UMTRA PROJECT WATER SAMPLING AND ANALYSIS PLAN

GRAND JUNCTION, COLORADO

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**UMTRA PROJECT WATER SAMPLING AND
ANALYSIS PLAN**

GRAND JUNCTION, COLORADO

September 1995

**Prepared for
U.S. Department of Energy
Environmental Restoration Division
UMTRA Project Team
Albuquerque, New Mexico**

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LIST OF ACRONYMS

Acronym	Definition
BLRA	baseline risk assessment
DCO	data collection objective
DOE	U.S. Department of Energy
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
MCL	maximum concentration limit
MSL	mean sea level
QA	quality assurance
QAIP	quality assurance implementation plan
QC	quality control
SOP	standard operating procedure
SOWP	site observational work plan
TDS	total dissolved solids
UMTRA	Uranium Mill Tailings Remedial Action
WSAP	water sampling and analysis plan
UMTRA	Uranium Mill Tailings Remedial Action

1.0 INTRODUCTION

1.1 PURPOSE

This water sampling and analysis plan (WSAP) describes the planned, routine ground water sampling activities at the Grand Junction U.S. Department of Energy (DOE) Uranium Mill Tailings Remedial Action (UMTRA) Project site (GRJ-01) in Grand Junction, Colorado, and at the Cheney disposal site (GRJ-03) near Grand Junction, Colorado. The plan identifies and justifies the sampling locations, analytical parameters, detection limits, and sampling frequencies for the routine monitoring stations at the sites.

The regulatory basis for routine ground water monitoring at UMTRA sites is derived from U.S. Environmental Protection Agency (EPA) regulations in 40 CFR Part 192 (1994) and the EPA ground water quality standards of 1995 (60 FR 2854). Sampling procedures are guided by the UMTRA Project standard operating procedures (SOP) (JEG, n.d.), the *Technical Approach Document* (DOE, 1989), and the most effective technical approach for the site.

This WSAP summarizes the results of past water sampling activities, details water sampling activities planned for the next 2 years, and projects sampling activities for the subsequent 5 years.

1.2 SITE LOCATIONS AND HISTORIES

1.2.1 Grand Junction processing site

The former Grand Junction processing site is in the central part of western Colorado, in an industrial area just southeast of the city of Grand Junction, adjacent to the north side of the Colorado River (Figure 1.1). The site is in Sections 23 and 24, Township 1 South, Range 1 West, Sixth Principal Meridian.

The Climax Uranium Company processed uranium and vanadium ore at the Grand Junction mill site from June 1951 to March 1970. The mill produced 2.2 million tons (2 million tonnes) of tailings, of which approximately 300,000 tons (272,100 tonnes) were removed from the site and used as construction material or earth fill. The locations of these materials are termed "vicinity properties." The uranium ore processed by the mill averaged 0.28 percent uranium and 1.41 percent vanadium. The ore was crushed, ground, and treated to extract the product. Shortly after the mill shut down, efforts were made to stabilize the pile. The tailings pile was covered with 6 inches (15 centimeters [cm]) of soil. The pile was vegetated and irrigated, but little vegetation remained prior to surface remediation.

Surface remedial action at the Grand Junction processing site was conducted in two phases. Phase I remedial action involved fencing, constructing retention ponds, and preparing the wastewater treatment plant foundation at the processing site.

Figure 1.1
Locations of Grand Junction Site and Cheney Reservoir Disposal Site
Grand Junction, Colorado

MAC: SITE/GRJWSAP/REGIONALMAP

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Phase I was completed in 1989. Phase II began in 1990 and included constructing the disposal cell and assembling the wastewater treatment plant. Tailings movement started in the spring of 1991. Remedial action at the Grand Junction site was completed in 1994.

1.2.2 Cheney disposal site

The Cheney disposal site is located approximately 18 miles (mi) (30 kilometer [km]) southeast of the former Grand Junction processing site on highway U.S. 50 (Figure 1.1).

1.3 SITE STATUS

The tailings and other contaminated materials have been removed from the former processing site and stabilized in the Cheney disposal cell. The processing site is being revegetated. Part of the revegetation process involved constructing wetlands, including eight ponds along the southern boundary of the processing site. A flood control levee also is being constructed at and in the processing site vicinity and is scheduled for completion in 1995.

The Cheney disposal cell is scheduled for closure in September 1998.

