<6.0
	NDA-157	12/10/1996	~1.3	8.39	<4.0	2010000	3405	5.0	426	<6.0
	NDA-158	12/10/1996	~1.2	-	<4.0	2010000	3350	-	422	<6.0
Upper Gunnison	NBD-443	03/28/1996	<0.20	8.04	<2.0	147000	332	7.5	~3.5	~6.6
	NDA-151	12/09/1996	4.6	8.68	<4.0	233000	507	3.1	5.6	<6.0
Upper Mid Gunnison	NBD-444	03/28/1996	<0.20	8.35	<2.0	149000	355	8.5	~3.6	<6.0
	NDA-152	12/09/1996	~1.3	8.85	~4.3	233000	508	3.6	5.7	<6.0
Wetland Area	NBD-436	03/27/1996	~0.21	8.36	<2.0	5220000	9160	11.9	616	<6.0
	NDA-156	12/10/1996	~2.4	8.85	<4.0	13100000	21960	4.6	670	<6.0

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit). A "-" indicates an approximate value (the value was outside the limits for which the instrument was calibrated).

^d Total dissolved solids.

Table A-2 (continued). Surface-Water Chemistry Data Collected At and Near the GJO Facility During 1996^a

Sample Location	Ticket Number	Sample Date	Non-Radiological Data								
			Cl (µg/L)	Cr (µg/L)	Fe (µg/L)	K (µg/L)	Mg (µg/L)	Mn (µg/L)	Mo (µg/L)	Na (µg/L)	NO ₃ (µg/L)
Lower Gunnison	NBD-446	03/28/1996	5730	<4.0	<5.0	~2680	20300	23.8	~2.0	33200	1430
	NDA-154	12/09/1996	6090	<3.0	<5.0	2640	27100	23.4	~2.2	44000	3140
Middle Gunnison	NBD-445	03/28/1996	4380	<4.0	~6.4	~1330	19700	19.1	~2.0	29300	1440
	NDA-153	12/09/1996	5720	<3.0	~11.4	2620	26700	20.0	~2.1	42700	3130
North Pond	NBD-437	03/27/1996	327000	<4.0	~24.8	23700	174000	156	~25.4	763000	120
	NDA-155	12/10/1996	338000	<3.0	57.7	21000	167000	21.2	15.5	785000	~176
South Pond	NBD-433	03/26/1996	117000	<4.0	~8.7	12900	74400	313	82.9	406000	<12.0
	NBD-434	03/26/1996	115000	<4.0	~12.2	13600	76100	318	81.8	414000	<12.0
	NDA-157	12/10/1996	144000	<3.0	~7.5	17200	92100	32.2	107	502000	~362
	NDA-158	12/10/1996	145000	<3.0	~13.1	17500	92000	32.4	106	503000	~354
Upper Gunnison	NBD-443	03/28/1996	4280	<4.0	~6.1	~1480	19500	19.2	~2.1	28700	1450
	NDA-151	12/09/1996	5610	<3.0	~23.8	2610	27500	20.0	~2.3	43400	3160
Upper Mid Gunnison	NBD-444	03/28/1996	4370	<4.0	~8.2	~1670	19800	19.1	~2.0	29000	1440
	NDA-152	12/09/1996	5650	<3.0	<5.0	2620	27000	19.2	~2.2	43300	3140
Wetland Area	NBD-436	03/27/1996	715000	<4.0	~13.0	47800	246000	1200	314	1930000	~18.1
	NDA-156	12/10/1996	1690000	<3.0	<5.0	99900	636000	20.4	358	5660000	~43.4

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit). A "~" indicates an approximate value (the value was outside the limits for which the instrument was calibrated).

Table A-3. Groundwater Chemistry Data Collected by Rust and WASTREN At and Near the GJO Facility During 1996^a

Sample Location	Ticket Number	Sample Date	Radiological Data				Non-Radiological Data				
			Alpha (pCi/L) ^b	Beta (pCi/L)	Ra-226 (pCi/L)	Alkalinity (as CaCO ₃) (ppm)	As (µg/L)	Ba (µg/L)	Ca (µg/L)	Cd (µg/L)	CDT ^c (µmhos/cm)
10-19N	NBD-431	03/25/1996	260.57	-	0.23	363	~3.4	~19.1	401000	<0.30	7290
	NDA-167	12/12/1996	200.02	<83.67	0.09	408	13.0	~21.9	376000	<1.0	6800
10-2NA	NBD-442	03/28/1996	914.13	-	0.25	323	<3.0	~17.1	266000	<0.30	3410
	NDA-171	12/13/1996	426.91	124.78	0.19	278	14.6	~21.9	249000	<1.0	3070
11-12NA	NDA-172	12/13/1996	532.56	128.49	0.18	-	6.3	~19.6	248000	<1.0	-
	NBD-441	03/27/1996	355.68	-	0.16	378	23.1	~17.0	223000	<0.30	2790
11-1S	NDA-166	12/12/1996	228.53	32.54	<0.07	378	45.0	~22.6	225000	<1.0	2700
	NBD-439	03/27/1996	911.00	-	0.15	282	<3.0	~16.8	200000	<0.30	3030
14-13NA	NDA-162	12/11/1996	386.76	108.19	<0.07	272	11.5	~28.7	147000	<1.0	-
	NBD-440	03/27/1996	399.88	-	0.13	192	~5.3	~11.5	399000	<0.30	4100
14-6NA	NDA-165	12/12/1996	178.56	<58.83	<0.11	182	19.7	~15.6	424000	<1.0	4040
	NBD-432	03/26/1996	82.84	-	0.48	255	313	~76.5	273000	<0.30	2650
5-12NA	NDA-163	12/11/1996	34.85	17.32	0.09	221	285	~36.0	110000	<1.0	1370
	NBD-428	03/25/1996	96.97	-	0.43	379	<3.0	~16.9	327000	<0.30	3560
6-2N	NBD-429	03/25/1996	92.77	-	0.17	-	<3.0	~17.3	332000	<0.30	-
	NDA-168	12/12/1996	46.25	<38.57	0.13	366	10.2	~19.2	315000	<1.0	3230
8-4S	NBD-447	03/28/1996	399.79	-	0.15	263	<3.0	~25.2	296000	~0.74	3490
	NDA-170	12/13/1996	194.36	52.42	0.12	256	8.4	~27.9	296000	<1.0	3330
GJ84-04	NBD-435	03/26/1996	299.14	-	0.28	175	<3.0	~13.5	501000	<0.30	2700
	NDA-160	12/10/1996	424.01	121.06	0.18	246	9.2	~18.8	366000	<1.0	2810
GJ84-09	NBD-430	03/25/1996	336.85	-	0.31	263	~7.3	~21.7	289000	<0.30	4430
	NDA-164	12/12/1996	234.47	90.97	0.08	273	18.6	~22.7	303000	<1.0	4210
GJ87-15	NBD-426	03/25/1996	<24.25	-	0.13	291	<3.0	~15.8	132000	<0.30	2390
	NDA-161	12/11/1996	<20.59	<28.56	<0.08	218	11.4	~17.6	151000	<1.0	2480
	NBD-427	03/25/1996	433.27	-	0.34	234	45.8	~16.2	420000	~0.37	4020
	NDA-169	12/12/1996	249.54	77.73	0.09	222	67.5	~19.5	429000	<1.0	4160

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit). A "-" indicates an approximate value (the value was outside the limits for which the instrument was calibrated).

^b Values with units of pCi/L multiplied by 10⁻⁹ will yield values with units of µCi/mL for comparison with the Derived Concentration Guides listed in Chapter 3 of DOE Order 5400.5.

^c Conductivity measured in micromhos per centimeter.