The state of Colorado owns the Grand Junction site, and the DOE owns the Cheney Reservoir disposal site.

The status of major documents associated with the Grand Junction processing site is as follows:

- The draft baseline risk assessment (BLRA) has been delivered to the DOE and is scheduled to be completed in late 1995.
- The site observational work plan (SOWP) is scheduled to be initiated in September 1995.

1.4 SAMPLING PLAN SUMMARY

The current sampling plan for the Grand Junction processing site and the Cheney disposal site is to collect ground water and surface water samples semiannually, in June and December, from selected DOE monitor wells and surface water locations. The monitor wells are located to provide a representative distribution of sampling points to assess trends in ground water quality and flow conditions in the vicinity of the sites. The surface locations at the processing site are being monitored to assess the effects of ground water discharge to the eight ponds along the southern site boundary. The Corps of Engineers constructed these ponds in 1994 as part of an effort to establish wetlands. Figure 1.2 shows the locations of DOE monitor wells and surface locations being sampled in the former processing site vicinity, as well as the locations of other existing and preexisting monitor wells. Figure 1.3 shows the locations of best management practice paleochannel wells at the Cheney disposal site. The list of selected analytes has been modified with time, currently

Figure 1.2
Monitor Well Locations
Grand Junction, Colorado, Processing Site Vicinity

Sources: DOE, 1991; DOE, 1994.

Notes: 1. Abandoned monitor wells are indicated by an asterisk.
2. On-site ponds are not shown.

MAC: SITE/GRJ/WSAP/PSMONWELLS

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Figure 1.3
Paleochannel Monitor Well/Data Logger Locations
Cheney Disposal Site, Colorado

Revised from MKES, 1992.

MAC: SITE/GRJ/WSAPN/PALEOMONWELL

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reflecting hazardous constituents related to uranium processing activities. Table 1.1 presents monitor well completion and historical sampling data for both the Grand Junction processing site and the Cheney disposal site wells. Table 1.2 lists all proposed sampling locations and constituents to be analyzed over the next 2 years.

Three of the DOE monitor wells scheduled for sampling (GRJ-01-1000 through -1002) were installed in the alluvium at the processing site in September 1994. Quarterly gathering of additional time-dependent data (water levels) from these wells and from off-site well GRJ-01-0746 is needed to gain increased understanding of ground water/surface water interactions at the processing site over several years. These data may be used in future modeling to establish aquifer boundary conditions near the Grand Junction processing site. Data loggers were installed in these wells and water levels are monitored electronically six times a day.

In addition to collecting water level data from wells, three staff gages were installed in the processing site vicinity (Figure 1.2). Two of the staff gages (430 and 431) were placed on the site in wetland ponds to monitor their influence on ground water flow. The other staff gage (429) was placed directly in the Colorado River on the U.S. 50 bridge. Data from the staff gages will be compared with well hydrographs to define the surface and ground water interrelationship further.

At the Cheney disposal site, two shallow paleochannel monitor wells (GRJ-03-0731 and -0732) installed northwest and southwest of the cell in November 1994 will be sampled semiannually. These wells, installed as a best management practice, are used to conduct indirect monitoring of the disposal cell.

Continuous water level data collected quarterly from the paleochannel wells assess any flow variations within the paleochannels. The sampling frequency of paleochannel wells may change as a result of changes in data needs.

The next regularly scheduled water quality sampling at the disposal site will occur in June 1996 and will include the sites listed in Table 1.2. No routine sampling is scheduled at the processing site in fiscal year 1996 due to the transition of the Ground Water Project to the Grand Junction Projects Office.

It is recommended that sampling at the processing site be implemented semiannually over the next 2 years and annually thereafter, provided that water quality is stable. The end point for routine monitoring will be the acceptance of the ground water compliance strategy, which is yet to be proposed. Surface water monitoring of the eight ponds along the southern site boundary is included because site-related contaminants have been detected in several of the ponds. If additional ponds are constructed downgradient of the processing site over the next 7 years, they should be added to the sampling list.

Following 2 years of semiannual sampling, paleochannel wells at the Cheney disposal site also will be sampled annually, provided water quality and flow in the channels have been characterized sufficiently.