Table A-3 (continued). Groundwater Chemistry Data Collected by Rust and WASTREN At and Near the GJO Facility During 1996^a

Sample Location	Ticket Number	Sample Date	Non-Radiological Data								
			Cl (µg/L)	Cr (µg/L)	Fe (µg/L)	H ₂ O Depth (feet)	K (µg/L)	Mg (µg/L)	Mn (µg/L)	Mo (µg/L)	Na (µg/L)
10-19N	NBD-431	03/25/1996	462000	<4.0	1100	12.33	19300	219000	3740	80.8	1110000
	NDA-167	12/12/1996	451000	<3.0	971	12.45	19700	202000	3280	107	1230000
10-2NA	NBD-442	03/28/1996	117000	<4.0	~14.5	10.21	10100	108000	1050	213	409000
	NDA-171	12/13/1996	131000	<3.0	~5.4	10.50	9950	91600	887	189	377000
11-12NA	NDA-172	12/13/1996	129000	<3.0	<5.0	-	9680	91800	894	189	383000
	NBD-441	03/27/1996	142000	<4.0	<5.0	5.03	8260	74400	764	~25.8	327000
11-1S	NDA-166	12/12/1996	136000	<3.0	<5.0	5.08	8990	71200	799	23.2	325000
	NBD-439	03/27/1996	121000	<4.0	<5.0	15.82	7290	87500	56.8	194	367000
14-13NA	NDA-162	12/11/1996	99000	<3.0	<5.0	16.04	7750	61200	55.2	162	289000
	NBD-440	03/27/1996	128000	<4.0	<5.0	5.31	19700	87800	4780	292	471000
14-6NA	NDA-165	12/12/1996	137000	<3.0	<5.0	5.50	18400	84600	4930	301	513000
	NBD-432	03/26/1996	82000	<4.0	3390	18.56	21400	60600	8130	~26.8	242000
5-12NA	NDA-163	12/11/1996	21300	<3.0	1590	18.71	14900	24700	2730	26.4	134000
	NBD-428	03/25/1996	177000	<4.0	~9.7	9.70	6090	125000	640	~13.0	376000
6-2N	NBD-429	03/25/1996	175000	<4.0	<5.0	-	6540	126000	643	~12.8	381000
	NDA-168	12/12/1996	147000	<3.0	<5.0	9.59	6050	114000	540	12.2	348000
8-4S	NBD-447	03/28/1996	125000	<4.0	<5.0	13.51	10400	91600	1880	55.3	430000
	NDA-170	12/13/1996	115000	<3.0	<5.0	13.4	10000	85400	1880	51.0	431000
GJ84-04	NBD-435	03/26/1996	73400	<4.0	<5.0	11.10	~2000	63800	573	64.3	127000
	NDA-160	12/10/1996	93100	<3.0	<5.0	10.94	6150	73500	295	138	237000
GJ84-09	NBD-430	03/25/1996	159000	<4.0	~37.4	8.49	12600	75900	4120	204	652000
	NDA-164	12/12/1996	141000	<3.0	31.2	8.75	11900	74700	4350	170	668000
GJ87-15	NBD-426	03/25/1996	51200	<4.0	~29.2	20.20	6860	21500	43.2	~6.5	396000
	NDA-161	12/11/1996	71200	<3.0	173	19.83	8660	24100	231	~6.8	402000
	NBD-427	03/25/1996	139000	<4.0	<5.0	7.25	16100	89900	6050	226	460000
	NDA-169	12/12/1996	150000	<3.0	<5.0	7.31	16500	84500	6040	254	530000

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit). A "~" indicates an approximate value (the value was outside the limits for which the instrument was calibrated).

Table A-3 (continued). Groundwater Chemistry Data Collected by Rust and WASTREN At and Near the GJO Facility During 1996^a

Sample Location	Ticket Number	Sample Date	Non-Radiological Data								
			NO ₃ (µg/L)	Pb (µg/L)	pH	Se (µg/L)	SO ₄ (µg/L)	TDS ^d (mg/L)	Temperature (°C)	Turbidity (NTU) ^e	U (µg/L)
10-19N	NBD-431	03/25/1996	~19.7	~0.37	6.82	5.6	3330000	6090	10.7	4.10	330
	NDA-167	12/12/1996	<12.4	~1.5	6.95	<4.0	3350000	6060	15.6	4.28	354
10-2NA	NBD-442	03/28/1996	94400	~0.42	7.28	104	1390000	2710	15.9	18.0	833
	NDA-171	12/13/1996	110000	~1.4	7.05	80.6	1220000	2460	17.1	0.44	719
	NDA-172	12/13/1996	107000	<1.0	-	86.6	1200000	2450	-	-	723
	NBD-441	03/27/1996	43500	<0.20	7.08	53.9	914000	2070	13.0	0.78	329
11-12NA	NDA-166	12/12/1996	40900	~2.0	7.02	62.4	923000	2060	15.8	0.35	296
	NBD-439	03/27/1996	26600	<0.20	7.24	14.1	1190000	2250	13.6	2.70	893
11-1S	NDA-162	12/11/1996	3720	~2.0	7.28	6.2	794000	1650	14.9	2.23	677
	NBD-440	03/27/1996	41.0	<0.20	7.05	~3.1	2010000	3460	12.3	2.16	331
14-13NA	NDA-165	12/12/1996	~68.0	<1.0	6.57	<4.0	2120000	3560	15.9	0.39	297
	NBD-432	03/26/1996	37.3	<0.20	6.47	~2.7	1120000	2030	13.2	9.04	66.6
14-6NA	NDA-163	12/11/1996	~28.5	~2.4	7.07	<4.0	446000	925	15.0	27.7	52.4
	NBD-428	03/25/1996	4180	<0.20	6.88	18.0	1460000	2910	14.7	0.36	54.8
5-12NA	NBD-429	03/25/1996	4110	<0.20	-	12.5	1460000	2930	-	-	54.3
	NDA-168	12/12/1996	708	~1.7	7.17	<4.0	1360000	2690	15.2	0.27	51.4
6-2N	NBD-447	03/28/1996	61900	~0.25	7.57	136	1470000	2770	17.9	1.45	381
	NDA-170	12/13/1996	55600	<1.0	7.51	117	1480000	2760	17.9	0.21	346
8-4S	NBD-435	03/26/1996	29600	<0.20	7.46	23.2	1450000	2560	11.7	3.45	286
	NDA-160	12/10/1996	86200	~1.6	7.24	63.7	1200000	2350	14.5	4.54	661
GJ84-04	NBD-430	03/25/1996	<12.0	<0.20	6.86	<2.0	2000000	3530	12.9	0.79	494
	NDA-164	12/12/1996	<6.2	<1.0	6.83	<4.0	2040000	3520	14.8	0.57	416
GJ84-09	NBD-426	03/25/1996	29.2	<0.20	6.65	<2.0	902000	1660	14.4	0.55	10.0
	NDA-161	12/11/1996	~14.8	~2.6	7.29	<4.0	973000	1830	14.7	1.37	8.6
GJ87-15	NBD-427	03/25/1996	1700	~0.22	6.78	<2.0	1920000	3370	11.6	3.84	418
	NDA-169	12/12/1996	~381	<1.0	7.05	<4.0	2110000	3620	16.0	2.8	396

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit). A "~" indicates an approximate value (the value was outside the limits for which the instrument was calibrated).

^d Total dissolved solids.

^e Nephelometric turbidity units.

Table A-3 (continued). Groundwater Chemistry Data Collected by Rust and WASTREN At and Near the GJO Facility During 1996^a

Non-Radiological Data			
Sample Location	Ticket Number	Sample Date	V (µg/L)
10-19N	NBD-431	03/25/1996	<6.0
	NDA-167	12/12/1996	<6.0
10-2NA	NBD-442	03/28/1996	<6.0
	NDA-171	12/13/1996	<6.0
	NDA-172	12/13/1996	<6.0
11-12NA	NBD-441	03/27/1996	141
	NDA-166	12/12/1996	148
11-1S	NBD-439	03/27/1996	-7.7
	NDA-162	12/11/1996	<6.0
14-13NA	NBD-440	03/27/1996	-17.0
	NDA-165	12/12/1996	-9.2
14-6NA	NBD-432	03/26/1996	<6.0
	NDA-163	12/11/1996	<6.0
5-12NA	NBD-428	03/25/1996	<6.0
	NBD-429	03/25/1996	<6.0
	NDA-168	12/12/1996	<6.0
6-2N	NBD-447	03/28/1996	<6.0
	NDA-170	12/13/1996	-8.5
8-4S	NBD-435	03/26/1996	-10.7
	NDA-160	12/10/1996	-7.7
GJ84-04	NBD-430	03/25/1996	-18.0
	NDA-164	12/12/1996	10.4
GJ84-09	NBD-426	03/25/1996	<6.0
	NDA-161	12/11/1996	<6.0
GJ87-15	NBD-427	03/25/1996	86.9
	NDA-169	12/12/1996	85.6

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit). A "--" indicates an approximate value (the value was outside the limits for which the instrument was calibrated).

Table A-4. QA/QC Chemistry Data Collected by Rust and WASTREN At and Near the GJO Facility During 1996^a

Sample Location	Ticket Number	Sample Date	Radiological Data				Non-Radiological Data					
			Alpha (pCi/L) ^b	Beta (pCi/L)	Ra-226 (pCi/L)	As (µg/L)	Ba (µg/L)	Ca (µg/L)	Cd (µg/L)	Cl (µg/L)	Cr (µg/L)	
Equipment Blank	NBD-438	03/27/1996	<3.22	-	0.21	<3.0	<2.0	~53.5	<0.30	<5.0	<4.0	
	NDA-159	12/10/1996	<1.82	<3.75	<0.07	<4.0	<4.0	~151	<1.0	<3.4	<3.0	
Sample Location	Ticket Number	Sample Date	Non-Radiological Data				Non-Radiological Data					
			Fe (µg/L)	K (µg/L)	Mg (µg/L)	Mn (µg/L)	Mo (µg/L)	Na (µg/L)	NO ₃ (µg/L)	Pb (µg/L)	Se (µg/L)	
Equipment Blank	NBD-438	03/27/1996	<5.0	<1210	<68.0	<1.0	-0.58	-412	-6.0	<0.20	-3.1	
	NDA-159	12/10/1996	82.4	~25.4	<68.0	<1.0	<1.0	~305	<3.1	~1.7	<4.0	
Sample Location	Ticket Number	Sample Date	Non-Radiological Data				Non-Radiological Data					
			SO ₄ (µg/L)	TDS ^c (mg/L)	U (µg/L)	V (µg/L)						
Equipment Blank	NBD-438	03/27/1996	~41.5	<10.0	~0.17	<6.0						
	NDA-159	12/10/1996	<35.0	<10.0	<1.0	<6.0						

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit). A "-" indicates an approximate value (the value was outside the limits for which the instrument was calibrated).

^b Values with units of pCi/L multiplied by 10⁻⁹ will yield values with units of µCi/mL for comparison with the Derived Concentration Guides listed in Chapter 3 of DOE Order 5400.5.

^c Total dissolved solids.

Table A-5. Groundwater Chemistry Data Collected by Oak Ridge National Laboratory At and Near the GJO During 1996^a

Sample Location	Sample Date	Radiological		Non-Radiological Data							
		Ra-226 ^b (pCi/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (mg/L)	Be (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)
10-2NB	01/18/1996	<1.486	<0.005	<0.05	<0.01	0.63	0.025	<0.001	270	<0.005	120
11-12NA	09/26/1996	-	<0.005	<0.05	0.028	0.51	0.023	<0.001	240	<0.005	-
11-1S	01/22/1996	<0.838	<0.005	<0.05	<0.01	0.75	0.033	<0.001	310	<0.005	390
	06/26/1996	-	<0.005	<0.05	<0.01	0.21	0.015	<0.001	72	<0.005	-
14-13NA	09/27/1996	-	<0.005	<0.05	0.0099	0.8	0.019	<0.001	420	<0.005	-
14-6NA	01/22/1996	<1.568	<0.005	<0.05	0.27	0.38	0.078	<0.001	270	<0.005	84
6-2N	01/19/1996	<1.486	<0.005	<0.05	<0.01	0.46	0.027	<0.001	290	<0.005	140
8-4S	01/23/1996	2.432	<0.005	<0.05	<0.01	0.79	0.024	<0.001	360	<0.005	200
	09/26/1996	-	<0.005	<0.05	0.0033	0.66	0.024	<0.001	390	<0.005	-
GJ84-03	06/25/1996	-	<0.005	<0.05	0.064	0.62	0.023	0.001	300	<0.005	-
GJ84-04	01/19/1996	<1.459	<0.005	<0.05	<0.01	0.77	0.029	<0.001	300	<0.005	200
	06/24/1996	-	<0.005	<0.05	<0.01	0.69	0.023	<0.001	290	<0.005	-
GJ84-05	06/24/1996	-	<0.005	<0.05	<0.01	1.2	0.025	<0.001	250	<0.005	-
GJ87-15	06/25/1996	-	<0.005	<0.05	0.057	0.65	0.023	<0.001	460	<0.005	-
GJ94-01	01/09/1996	<2.243	-	-	-	-	-	-	-	-	-
	09/23/1996	-	<0.005	<0.05	0.0065	1.7	0.029	<0.001	360	<0.005	-
GJ94-02	01/09/1996	1.784	-	-	-	-	-	-	-	-	-
	04/23/1996	-	<0.005	<0.05	<0.01	1.2	0.019	<0.001	480	<0.005	-
	06/26/1996	-	<0.005	<0.05	<0.01	1	0.017	<0.001	380	<0.005	-
	09/23/1996	-	<0.005	<0.05	0.0027	1.1	0.02	<0.001	430	<0.005	-
GJ94-03	09/23/1996	-	<0.005	<0.05	0.0023	1.1	0.019	<0.001	430	<0.005	-
	01/10/1996	<1.865	-	-	-	-	-	-	-	-	-
	01/10/1996	2.703	-	-	-	-	-	-	-	-	-
	04/25/1996	-	<0.005	<0.05	<0.01	0.63	0.029	<0.001	380	<0.005	-
	06/25/1996	-	<0.005	<0.05	<0.01	0.59	0.025	<0.001	380	<0.005	-

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).

^b Radium-226 activities were measured in becquerels per liter and the results were converted to picocuries per liter for reporting purposes. Values with units of picocuries per liter multiplied by 10⁻⁹ will yield values with units of microcuries per milliliter for comparison with the Derived Concentration Guides listed in Chapter 3 of DOE Order 5400.5.

Table A-5 (continued). Groundwater Chemistry Data Collected by Oak Ridge National Laboratory At and Near the GJO During 1996^a

Sample Location	Sample Date	Non-Radiological Data									
		Co (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Li (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)
10-2NB	01/18/1996	<0.004	<0.004	<0.007	<0.05	<0.0002	11	-	100	1.2	0.17
11-12NA	09/26/1996	<0.004	<0.004	<0.007	<0.05	<0.0002	9.6	-	73	0.74	<0.04
11-1S	01/22/1996	<0.004	<0.004	<0.007	<0.05	0.00021	11	-	140	0.087	0.13
	06/26/1996	<0.004	<0.004	<0.007	<0.05	-	-	0.05	30	0.026	0.097
14-13NA	09/27/1996	<0.004	<0.004	<0.007	<0.05	<0.0002	24	-	84	4.5	0.26
14-6NA	01/22/1996	<0.004	<0.004	<0.007	3.2	<0.0002	23	-	58	6.9	<0.04
6-2N	01/19/1996	<0.004	<0.004	0.0076	<0.05	<0.0002	11	-	89	1.7	<0.04
8-4S	01/23/1996	<0.004	<0.004	<0.007	<0.05	0.00023	8.7	-	120	0.83	0.13
	09/26/1996	<0.004	<0.004	<0.007	<0.05	<0.0002	8.6	-	93	0.54	0.13
GJ84-03	06/25/1996	<0.004	<0.004	<0.007	<0.05	-	-	0.083	78	1.9	0.06
GJ84-04	01/19/1996	0.006	<0.004	<0.007	<0.05	<0.0002	14	-	77	4	0.16
	06/24/1996	<0.004	<0.004	<0.007	0.056	-	-	0.08	73	3.4	0.13
GJ84-05	06/24/1996	<0.004	<0.004	<0.007	<0.05	-	-	0.2	110	1.4	0.044
GJ87-15	06/25/1996	<0.004	<0.004	<0.007	<0.05	-	-	0.068	95	5.9	0.18
GJ94-01	01/09/1996	-	-	-	-	-	-	-	-	-	-
	09/23/1996	<0.004	<0.004	<0.007	2.8	<0.0002	25	-	210	3.4	<0.04
GJ94-02	01/09/1996	-	-	-	-	-	-	-	-	-	-
	04/23/1996	<0.004	<0.004	<0.007	0.54	<0.0002	13	-	110	4.2	0.12
	06/26/1996	<0.004	<0.004	<0.007	0.46	-	-	0.16	92	3.1	<0.04
	09/23/1996	<0.004	<0.004	<0.007	0.44	<0.0002	14	-	98	3.4	0.15
	09/23/1996	<0.004	<0.004	<0.007	0.43	<0.0002	14	-	98	3.4	0.15
GJ94-03	01/10/1996	-	-	-	-	-	-	-	-	-	-
	01/10/1996	-	-	-	-	-	-	-	-	-	-
	04/25/1996	<0.004	<0.004	<0.007	0.55	<0.0002	12	-	70	6.5	0.06
	06/25/1996	<0.004	<0.004	<0.007	0.47	-	-	0.071	70	5.4	0.065

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).