Table 1.1 DOE ground water monitor well completion and historical sampling data for the Grand Junction, Colorado, processing site and the Cheney disposal site

Well ID	Unit/formation screened	Location	Screened interval (ft, bls)	Years sampled	Decommissioned	Number of sampling rounds
Grand Junction processing site						
GRJ-01-0581	Qal	On-site	27-31	89	X	1
GRJ-01-0582	M	On-site	36-43	89	X	1
GRJ-01-0583	Qal	On-site	29-34	83, 85	X	6
GRJ-01-0584	Qal	On-site	25-27	83, 85	X	6
GRJ-01-0585	Qal	On-site	12-14	89	X	1
GRJ-01-0586	Qal	On-site	10-12	89	X	1
GRJ-01-0587	Qal	Crossgradient	8-13	83	X	3
GRJ-01-0588	Qal	Background	8-18	89, 91, 92	X	9
GRJ-01-0589	Qal	Downgradient	7-15	89, 91, 92	X	7
GRJ-01-0590	Qal	Downgradient	7-15	83-95	X	17
GRJ-01-0710	Qal	Background	7	89	X	1
GRJ-01-0724	DS	Upgradient	131-141	86-89	X	6
GRJ-01-0725	DS	Upgradient	69-99	86, 89	X	3
GRJ-01-0726	SS	Upgradient	110-140	86, 89, 90		3
GRJ-01-0727	M	Upgradient	44-54	87	X	1
GRJ-01-0728	M	Downgradient	12-17	85	X	3
GRJ-01-0729	M	On-site	55-65	89	X	1
GRJ-01-0731	M	Downgradient	26-36	85	X	3
GRJ-01-0732	Qal	Downgradient	16-21	85		3
GRJ-01-0733	Qal	Downgradient	16-21	86, 88, 89	X	5
GRJ-01-0735	M	Downgradient	26-36	89		2
GRJ-01-0736A	Qal	Downgradient	10-15	85-95		14
GRJ-01-0737	Qal	Crossgradient	22-27	87, 88, 89		4
GRJ-01-0739	Qal	Crossgradient	25-30	85	X	3
GRJ-01-0740	Qal	Downgradient	12-17	85-95		13
GRJ-01-0741	M	Crossgradient	35-45	86, 87, 88, 89, 91, 92, 93		13
GRJ-01-0742	Qal	Crossgradient	18-23	85-95		12
GRJ-01-0743	M	Upgradient	25-35	86, 89, 91, 92, 93		12

Table 1.1 DOE ground water monitor well completion and historical sampling data for the Grand Junction, Colorado, processing site and the Cheney disposal site (Concluded)

Well ID	Unit/formation screened	Location	Screened interval (ft, bls)	Years sampled	Decommissioned	Number of sampling rounds
Grand Junction processing site						
GRJ-01-0744	Qal	Upgradient	10-15	89, 91, 92		10
GRJ-01-0745	Qal	Background	15-20	85-95		16
GRJ-01-0746	Qal	Background	20-25	85-95		16
GRJ-01-1000	Qal	On-site	4-9	95		2
GRJ-01-1001	Qal	On-site	6.5-11.5	95		2
GRJ-01-1002	Qal	On-site	8-13	95		2
Cheney disposal site						
GRJ-03-0731	Qal	Crossgradient	17.5-32.5	95		1
GRJ-03-0732	Qal	Downgradient	17.5-32.5	95		2

bls - below land surface.

DS - Dakota Sandstone.

ft - feet.

M - Mancos.

Qal - alluvium.

Table 1.2 Proposed sampling locations and analytical parameters

Processing site (GRJ-01)	Disposal site (GRJ-03)	Parameters ^a
Monitor wells - 745, 746, 742, 590, 736, 740, 1000, 1001, and 1002	Monitor wells - 731 and 732	Ammonium, arsenic, bromide, cadmium, calcium, chloride, cobalt, copper, fluoride, iron, magnesium, manganese, molybdenum, nickel, nitrate, potassium, radium (Ra)-226 and Ra-228, selenium, sodium, sulfate, TDS, uranium, vanadium, and zinc.
Surface water - 2000 through 2007		

^aAll samples are to be filtered.

TDS - total dissolved solids.