Table A-5 (continued). Groundwater Chemistry Data Collected by Oak Ridge National Laboratory At and Near the GJO During 1996^a

Non-Radiological Data											
Sample Location	Sample Date	Na (mg/L)	Ni (mg/L)	NO ₃ (mg/L)	P (mg/L)	Pb (mg/L)	Pesticide (µg/L)	PO ₄ (mg/L)	Sb (mg/L)	Se (mg/L)	Semivolatile ^c (µg/L)
10-2NB	01/18/1996	380	<0.01	98	-	<0.003	No Detect	<25	<0.06	0.085	No Detect
11-12NA	09/26/1996	300	<0.01	-	-	<0.001	-	-	<0.001	0.052	-
11-1S	01/22/1996	460	<0.01	52	-	<0.003	No Detect	<25	<0.06	0.028	No Detect
	06/26/1996	150	<0.01	-	<0.3	<0.02	-	-	<0.005	0.063	-
14-13NA	09/27/1996	500	<0.01	-	-	<0.001	-	-	<0.001	0.0056	-
14-6NA	01/22/1996	230	<0.01	4.3	-	<0.003	No Detect	<25	<0.06	<0.005	See Table
6-2N	01/19/1996	420	<0.01	67	-	<0.003	No Detect	<25	<0.06	0.11	No Detect
8-4S	01/23/1996	350	0.013	120	-	<0.003	No Detect	<25	<0.06	0.079	See Table
	09/26/1996	270	0.013	-	-	<0.001	-	-	<0.001	0.075	-
GJ84-03	06/25/1996	350	<0.01	-	<0.3	<0.02	-	-	<0.005	0.028	-
GJ84-04	01/19/1996	690	<0.01	<0.1	-	<0.002	No Detect	<25	<0.06	0.0052	No Detect
	06/24/1996	680	<0.01	-	<0.3	<0.02	-	-	<0.005	<0.005	-
GJ84-05	06/24/1996	820	<0.01	-	<0.3	<0.02	-	-	<0.005	<0.005	-
GJ87-15	06/25/1996	450	0.012	-	<0.3	<0.02	-	-	<0.005	0.0058	-
GJ94-01	01/09/1996	-	-	-	-	-	No Detect	-	-	-	No Detect
	09/23/1996	960	<0.01	-	-	<0.001	-	-	<0.001	0.0093	-
GJ94-02	01/09/1996	-	-	-	-	-	No Detect	-	-	-	No Detect
	04/23/1996	980	<0.01	-	-	<0.02	-	-	<0.005	<0.005	-
	06/26/1996	880	<0.01	-	<0.3	<0.02	-	-	<0.005	<0.005	-
	09/23/1996	890	<0.01	-	-	<0.001	-	-	<0.001	0.0086	-
	09/23/1996	880	<0.01	-	-	<0.001	-	-	<0.001	0.0067	-
GJ94-03	01/10/1996	-	-	-	-	-	No Detect	-	-	-	No Detect
	01/10/1996	-	-	-	-	-	-	-	-	-	No Detect
	04/25/1996	430	<0.01	-	-	<0.02	-	-	<0.005	<0.005	-
	06/25/1996	410	<0.01	-	<0.3	<0.02	-	-	<0.005	<0.005	-

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).^c Refer to Table A-7 for a list of detected constituents.

Table A-5 (continued). Groundwater Chemistry Data Collected by Oak Ridge National Laboratory At and Near the GJO During 1996^a

Sample Location	Sample Date	Non-Radiological Data									
		Si (mg/L)	Sn (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	Tl (mg/L)	U (mg/L)	V (mg/L)	Volatile ^c (µg/L)	Zn (mg/L)
10-2NB	01/18/1996	8	-	1700	-	-	<0.01	0.84	0.0073	See Table	<0.005
11-12NA	09/26/1996	14	-	-	-	-	<0.001	0.31	0.16	-	<0.005
11-1S	01/22/1996	8.5	-	1700	-	-	<0.01	0.92	0.0069	See Table	<0.005
	06/26/1996	6.5	<0.05	-	0.52	<0.02	<0.005	0.34	0.0056	-	0.0062
14-13NA	09/27/1996	11	-	-	-	-	<0.001	0.31	0.019	-	0.0054
14-6NA	01/22/1996	11	-	1200	-	-	<0.01	0.052	0.0056	See Table	0.0056
6-2N	01/19/1996	9.6	-	1700	-	-	<0.01	0.34	0.012	See Table	0.0074
8-4S	01/23/1996	8.3	-	1600	-	-	<0.01	0.82	0.0094	See Table	0.0055
	09/26/1996	9.3	-	-	-	-	<0.001	0.72	0.01	-	0.0099
GJ84-03	06/25/1996	11	<0.05	-	2.3	<0.02	<0.005	0.42	0.23	-	<0.005
GJ84-04	01/19/1996	9.6	-	2300	-	-	<0.01	0.5	0.019	See Table	<0.005
	06/24/1996	9.4	<0.05	-	1.9	<0.02	<0.005	0.46	0.014	-	<0.005
GJ84-05	06/24/1996	9.3	<0.05	-	2.2	<0.02	<0.005	0.27	<0.002	-	<0.005
GJ87-15	06/25/1996	11	<0.05	-	3	<0.02	<0.005	0.37	0.11	-	<0.005
GJ94-01	01/09/1996	-	-	-	-	-	-	-	-	See Table	-
	09/23/1996	10	-	-	-	-	<0.001	0.14	<0.002	-	<0.005
GJ94-02	01/09/1996	-	-	-	-	-	-	-	-	See Table	-
	04/23/1996	10	-	-	-	-	<0.005	0.76	<0.002	-	<0.005
	06/26/1996	9.6	<0.05	-	3.3	<0.02	<0.005	0.57	0.004	-	0.0055
	09/23/1996	11	-	-	-	-	<0.001	0.7	0.0032	-	0.0079
	09/23/1996	10	-	-	-	-	<0.001	0.66	0.0059	-	<0.005
GJ94-03	01/10/1996	-	-	-	-	-	-	-	-	See Table	-
	01/10/1996	-	-	-	-	-	-	-	-	See Table	-
	04/25/1996	9.8	-	-	-	-	<0.005	0.19	<0.002	-	<0.005
	06/25/1996	8.6	<0.05	-	3.5	<0.02	<0.005	0.2	<0.002	-	<0.005

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).

^c Refer to Table A-7 for a list of detected constituents.

Table A-5 (continued). Groundwater Chemistry Data Collected by Oak Ridge National Laboratory At and Near the GJO During 1996^a

Non-Radiological Data		
Sample Location	Sample Date	Zr (mg/L)
10-2NB	01/18/1996	-
11-12NA	09/26/1996	-
11-1S	01/22/1996	-
	06/26/1996	<0.02
14-13NA	09/27/1996	-
14-6NA	01/22/1996	-
6-2N	01/19/1996	-
8-4S	01/23/1996	-
	09/26/1996	-
GJ84-03	06/25/1996	<0.02
GJ84-04	01/19/1996	-
	06/24/1996	<0.02
GJ84-05	06/24/1996	<0.02
GJ87-15	06/25/1996	<0.02
GJ94-01	01/09/1996	-
	09/23/1996	-
GJ94-02	01/09/1996	-
	04/23/1996	-
	06/26/1996	<0.02
	09/23/1996	-
	09/23/1996	-
GJ94-03	01/10/1996	-
	01/10/1996	-
	04/25/1996	-
	06/25/1996	<0.02

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).

Table A-5 (continued). Groundwater Chemistry Data Collected by Oak Ridge National Laboratory At and Near the GJO During 1996^a

Sample Location	Sample Date	Radiological		Non-Radiological Data							
		Ra-226 ^b (pCi/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (mg/L)	Be (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)
GJ94-03	06/25/1996	-	<0.005	<0.05	<0.01	0.59	0.025	<0.001	390	<0.005	-
	09/23/1996	-	<0.005	<0.05	0.0029	0.65	0.027	<0.001	350	<0.005	-
GJ94-04	01/10/1996	<1.486	<0.005	<0.05	<0.01	0.57	0.027	<0.001	330	<0.005	120
	04/24/1996	-	<0.005	<0.05	0.011	0.52	0.024	<0.001	330	<0.005	-
	06/27/1996	-	<0.005	<0.05	<0.01	0.51	0.021	<0.001	250	<0.005	-
	09/24/1996	-	<0.005	<0.05	0.014	0.51	0.025	<0.001	220	<0.005	-
GJ94-05	01/11/1996	<1.811	<0.005	<0.05	0.37	0.41	0.038	<0.001	360	<0.005	110
	04/24/1996	-	<0.005	<0.05	0.25	0.31	0.034	<0.001	290	<0.005	-
	09/24/1996	-	<0.005	<0.05	0.26	0.27	0.039	<0.001	140	<0.005	-
GJ94-06	09/24/1996	-	<0.005	<0.05	0.026	0.56	0.045	<0.001	200	<0.005	-
GJ94-07	01/11/1996	<2	<0.005	<0.05	<0.001	0.49	0.034	<0.001	320	<0.005	260
	04/24/1996	-	<0.005	0.1	<0.01	0.71	0.025	<0.001	410	<0.005	-
	06/27/1996	-	<0.005	<0.05	<0.01	0.6	0.023	<0.001	390	<0.005	-
	09/25/1996	-	<0.005	<0.05	0.0027	0.82	0.025	<0.001	420	<0.005	-
GJ94-08	01/16/1996	<2.135	<0.005	<0.05	<0.01	2.2	0.029	<0.001	380	<0.005	290
	04/25/1996	-	<0.005	<0.05	<0.01	0.92	0.022	<0.001	310	<0.005	-
	04/25/1996	-	<0.005	<0.05	<0.01	0.9	0.022	<0.001	310	<0.005	-
	06/28/1996	-	<0.005	<0.05	<0.01	0.77	0.021	<0.001	310	<0.005	-
	09/25/1996	-	<0.005	<0.05	0.0031	0.91	0.029	<0.001	280	<0.005	-
GJ94-09	01/16/1996	<1.486	<0.005	<0.05	<0.01	0.43	0.015	<0.001	220	<0.005	74
	04/25/1996	-	<0.005	<0.05	<0.01	0.44	0.017	<0.001	220	<0.005	-
	06/27/1996	-	<0.005	<0.05	<0.01	0.44	0.017	<0.001	230	<0.005	-
	09/26/1996	-	<0.005	<0.05	0.0023	0.46	0.022	<0.001	190	<0.005	-
P-3A	09/27/1996	-	<0.005	<0.05	0.0031	0.36	0.031	<0.001	170	<0.005	-
P-3B	09/27/1996	-	<0.005	<0.05	0.0095	0.61	0.05	<0.001	230	<0.005	-

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).

^b Radium-226 activities were measured in becquerels per liter and the results were converted to picocuries per liter for reporting purposes. Values with units of picocuries per liter multiplied by 10⁻⁹ will yield values with units of microcuries per milliliter for comparison with the Derived Concentration Guides listed in Chapter 3 of DOE Order 5400.5.

Table A-5 (continued). Groundwater Chemistry Data Collected by Oak Ridge National Laboratory At and Near the GJO During 1996^a

Sample Location	Sample Date	Non-Radiological Data									
		Co (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Li (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)
GJ94-03	06/25/1996	<0.004	<0.004	<0.007	0.47	-	-	0.072	71	5.4	0.064
	09/23/1996	<0.004	<0.004	<0.007	0.46	<0.0002	12	-	62	5.3	0.073
GJ94-04	01/10/1996	0.0046	<0.004	<0.007	0.26	<0.0002	8.8	-	59	3.5	0.042
	04/24/1996	<0.004	<0.004	<0.007	0.31	<0.0002	8.8	-	59	4	0.04
	06/27/1996	<0.004	<0.004	<0.007	0.2	-	-	0.068	42	2.5	0.05
	09/24/1996	<0.004	<0.004	<0.007	0.19	<0.0002	96	-	38	2.4	0.053
GJ94-05	01/11/1996	0.0057	<0.004	<0.007	1.6	<0.0002	23	-	60	8.3	<0.04
	04/24/1996	0.0051	<0.004	<0.007	1.2	<0.0002	18	-	50	7.2	<0.04
	09/24/1996	<0.004	<0.004	<0.007	0.51	<0.0002	16	-	24	3	<0.04
GJ94-06	09/24/1996	<0.004	<0.004	<0.007	4.1	<0.0002	17	-	42	2.6	0.082
GJ94-07	01/11/1996	0.0049	<0.004	<0.007	0.064	<0.0002	15	-	83	1.5	0.52
	04/24/1996	<0.004	<0.004	<0.007	<0.05	<0.0002	15	-	100	1.8	0.43
	06/27/1996	<0.004	<0.004	<0.007	<0.05	-	-	0.085	99	1.7	0.42
	09/25/1996	<0.004	<0.004	<0.007	<0.05	<0.0002	17	-	100	1.4	0.46
GJ94-08	01/16/1996	0.016	<0.004	<0.007	0.14	0.00023	9.2	-	110	0.04	0.16
	04/25/1996	<0.004	<0.004	<0.007	<0.05	<0.0002	7.8	-	87	0.085	0.13
	04/25/1996	<0.004	<0.004	<0.007	0.052	<0.0002	7.5	-	87	0.083	0.13
	06/28/1996	<0.004	<0.004	<0.007	<0.05	-	-	0.085	82	0.08	0.13
	09/25/1996	<0.004	<0.004	<0.007	<0.05	<0.0002	9	-	77	0.051	0.16
GJ94-09	01/16/1996	0.007	<0.004	<0.007	0.11	<0.0002	8.7	-	44	0.92	0.14
	04/25/1996	<0.004	<0.004	<0.007	0.079	<0.0002	8.4	-	45	0.94	0.13
	06/27/1996	<0.004	<0.004	<0.007	0.068	-	-	0.061	49	0.91	0.13
	09/26/1996	<0.004	<0.004	<0.007	<0.05	<0.0002	9.9	-	42	1	0.13
P-3A	09/27/1996	0.0044	<0.004	<0.007	0.45	<0.0002	9.2	-	47	2.9	0.054
P-3B	09/27/1996	<0.004	<0.004	<0.007	0.077	<0.0002	11	-	49	4.1	0.047

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).

Table A-5 (continued). Groundwater Chemistry Data Collected by Oak Ridge National Laboratory At and Near the GJO During 1996^a

Non-Radiological Data											
Sample Location	Sample Date	Na (mg/L)	Ni (mg/L)	NO ₃ (mg/L)	P (mg/L)	Pb (mg/L)	Pesticide (µg/L)	PO ₄ (mg/L)	Sb (mg/L)	Se (mg/L)	Semivolatile ^c (µg/L)
GJ94-03	06/25/1996	410	<0.01	-	<0.3	<0.02	-	-	<0.005	<0.005	-
	09/23/1996	37	<0.01	-	-	0.0046	-	-	<0.001	0.0039	-
GJ94-04	01/10/1996	350	<0.01	<0.1	-	<0.003	No Detect	<50	<0.06	<0.005	No Detect
	04/24/1996	360	<0.01	-	-	<0.02	-	-	<0.005	0.0067	-
	06/27/1996	310	<0.01	-	<0.3	<0.02	-	-	<0.005	<0.005	-
	09/24/1996	270	<0.01	-	-	<0.001	-	-	<0.001	0.0021	-
GJ94-05	01/11/1996	260	<0.01	1000 ^d	-	<0.003	No Detect	<50	<0.06	<0.005	See Table
	04/24/1996	220	<0.01	-	-	<0.02	-	-	<0.005	<0.005	-
	09/24/1996	140	<0.01	-	-	<0.001	-	-	<0.001	0.0022	-
GJ94-06	09/24/1996	290	<0.01	-	-	<0.001	-	-	<0.001	0.0025	-
GJ94-07	01/11/1996	370	<0.01	21	-	<0.003	No Detect	<50	<0.06	0.045	No Detect
	04/24/1996	400	<0.01	-	-	<0.01	-	-	<0.005	0.037	-
	06/27/1996	380	<0.01	-	<0.3	<0.005	-	-	<0.005	0.019	-
	09/25/1996	410	<0.01	-	-	<0.001	-	-	<0.001	0.053	-
GJ94-08	01/16/1996	460	0.023	170	-	<0.003	No Detect	<25	<0.06	0.074	No Detect
	04/25/1996	350	<0.01	-	-	<0.02	-	-	<0.005	0.087	-
	04/25/1996	350	<0.01	-	-	<0.02	-	-	<0.005	0.09	-
	06/28/1996	310	<0.01	-	<0.3	<0.02	-	-	<0.005	0.071	-
	09/25/1996	310	<0.01	-	-	<0.001	-	-	<0.001	0.077	-
GJ94-09	01/16/1996	310	<0.01	53	-	<0.003	No Detect	<25	<0.06	0.068	No Detect
	04/25/1996	320	<0.01	-	-	<0.02	-	-	<0.005	0.069	-
	06/27/1996	320	<0.01	-	<0.3	<0.02	-	-	<0.005	0.059	-
	09/26/1996	310	<0.01	-	-	<0.001	-	-	<0.001	0.053	-
P-3A	09/27/1996	220	<0.01	-	-	<0.001	-	-	<0.001	<0.002	-
P-3B	09/27/1996	260	<0.01	-	-	<0.001	-	-	<0.001	<0.002	-

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).

^c Refer to Table A-7 for a list of detected constituents.