2.0 GRAND JUNCTION PROCESSING SITE

2.1 SITE BACKGROUND INFORMATION

2.1.1 Surrounding land use

The Grand Junction processing site is in a primarily urbanized area, with residential, commercial, and commercial/industrial uses (Figure 2.1). Residential land use in the site vicinity is limited to areas west, north, and east of the site as well as south of the Colorado River. Commercial and industrial land uses occur immediately north and east of the site. The Denver and Rio Grande Western Railroad, situated approximately 0.5 mi (0.8 km) north of the site, is approximately the northern boundary of the industrial use area. Residential land use becomes much more prevalent about .25 mi (.5 km) north of the railroad tracks. Further east of the former processing site are large tracts of vacant land and land used for agricultural purposes. The Grand Valley By-Products Company, located near the southeastern boundary of the mill site, is a rendering plant that has been processing animal and animal by-products into hog and dairy feed for nearly 100 years.

2.1.2 Surrounding water use

Examination of current data bases and intensive field reconnaissance downgradient and crossgradient from the processing site indicates that no known users of alluvial ground water are within the area impacted by the former processing. The Grand Junction zoning and development code requires that all development be served by the city water treatment and distribution system.

In the site vicinity and much of the surrounding Grand Valley area, surface water supplies municipal and industrial needs. Most of the water for the Grand Valley originates as surface water high on the Grand Mesa. During times of drought, water may be obtained from the Gunnison River about 1 mi (1.6 km) upstream from its confluence with the Colorado River (Figure 1.2).

The Mancos Shale, which underlies the alluvium in the former processing site vicinity, is not considered a ground water source in the Grand Junction vicinity. The Dakota Sandstone, which underlies the Mancos Shale, is the uppermost artesian aquifer in the site vicinity. No registered wells are known to be completed in the Dakota Sandstone within the area of concern.

No future domestic use of shallow ground water in the site vicinity is anticipated due to the availability of city water and the seasonally low quality of ground water in the alluvial aquifer. Also, no future use of ground water in the Dakota Sandstone is anticipated due to the poor water quality.

Although no residential use of downgradient alluvial ground water is expected, several surface water ponds may be planned. If potential exposure routes are identified, these ponds will be sampled periodically to determine any site-related impacts.

Figure 2.1
Land Use Map
Grand Junction, Colorado, Processing Site Vicinity

A small pond located on Grand Valley By-Products Company property is present upgradient of the site (Figure 1.2). The pond currently is used by various types of birds.

2.1.3 Contaminant sources

Based on information presented in Section 1.3, as well as the Grand Junction Final Environmental Impact Statement (DOE, 1986), the primary source of contamination was from uranium mill tailings, which covered much of the western two-thirds of the processing site. The thickness of the tailings pile ranged from approximately 10 to 50 feet (ft) (3 to 15 meters [m]). According to Merritt (1971), the Grand Junction mill was the first American mill designed primarily for the production of uranium with vanadium as a by-product. The milling process used at this site was somewhat more complex than at newer mills and is reflected in the relatively large number of chemicals used in the milling process (Table 2.1).

Table 2.1 Major chemicals used at the Grand Junction mill

Inorganics	Organics
Sulfuric acid	Number 2 fuel oil
Hydrochloric acid	di-(2-ethylhexyl) phosphoric acid
Sodium chlorate	Tributyl phosphate
Sodium carbonate	Tertiary amines
Hydrogen peroxide	
Powdered iron metal	

Ground water was screened for the organic constituents listed in 40 CFR Part 264 (1993), Appendix IV, in 1988. No organic contamination, as represented by the Appendix IX analyte list, was found at the site. However, acidic pore water from the tailings has infiltrated and variably contaminated the alluvial ground water system on the site and downgradient from the former processing site.

2.2 GEOLOGY AND HYDROLOGY

2.2.1 Physical setting

The Grand Junction processing site elevation is approximately 4600 ft (1400 m) above sea level. The site is situated in the Grand Valley, a broad, semiarid valley cut by the Colorado River and bounded by the Book Cliffs escarpment, the Grand Mesa, and the Uncompahgre Plateau. The Colorado River and one of its tributaries, the Gunnison River, drain the Grand Valley.

2.2.2 Geology

The shallow stratigraphy near the processing site comprises three hydrogeologic zones (in descending order):

- A surficial disturbed zone.

- A zone of unconsolidated alluvial sediments.
- A sequence of consolidated sedimentary formations.

The surficial disturbed zone includes a variety of soil classifications and material types deposited or altered during surface remediation. The zone varies in depth from less than several feet to more than 20 ft (6 m).