^d Result is a probable outlier. It was more than 5 times higher than any other well value for 1996, and more than 4 orders of magnitude higher than the value obtained from the same well in 1995.

Table A-5 (continued). Groundwater Chemistry Data Collected by Oak Ridge National Laboratory At and Near the GJO During 1996^a

Sample Location	Sample Date	Non-Radiological Data									
		Si (mg/L)	Sn (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	Tl (mg/L)	U (mg/L)	V (mg/L)	Volatile ^c (µg/L)	Zn (mg/L)
GJ94-03	06/25/1996	8.6	<0.05	-	3.5	<0.02	<0.005	0.21	<0.002	-	<0.005
	09/23/1996	9.2	-	-	-	-	<0.001	0.22	<0.002	-	0.0065
GJ94-04	01/10/1996	7.7	-	1700	-	-	<0.01	0.2	0.002	See Table	<0.005
	04/24/1996	8.7	-	-	-	-	<0.005	0.22	<0.002	-	0.0078
	06/27/1996	8.3	<0.05	-	2.9	<0.02	<0.005	0.17	0.0024	-	0.014
	09/24/1996	10	-	-	-	-	<0.001	0.14	<0.002	-	0.013
GJ94-05	01/11/1996	8	-	1800	-	-	<0.01	0.13	0.0063	See Table	<0.005
	04/24/1996	89	-	-	-	-	<0.005	0.15	0.0054	-	0.0081
	09/24/1996	9.3	-	-	-	-	<0.001	0.063	0.0051	-	0.0096
GJ94-06	09/24/1996	11	-	-	-	-	<0.001	0.03	<0.002	-	0.0089
GJ94-07	01/11/1996	7	-	1600	-	-	<0.001	1.3	0.0027	See Table	<0.005
	04/24/1996	7.5	-	-	-	-	<0.005	1.6	<0.002	-	0.005
	06/27/1996	6.8	<0.05	-	2.6	<0.02	<0.005	1.5	0.003	-	0.012
	09/25/1996	7.6	-	-	-	-	<0.001	1.7	<0.002	-	0.011
GJ94-08	01/16/1996	8.7	-	1700	-	-	<0.01	1.3	<0.002	See Table	0.018
	04/25/1996	10	-	-	-	-	<0.005	0.95	0.0025	-	0.01
	04/25/1996	10	-	-	-	-	<0.005	1	<0.002	-	0.0056
	06/28/1996	9.5	<0.05	-	3	<0.02	<0.005	0.97	0.0025	-	0.018
	09/25/1996	12	-	-	-	-	<0.001	1.1	<0.002	-	0.017
GJ94-09	01/16/1996	5.8	-	1200	-	-	<0.01	0.91	<0.002	See Table	0.0087
	04/25/1996	7.2	-	-	-	-	<0.005	0.94	<0.002	-	0.0084
	06/27/1996	6.7	<0.05	-	1.9	<0.02	<0.005	0.81	<0.002	-	0.0064
	09/26/1996	7.7	-	-	-	-	<0.001	0.83	<0.002	-	0.012
P-3A	09/27/1996	10	-	-	-	-	<0.001	0.17	<0.002	-	0.011
P-3B	09/27/1996	9.4	-	-	-	-	<0.001	0.16	0.003	-	<0.005

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).

^c Refer to Table A-7 for a list of detected constituents.

Table A-5 (continued). Groundwater Chemistry Data Collected by Oak Ridge National Laboratory At and Near the GJO During 1996^a

Non-Radiological Data		
Sample Location	Sample Date	Zr (mg/L)
GJ94-03	06/25/1996	<0.02
	09/23/1996	-
GJ94-04	01/10/1996	-
	04/24/1996	-
	06/27/1996	<0.02
GJ94-05	09/24/1996	-
	01/11/1996	-
	04/24/1996	-
GJ94-06	09/24/1996	-
	01/11/1996	-
	04/24/1996	-
GJ94-07	06/27/1996	<0.02
	09/25/1996	-
	01/16/1996	-
GJ94-08	04/25/1996	-
	04/25/1996	-
	06/28/1996	<0.02
GJ94-09	09/25/1996	-
	01/16/1996	-
	04/25/1996	-
P-3A	06/27/1996	<0.02
	09/26/1996	-
	09/27/1996	-
P-3B	09/27/1996	-

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).

Table A-6. QA/QC Chemistry Data Collected by Oak Ridge National Laboratory At and Near the GJO During 1996^a

Sample Location	Sample Date	Radiological		Non-Radiological Data							
		Ra-226 ^b (pCi/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (mg/L)	Be (mg/L)	Ca (mg/L)	Cd (mg/L)	Cl (mg/L)
10-2NB Equip. Rinse	01/18/1996	<1.297	<0.005	<0.05	<0.01	<0.08	<0.001	<0.001	0.3	<0.005	<0.1
Field Blank	04/25/1996	-	<0.005	0.059	<0.01	<0.08	0.037	<0.001	31	<0.005	-
	06/28/1996	-	<0.005	<0.05	<0.01	<0.08	0.0046	<0.001	0.17	<0.005	-
	09/27/1996	-	<0.005	<0.05	<0.001	<0.08	0.0023	<0.001	0.19	<0.005	-
GJ84-03 Equip. Rinse	06/26/1996	-	<0.005	<0.05	<0.01	<0.08	0.0029	<0.001	0.26	<0.005	-
GJ94-08 Equip. Rinse	04/25/1996	-	<0.005	0.065	<0.01	<0.08	0.039	<0.001	32	<0.005	-
GJ94-09 Equip. Rinse	09/26/1996	-	<0.005	<0.05	<0.001	<0.08	0.0021	<0.001	0.2	<0.005	-
Trip Blank 01	01/11/1996	-	-	-	-	-	-	-	-	-	-
	01/17/1996	-	-	-	-	-	-	-	-	-	-
	01/18/1996	-	-	-	-	-	-	-	-	-	-
	01/19/1996	-	-	-	-	-	-	-	-	-	-
	01/23/1996	-	-	-	-	-	-	-	-	-	-
Trip Blank 02	01/11/1996	-	-	-	-	-	-	-	-	-	-
	01/18/1996	-	-	-	-	-	-	-	-	-	-
	01/23/1996	-	-	-	-	-	-	-	-	-	-
Trip Blank 03	01/23/1996	-	-	-	-	-	-	-	-	-	-
Trip Blank A	01/10/1996	-	-	-	-	-	-	-	-	-	-
Trip Blank B	01/10/1996	-	-	-	-	-	-	-	-	-	-

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).

^b Radium-226 activities were measured in becquerels per liter and the results were converted to picocuries per liter for reporting purposes. Values with units of picocuries per liter multiplied by 10⁻⁹ will yield values with units of microcuries per milliliter for comparison with the Derived Concentration Guides listed in Chapter 3 of DOE Order 5400.5.

Table A-6 (continued). QA/QC Chemistry Data Collected by Oak Ridge National Laboratory At and Near the GJO During 1996^a

Sample Location	Sample Date	Non-Radiological Data									
		Co (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Hg (mg/L)	K (mg/L)	Li (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)
10-2NB Equip. Rinse	01/18/1996	0.0044	<0.004	<0.007	<0.05	0.00032	<2	-	0.063	0.0016	<0.04
Field Blank	04/25/1996	<0.004	<0.004	0.019	0.089	<0.0002	<2	-	13	0.003	<0.04
	06/28/1996	<0.004	<0.004	<0.007	<0.05	-	-	<0.005	0.023	0.0032	<0.04
	09/27/1996	<0.004	<0.004	<0.007	<0.05	<0.0002	<2	-	0.048	0.0028	<0.04
GJ84-03 Equip. Rinse	06/26/1996	<0.004	<0.004	<0.007	<0.05	-	-	<0.005	0.056	0.0038	<0.04
GJ94-08 Equip. Rinse	04/25/1996	<0.004	<0.004	0.024	0.11	<0.0002	<2	-	14	0.0039	<0.04
GJ94-09 Equip. Rinse	09/26/1996	<0.004	<0.004	<0.007	<0.05	<0.0002	<2	-	0.051	0.0017	<0.04
Trip Blank 01	01/11/1996	-	-	-	-	-	-	-	-	-	-
	01/17/1996	-	-	-	-	-	-	-	-	-	-
	01/18/1996	-	-	-	-	-	-	-	-	-	-
	01/19/1996	-	-	-	-	-	-	-	-	-	-
	01/23/1996	-	-	-	-	-	-	-	-	-	-
Trip Blank 02	01/11/1996	-	-	-	-	-	-	-	-	-	-
	01/18/1996	-	-	-	-	-	-	-	-	-	-
	01/23/1996	-	-	-	-	-	-	-	-	-	-
Trip Blank 03	01/23/1996	-	-	-	-	-	-	-	-	-	-
Trip Blank A	01/10/1996	-	-	-	-	-	-	-	-	-	-
Trip Blank B	01/10/1996	-	-	-	-	-	-	-	-	-	-

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).

Table A-6 (continued). QA/QC Chemistry Data Collected by Oak Ridge National Laboratory At and Near the GJO During 1996^a

Non-Radiological Data											
Sample Location	Sample Date	Na (mg/L)	Ni (mg/L)	NO ₃ (mg/L)	P (mg/L)	Pb (mg/L)	Pesticide (µg/L)	PO ₄ (mg/L)	Sb (mg/L)	Se (mg/L)	Semivolatile (µg/L)
10-2NB Equip. Rinse	01/18/1996	0.4	<0.01	<0.1	-	<0.003	No Detect	<0.5	<0.06	<0.005	No Detect
Field Blank	04/25/1996	18	<0.01	-	-	<0.02	-	-	<0.005	<0.005	-
	06/28/1996	0.14	<0.01	-	<0.3	<0.02	-	-	<0.005	<0.005	-
	09/27/1996	0.4	<0.01	-	-	<0.001	-	-	<0.001	<0.002	-
GJ84-03 Equip. Rinse	06/26/1996	0.15	<0.01	-	<0.3	<0.02	-	-	<0.005	<0.005	-
GJ94-08 Equip. Rinse	04/25/1996	18	<0.01	-	-	<0.02	-	-	<0.005	<0.005	-
GJ94-09 Equip. Rinse	09/26/1996	0.38	<0.01	-	-	<0.001	-	-	<0.001	<0.002	-
Trip Blank 01	01/11/1996	-	-	-	-	-	-	-	-	-	No Detect
	01/17/1996	-	-	-	-	-	-	-	-	-	No Detect
	01/18/1996	-	-	-	-	-	-	-	-	-	No Detect
	01/19/1996	-	-	-	-	-	-	-	-	-	No Detect
	01/23/1996	-	-	-	-	-	-	-	-	-	No Detect
Trip Blank 02	01/11/1996	-	-	-	-	-	-	-	-	-	No Detect
	01/18/1996	-	-	-	-	-	-	-	-	-	No Detect
	01/23/1996	-	-	-	-	-	-	-	-	-	No Detect
Trip Blank 03	01/23/1996	-	-	-	-	-	-	-	-	-	No Detect
Trip Blank A	01/10/1996	-	-	-	-	-	-	-	-	-	No Detect
Trip Blank B	01/10/1996	-	-	-	-	-	-	-	-	-	No Detect

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).

Table A-6 (continued). QA/QC Chemistry Data Collected by Oak Ridge National Laboratory At and Near the GJO During 1996^a

Sample Location	Sample Date	Non-Radiological Data									
		Si (mg/L)	Sn (mg/L)	SO ₄ (mg/L)	Sr (mg/L)	Ti (mg/L)	Tl (mg/L)	U (mg/L)	V (mg/L)	Volatile ^c (µg/L)	Zn (mg/L)
10-2NB Equip. Rinse	01/18/1996	<0.2	-	3.8	-	-	<0.01	0.00012	<0.002	Table A-7	0.0084
Field Blank	04/25/1996	6.7	-	-	-	-	<0.005	0.00082	<0.002	-	0.28
	06/28/1996	<0.2	<0.05	-	<0.005	<0.02	<0.005	<0.0001	<0.002	-	0.007
	09/27/1996	<0.2	-	-	-	-	<0.001	<0.0001	<0.002	-	0.0054
GJ84-03 Equip. Rinse	06/26/1996	<0.2	<0.05	-	<0.005	<0.02	<0.005	<0.0001	0.0033	-	0.0099
GJ94-08 Equip. Rinse	04/25/1996	6.9	-	-	-	-	<0.005	0.00091	<0.002	-	0.29
GJ94-09 Equip. Rinse	09/26/1996	<0.2	-	-	-	-	<0.001	<0.0001	<0.002	-	0.0063
Trip Blank 01	01/11/1996	-	-	-	-	-	-	-	-	Table A-7	-
	01/17/1996	-	-	-	-	-	-	-	-	Table A-7	-
	01/18/1996	-	-	-	-	-	-	-	-	Table A-7	-
	01/19/1996	-	-	-	-	-	-	-	-	Table A-7	-
	01/23/1996	-	-	-	-	-	-	-	-	Table A-7	-
Trip Blank 02	01/11/1996	-	-	-	-	-	-	-	-	Table A-7	-
	01/18/1996	-	-	-	-	-	-	-	-	Table A-7	-
	01/23/1996	-	-	-	-	-	-	-	-	Table A-7	-
Trip Blank 03	01/23/1996	-	-	-	-	-	-	-	-	Table A-7	-
Trip Blank A	01/10/1996	-	-	-	-	-	-	-	-	Table A-7	-
Trip Blank B	01/10/1996	-	-	-	-	-	-	-	-	Table A-7	-

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).

^c Refer to Table A-7 for a list of detected constituents.

Table A-6 (continued). QA/QC Chemistry Data Collected by Oak Ridge National Laboratory At and Near the GJO During 1996^a

Non-Radiological Data		
Sample Location	Sample Date	Zr (mg/L)
10-2NB Equip. Rinse	01/18/1996	-
Field Blank	04/25/1996	-
	06/28/1996	<0.02
	09/27/1996	-
GJ84-03 Equip. Rinse	06/26/1996	<0.02
GJ94-08 Equip. Rinse	04/25/1996	-
GJ94-09 Equip. Rinse	09/26/1996	-
Trip Blank 01	01/11/1996	-
	01/17/1996	-
	01/18/1996	-
	01/19/1996	-
	01/23/1996	-
Trip Blank 02	01/11/1996	-
	01/18/1996	-
	01/23/1996	-
Trip Blank 03	01/23/1996	-
Trip Blank A	01/10/1996	-
Trip Blank B	01/10/1996	-

^a A "<" symbol indicates that the maximum concentration was below the detection limit (number shown is detection limit).

Table A-7. Organic Constituents Detected in Samples Collected from Groundwater at and Near the GJO by Oak Ridge National Laboratory during 1996^a

Sample Location	Sample Date	Analyte Name	CAS Number	Concentration (µg/L)	Category	TCL Constituent ^b
Groundwater						
10-2NB	01/18/1996	2-Butanone	78-93-3	~6.	Volatile	X
11-1S	01/22/1996	2-Butanone	78-93-3	~7.00	Volatile	X
14-6NA	01/22/1996	1,4-Dichlorobenzene	106-46-7	~2.	Semivolatile	X
		2-Butanone	78-93-3	~7.	Volatile	X
6-2N	01/19/1996	2-Butanone	78-93-3	~7.	Volatile	X
8-4S	01/23/1996	2-Butanone	78-93-3	~7.	Volatile	X
		di-n-Butylphthalate	84-74-2	~1.	Semivolatile	X
GJ84-04	01/19/1996	2-Butanone	78-93-3	~7.	Volatile	X
GJ94-01	01/09/1996	2-Butanone	78-93-3	~7.	Volatile	X
		Styrene	100-42-5	~1.	Volatile	X
GJ94-02	01/09/1996	2-Butanone	78-93-3	~7.	Volatile	X
GJ94-03	01/10/1996	2-Butanone	78-93-3	~6.	Volatile	X
GJ94-03 Duplicate	01/10/1996	2-Butanone	78-93-3	~6.	Volatile	X
		Styrene	100-42-5	~3.	Volatile	X
GJ94-04	01/10/1996	2-Butanone	78-93-3	~6.00	Volatile	X
GJ94-05	01/11/1996	1,4-Dichlorobenzene	106-46-7	~1.00	Semivolatile	X
		2-Butanone	78-93-3	~6.00	Volatile	X
		Acetone	67-64-1	~4.00	Volatile	X
GJ94-07	01/11/1996	2-Butanone	78-93-3	~6.	Volatile	X
GJ94-08	01/16/1996	2-Butanone	78-93-3	~7.	Volatile	X
GJ94-09	01/16/1996	2-Butanone	78-93-3	~5.	Volatile	X
QA/QC						
10-2NB Equip. Rinse	01/18/1996	2-Butanone	78-93-3	~6.	Volatile	X
		Bromodichloromethane	75-27-4	~5.	Volatile	X

^a A "~" indicates an approximate value.

^b Constituents not identified by an "X" are tentatively identified compounds.