Underlying, or adjacent to, the surficial disturbed zone is a zone of unconsolidated alluvial sediments. In the processing site vicinity, this zone includes mixed gravel sand and silty layers, ranging in depth from less than 7 ft (2 m) to more than 20 ft (6 m). The bottom of the alluvial aquifer is formed by the erosional surface of the Mancos Shale Formation, which dips gently (about 5 ft [1.5 m] per mile) to the north (USBR, n.d.).

Underlying the unconsolidated alluvial sediments is a sequence of consolidated sedimentary formations (Figure 2.2), which includes (in descending order) (Lohman, 1965):

- Mancos Shale Formation.
- Dakota Sandstone Formation.
- Burro Canyon Formation.
- Morrison Formation.

Other deeper formations present beneath the site will not be discussed because the Dakota Sandstone Formation is the uppermost artesian aquifer.

The Mancos Shale Formation is a thick, relatively extensive sequence of shale that includes some sandy layers and thin sandstone beds. The Mancos Shale Formation varies in thickness from 70 to 170 ft (20 to 50 m) near the former processing site to nearly absent west of the processing site. The Mancos Shale Formation is not considered a water source in the Grand Junction vicinity. It is an aquitard that acts as a barrier to downward migration of contamination.

The Dakota Sandstone and Burro Canyon Formations form the uppermost bedrock aquifer that underlies the Mancos Shale Formation. The Dakota Sandstone and Burro Canyon Formations consist of beds of sandstone, conglomeritic sandstone, shale, and coal. These units are not considered productive in the Grand Junction area (Lohman, 1965).

2.2.3 Ground water hydrology

The alluvium is the uppermost aquifer in the Grand Junction processing site vicinity. Based on water level measurements from on-site monitor wells and piezometers, the depth to ground water in the alluvium ranges from approximately 20 ft (6 m) to less than 4 ft (1 m) in areas closest to the Colorado River. Recent water levels taken during January 1995 indicate that hydraulic gradients in the processing site vicinity trend southwest, toward the Colorado River (Figure 2.3). The Colorado River serves as the ultimate discharge point for alluvial ground water.

Figure 2.2
Generalized Geologic Cross Section of the Grand Valley

Modified from Cohn et al., 1988.

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Figure 2.3
Water Table Contour Map of the Alluvium, January 1995
Grand Junction, Colorado, Processing Site Vicinity

Note: Data collected January 1995.

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Ground water levels beneath the site fluctuate 2 to 5 ft (0.61 to 1.5 m) annually and are lowest during fall and winter. These fluctuations occur due to changes in river stage, precipitation, and local irrigation. Continuous monitoring of water level data from new on-site wells GRJ-01-1000 through -1002 and off-site well -0746 currently is collected and assessed quarterly.

Regionally, the Mancos Shale Formation is a low-permeability formation that is not water-bearing or transmits only limited quantities of water (Cooley et al., 1969; Lohman, 1965). Although the upper weathered Mancos Shale Formation is saturated beneath the processing site, it functions as an aquitard.

Ground water flow directions in the Dakota Sandstone were not determined due to a lack of borings into the unit. The probable recharge area is an outcrop of Dakota Sandstone south of the site (Lohman, 1965).

Hydraulic characteristics

The average hydraulic conductivity in the alluvium is approximately 9.8×10^{-4} ft (3×10^{-2} cm) per second, as determined from aquifer pumping tests (DOE, 1991). Ground water velocity in the alluvium averages 0.2 to 5 ft (0.06 to 1.5 m) per day (DOE, 1991).

Calculated hydraulic conductivities in the Mancos Shale Formation average 2.09×10^{-7} ft (6.4×10^{-6} cm) per second (DOE, 1991). The horizontal hydraulic conductivity of the shale decreases slightly with increasing depth, as confirmed by slug withdrawal tests conducted at various depths in the Mancos Shale.

Limited results from two slug withdrawal tests in the upper Dakota Sandstone near the processing site indicate that its hydraulic conductivity is comparable to that of the Mancos Shale (DOE, 1991).