Table A-7 (continued). Organic Constituents Detected in Samples Collected from Groundwater at and Near the GJO by Oak Ridge National Laboratory during 1996^a

Sample Location	Sample Date	Analyte Name	CAS Number	Concentration (µg/L)	Category	TCL Constituent ^b
QA/QC						
Trip Blank 01	01/11/1996	2-Butanone	78-93-3	~10.	Volatile	X
		Acetone	67-64-1	~10.	Volatile	X
	01/17/1996	2-Butanone	78-93-3	10.	Volatile	X
		Acetone	67-64-1	~10.	Volatile	X
	01/18/1996	2-Butanone	78-93-3	~8.	Volatile	X
		Acetone	67-64-1	~7.	Volatile	X
	01/19/1996	2-Butanone	78-93-3	12.	Volatile	X
	01/23/1996	2-Butanone	78-93-3	10.	Volatile	X
		Acetone	67-64-1	~10.	Volatile	X
		Carbon Disulfide	75-15-0	~3.	Volatile	X
Trip Blank 02	01/11/1996	2-Butanone	78-93-3	~10.	Volatile	X
		Acetone	67-64-1	~9.	Volatile	X
	01/18/1996	2-Butanone	78-93-3	10.	Volatile	X
		Acetone	67-64-1	~10.	Volatile	X
	01/23/1996	2-Butanone	78-93-3	~9.	Volatile	X
Trip Blank 03	01/23/1996	Acetone	67-64-1	~8.	Volatile	X
		2-Butanone	78-93-3	~8.	Volatile	X
Trip Blank A	01/10/1996	Acetone	67-64-1	~7.	Volatile	X
		2-Butanone	78-93-3	10.	Volatile	X
Trip Blank B	01/10/1996	Acetone	67-64-1	~9.	Volatile	X
		2-Butanone	78-93-3	~8.	Volatile	X
		Carbon Disulfide	75-15-0	~2.	Volatile	X

^a A "~" indicates an approximate value.

^b Constituents not identified by an "X" are tentatively identified compounds.

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Appendix B

Time-Concentration Graphs

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Figure B-1a. Uranium Concentrations at the Upper Gunnison and Upper Middle Gunnison Sampling Locations

Figure B-1b. Uranium Concentrations at the Middle Gunnison and Lower Gunnison Sampling Locations

Figure B-2a. Uranium Concentrations at the North Pond and South Pond Sampling Locations

Figure B-2b. Uranium Concentrations at the Wetland Area Sampling Location

Figure B-3a. Lead Concentrations at the Upper Gunnison and Upper Middle Gunnison Sampling Locations

Figure B-3b. Lead Concentrations at the Middle Gunnison and Lower Gunnison Sampling Locations

Figure B-4a. Arsenic Concentrations at the Upper Gunnison and Upper Middle Gunnison Sampling Locations

Figure B-4b. Arsenic Concentrations at the Middle Gunnison and Lower Gunnison Sampling Locations

Figure B-5a. Nitrate Concentrations at the Upper Gunnison and Upper Middle Gunnison Sampling Locations

Figure B-5b. Nitrate Concentrations at the Middle Gunnison and Lower Gunnison Sampling Locations

Figure B-6a. Selenium Concentrations at the Upper Gunnison and Upper Middle Gunnison Sampling Locations

Figure B-6b. Selenium Concentrations at the Middle Gunnison and Lower Gunnison Sampling Locations

Figure B-7a. Manganese Concentrations at the Upper Gunnison and Upper Middle Gunnison Sampling Locations

Figure B-7b. Manganese Concentrations at the Middle Gunnison and Lower Gunnison Sampling Locations

Figure B-8a. Sulfate Concentrations at the Upper Gunnison and Upper Middle Gunnison Sampling Locations

Figure B-8b. Sulfate Concentrations at the Middle Gunnison and Lower Gunnison Sampling Locations

GJ84-04

Figure B-9a. Uranium-234, -238 Concentrations in Downgradient Well GJ84-04

11-1S

Figure B-9b. Uranium-234, -238 Concentrations in On-Site Well 11-1S

Figure B-9c. Uranium-234, -238 Concentrations in Upgradient Well GJ84-09

8-4S

Figure B-10a. Radium-226, -228 Concentrations in On-Site Well 8-4S

GJ84-04

Figure B-10b. Radium-226, -228 Concentrations in Downgradient Well GJ84-04

GJ84-09

Figure B-10c. Radium-226, -228 Concentrations in Upgradient Well GJ84-09

Figure B-11a. Molybdenum Concentrations in On-Site Well 10-19N

14-13NA

Figure B-11b. Molybdenum Concentrations in On-Site Well 14-13NA

GJ84-04

Figure B-11c. Molybdenum Concentrations in Downgradient Well GJ84-04

GJ84-09

Figure B-11d. Molybdenum Concentrations in Upgradient Well GJ84-09

14-6NA

Figure B-12a. Arsenic Concentrations in On-Site Well 14-6NA

GJ84-09

Figure B-12b. Arsenic Concentrations in Upgradient Well GJ84-09

8-4S

Figure B-13a. Selenium Concentrations in On-Site Well 8-4S

11-12NA

Figure B-13b. Selenium Concentrations in On-Site Well 11-12NA

GJ84-09

Figure B-13c. Selenium Concentrations in Upgradient Well GJ84-09

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Appendix C

Groundwater Sampling and Design Schedule

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Table C-1. GJO Groundwater Sampling and Analytical Design Schedule

Month	Contractor	Wells Sampled	Analytes Measured
January	ORNL	10-2NB, 11-1S, 14-6NA, 6-2N, 8-4S, GJ84-04, GJ94-01, GJ94-02, GJ94-03, GJ94-04, GJ94-05, GJ94-07, GJ94-08, GJ94-09	Ag, Al, As, B, Ba, Be, Ca, Cd, Cl, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, NO ₃ , Na, Ni, PO ₄ , Pb, Ra-226, SO ₄ , Sb, Se, Si, Ti, U, V, and Zn; pesticides and PCBs, semivolatile organic compounds, and volatile organic compounds
March	RUST	10-19N, 10-2NA, 11-12NA, 11-1S, 14-13NA, 14-6NA, 5-12NA, 6-2N, 8-4S, GJ84-04, GJ84-09, GJ87-15	As, Ba, Ca, Cd, Cl, Cr, Fe, K, Mg, Mn, Mo, NO ₃ , Na, Pb, Ra-226, SO ₄ , Se, U, and V; alkalinity, conductivity, gross alpha, pH, total dissolved solids, temperature and turbidity
April	ORNL	GJ94-02, GJ94-03, GJ94-04, GJ94-05, GJ94-07, GJ94-08, GJ94-09	Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Si, Ti, U, V, and Zn
June	ORNL	11-1S, GJ84-03, GJ84-04, GJ84-05, GJ87-15, GJ94-02, GJ94-03, GJ94-04, GJ94-07, GJ94-08, GJ94-09	Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Sb, Se, Si, Sn, Sr, Ti, Tl, U, V, and Zn
September	ORNL	11-12NA, 14-13NA, 8-4S, GJ94-01, GJ94-02, GJ94-03, GJ94-04, GJ94-05, GJ94-06, GJ94-07, GJ94-08, GJ94-09, P-3A, P-3B	Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Si, Ti, U, V, and Zn
December	WASTREN-GJ	10-19N, 10-2NA, 11-12NA, 11-1S, 14-13NA, 14-6NA, 5-12NA, 6-2N, 8-4S, GJ84-04, GJ84-09, GJ87-15	As, Ba, Ca, Cd, Cl, Cr, Fe, K, Mg, Mn, Mo, NO ₃ , Na, Pb, Ra-226, SO ₄ , Se, U, and V; alkalinity, conductivity, gross alpha, pH, total dissolved solids, temperature and turbidity

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Appendix D
Well Location Maps Showing Groundwater Analytes
Exceeding Federal or State Standards

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Figure D-1. Concentrations of Groundwater Analytes Exceeding Federal or State Standards in Alluvial Aquifer Well Samples in January 1996

Figure D-2. Concentrations of Groundwater Analytes Exceeding Federal or State Standards in Alluvial Aquifer Well Samples in March 1996

Figure D-3. Concentrations of Groundwater Analytes Exceeding Federal or State Standards in Alluvial Aquifer Well Samples in April 1996

Figure D-4. Concentrations of Groundwater Analytes Exceeding Federal or State Standards in Alluvial Aquifer Well Samples in June 1996

Figure D-5. Concentrations of Groundwater Analytes Exceeding Federal or State Standards in Alluvial Aquifer Well Samples in September 1996

Figure D-6. Concentrations of Groundwater Analytes Exceeding Federal or State Standards in Alluvial Aquifer Well Samples in December 1996