2.2.4 Surface water hydrology

The northern channel of the Colorado River forms the southern boundary of the processing site (Figure 1.2). A Mancos Shale outcrop forms the southern bank of the Colorado River in the processing site vicinity. Several large sandbars, deposited in the river south and southwest of the site, cause the river to flow into separate channels during much of the year. The Gunnison River flows into the Colorado River about 1.5 mi (2.5 km) west and downstream of the processing site. No major domestic users of Colorado River water reside in the vicinity of the Grand Junction site (DOE, 1986). As previously stated, the Colorado River most likely is the ultimate discharge point for much of the ground water contamination migrating from the processing site.

The stages of the Colorado River fluctuate seasonally, with high stage usually occurring in June and low stage occurring in February. A staff gage installed in the Colorado River at the U.S. 50 overpass in late 1994 periodically monitors river stage fluctuations.

A series of eight ponds were constructed in a wetland along the southern boundary of the processing site in 1994 (Figure 1.2). Staff gages placed in the two westernmost ponds monitor any influence on ground water flow toward the Colorado River.

In addition, several drainage ditches irrigate agricultural land in the site vicinity (Figure 1.2). These ditches probably have a seasonal influence on local ground water levels and may contribute to background water quality in the site vicinity.

2.3 WATER QUALITY

2.3.1 Background water quality

Background ground water quality is defined as the quality of water that would be present if uranium processing activities had not occurred at the site. Background ground water quality was characterized by sampling monitor wells located hydraulically upgradient from the processing site and analyzing the ground water for appropriate constituents. Generally, the list of analytes includes the proposed EPA hazardous constituents and other chemical constituents recognized as indicators of uranium processing activities.

Upgradient DOE monitor wells GRJ-01-0745 and -0746 were selected as the monitor wells most representative of background ground water quality (Figure 1.2). Table 2.2 summarizes the minimum, median, and maximum values for selected chemical parameters in the background ground water.

The background ground water ranges from 6.7 to 7.5 pH, with a median value of 7.0. The total dissolved solids (TDS) in the background ground water samples range from approximately 3000 to 7200 milligrams per liter (mg/L). The background alkalinity (as mg/L CaCO_3) is between 343 and 439. Despite the relatively high alkalinity of the water, the dominant anionic species in background ground water is sulfate (median value = 2800 mg/L). The dominant cations in background ground waters are sodium, magnesium, and calcium, with median concentrations in the background ground water of 659 mg/L, 391 mg/L, and 532 mg/L, respectively.

Trace constituents such as arsenic, uranium, vanadium, and selenium are elevated or above maximum concentration limits (MCL) in the background ground water (Table 2.2). Uranium concentrations are particularly significant, with the median value in background ground water at 0.046 mg/L, slightly above its MCL.

The average TDS concentration in background ground water in the Dakota Sandstone is approximately 5500 mg/L (DOE, 1991). The background water is a sodium-bicarbonate-chloride type. Average concentrations of chloride, iron, manganese, and TDS exceed the EPA secondary drinking water standards by approximately 1 order of magnitude.

Table 2.2 Summary of filtered ground water quality at the Grand Junction, Colorado, processing site

Constituent	MCL (mg/L)	Observed		
		Minimum	Median ^a (mg/L)	Maximum
Inorganic constituents				
Ammonium	NA			
Background		<0.03	0.2	0.6
On-site		315	322	406
Downgradient		166	357	521
Antimony	NA			
Background		<0.003	NA	0.012
On-site		--	--	--
Downgradient		<0.003	NA	0.012
Arsenic	0.05			
Background		0.001	NA	0.04
On-site		<0.005	0.005	0.025
Downgradient		<0.001	0.016	0.18
Cadmium	0.01			
Background		<0.001	NA	0.04
On-site		0.002	0.003	0.003
Downgradient		<0.001	NA	0.42
Calcium	NA			
Background		325	445	595
On-site		510	598	506
Downgradient		360	545	654
Chloride				
Background	NA	306	598	2400
On-site		670	680	860
Downgradient		490	791	970
Cobalt	NA			
Background		<0.003	NA	0.01
On-site		<0.05	<0.05	<0.05
Downgradient		<0.001	0.03	0.66
Fluoride	NA			
Background		0.6	1.0	1.7
On-site		1.9	2.4	3.0
Downgradient		3.0	3.7	4.8

Table 2.2 Summary of filtered ground water quality at the Grand Junction, Colorado, processing site (Continued)

Constituent	MCL (mg/L)	Observed		
		Minimum	Median ^a (mg/L)	Maximum
Iron	NA			
Background		<0.005	0.4	2.2
On-site		0.1	0.14	3.27
Downgradient		0.018	3.7	16
Magnesium	NA			
Background		210	391	570
On-site		294	299	305
Downgradient		25	282	620
Manganese	NA			
Background		0.9	1.3	2.3
On-site		3.6	4.0	4.4
Downgradient		1.8	4.2	334
Molybdenum	0.1			
Background		0.01	0.11	0.23
On-site		0.12	0.26	0.26
Downgradient		0.08	0.25	0.53
Nickel	NA			
Background		<0.006	NA	0.12
On-site		<0.04	0.05	0.17
Downgradient		<0.04	0.14	0.38
Nitrate	44.0			
Background		<0.1	NA	16
On-site		2.6	2.8	3.7
Downgradient		<0.01	NA	50
Selenium	0.01			
Background		<0.001	NA	0.19
On-site		<0.005	<0.005	0.013
Downgradient		<0.002	NA	0.24
Sodium	NA			
Background		345	659	910
On-site		728	797	1220
Downgradient		520	950	1210
Sulfate	NA			
Background		1450	2800	11000
On-site		3320	3420	3450
Downgradient		2800	3800	4900

Table 2.2 Summary of filtered ground water quality at the Grand Junction, Colorado, processing site (Concluded)

Constituent	MCL (mg/L)	Observed		
		Minimum	Median ^a (mg/L)	Maximum
Uranium	0.044			
Background		0.017	0.046	0.072
On-site		0.096	0.380	0.638
Downgradient		0.043	0.24	0.45
Vanadium	NA			
Background		<0.005	NA	0.11
On-site		<0.01	0.03	0.39
Downgradient		<0.01	0.14	14
Zinc	NA			
Background		<0.002	NA	1.0
On-site		<0.05	<0.05	0.21
Downgradient		<0.005	0.05	37
Radionuclide				
Radium-226	5 pCi/L			
Background		0.0	0.1	2.3
On-site		0.2	0.2	0.4
Downgradient		0.0	2.1	29

^aCalculation of the median – the 50th percentile of the data – requires more than 50 percent of the measurements to be above detection.

Note: The BLRA of ground water contamination at the UMTRA site at Grand Junction, Colorado (in preparation), is the source for background and downgradient ground water quality; on-site ground water quality is from recent (January 1995) data.

NA - not applicable.

2.3.2 Contaminant delineation

Seepage of tailings fluids has contaminated ground water in the alluvium (uppermost aquifer) at the Grand Junction processing site. Table 2.2 summarizes the minimum, median, and maximum values for selected chemical parameters in on-site and downgradient ground water. On-site ground water (from wells GRJ-01-1000 through -1002) was sampled in January 1995, for the first time since surface remediation was initiated in 1989. Therefore, the extent and magnitude of on-site contamination will require further characterization to be planned in the SOWP. Contaminated ground water occurs directly below and downgradient of the former tailings pile area. The contamination extends westward approximately 3700 ft (1128 m), and much of the affected ground water ultimately discharges into the Colorado River. Monitor wells on the site and downgradient from the site commonly have concentrations of ammonium, chloride, sulfate, and uranium above the background levels. Ammonium is strongly adsorbed by clays and is not very mobile. As a result, the migration of this constituent away from the site has lagged behind more mobile species such as uranium, sulfate, and chloride. Uranium concentrations in on-site and downgradient ground water within the alluvium exceed the proposed EPA MCL by up to 15 times and provide a good indication of the contamination's extent and magnitude (Figure 2.4). The highest contaminant concentrations appear to be in the southwestern portion of the processing site. The Colorado River to the south limits the lateral extent of contamination.

Tailings seepage (Figure 2.4) has impacted several ponds along the southern boundary of the Grand Junction processing site. The westernmost ponds (sample locations 2000 and 2001) appear to be most impacted, with TDS concentrations ranging between 2600 and 9700 mg/L (Table 2.2). Cadmium and manganese have exceeded Colorado state water quality values protective of aquatic life (CDH, 1991) in pond 2002 and in ponds 2001, 2002, 2004, and 2007, respectively. Chloride has exceeded the federal water quality criterion protective of aquatic life in ponds 2000 through 2006. Figure 2.4 shows uranium concentrations higher within the western ponds than within ground water upgradient from the ponds. This suggests that the ponds may be seasonally influencing contaminant migration toward the river. Due to the high stage of the Colorado River in June 1995, many ponds were flooded. As a result, not all ponds could be sampled. Future sampling will be conducted in any remaining ponds.

To determine the effects of ground water discharge into the Colorado River, samples from the Colorado River upstream and downstream from the processing site during a low river stage in January 1991 were analyzed for potentially hazardous constituents. Analyses results indicate that no concentrations of any hazardous constituents related to past processing activities exceeded proposed EPA concentration limits.

2.4 SITE CONCEPTUAL MODEL

The Grand Junction mill was in operation from 1951 to 1970. From 1951 to 1966, the Climax Uranium Company released approximately 500,000 cubic yards (yd³) (380,000 cubic meters [m³]) of tailings to private individuals and contractors for

Figure 2.4
Distribution of Uranium in Alluvial Ground Water and Wetland Ponds
Grand Junction, Colorado, Processing Site Vicinity

Notes: 1. Data collected January 1995.
2. Samples are filtered.

Detail of surface water sampling locations

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use as construction fill material (see Section 1.2). Remedial action at the Grand Junction processing site occurred from 1989 to 1994. Approximately 3.1 million yd³ (2.4 million m³) of tailings were removed from the site during that time period. The state of Colorado currently owns the 114-acre (ac) (46-hectare [ha]) site.

The near-surface geology of the Grand Junction processing site consists of Quaternary alluvium deposited by the Colorado River and fill materials placed during surface remediation. These unconsolidated deposits reach a thickness of about 20 ft (6 m) beneath the site. Ground water occurs under unconfined conditions in the alluvium and generally flows southwest, toward the Colorado River. The underlying Mancos Formation is a thick (70 to 170 ft [20 to 50 m]) shale aquitard that includes some sandy layers and thin sandstones. Because the Mancos Formation is a barrier to downward flow of ground water, tailings seepage does not influence ground water in the Dakota Sandstone Formation beneath the Mancos. Since there is an upward flow potential in the Dakota Sandstone Formation, this also limits the vertical extent of contamination.

The major sources of recharge to the alluvial aquifer are from the Colorado River during high river stage, seasonal runoff, precipitation, and local irrigation ditches.

Ground water levels in the alluvial aquifer range from approximately 20 ft (6 m) to less than 4 ft (1 m) in areas closest to the Colorado River, based on water level measurements from on-site monitor wells and piezometers. Ground water levels beneath the site fluctuate on the average from 2 to 5 ft (0.5 to 1.5 m) annually and are lowest during the fall and winter months. High river stage occurs in mid to late June.

Tailings leachate solutions migrated into the alluvial aquifer and have migrated downgradient from the site. Although it is known that the extent of contamination is approximately 3,000 ft (900 m) west of the site, the extent of contamination downgradient of the site is unknown. However, any contamination that migrates past the present monitoring well network ultimately discharges into the Colorado River.

There is currently no known use of shallow ground water crossgradient or downgradient of the processing site in the area impacted by processing site activities.

A series of eight ponds were constructed in wetlands along the southern site boundary in 1994. Surface water sample results and recent ground water sample results indicate that the ponds may be seasonally influencing the flow of contaminated ground water toward the river. During periods of high river stage, stagnant contamination may be flushed from these ponds. Staff gages placed in two of the ponds and in the Colorado River, and data loggers placed in three on-site wells monitor fluctuating water levels. These water levels will provide further understanding of the interrelationship between surface and ground water at the site.

Construction of ponds in the park downgradient and west of the processing site has been proposed. If constructed, these ponds should be monitored to determine any site-related impacts.

2.5 DATA COLLECTION OBJECTIVES

Data collection objectives (DCO) identify the reasons for collecting data, which include regulatory requirements, compliance monitoring, site characterization, risk assessment, and other considerations.

Data quality requirements define the manner in which samples are collected, handled, and analyzed. This includes:

- Defining analytical support levels.
- Following standard procedures for water sampling, preservation, transport, and various other field procedures.
- Completing data quality requirements in accordance with quality assurance (QA) and quality control (QC) protocols.
- Providing analytical data validation.

Data quality requirements to be followed during data collection and evaluation activities are given in UMTRA Project documents such as the quality assurance implementation plan (QAIP) (DOE, 1993) and applicable SOPs (JEG, n.d.), and other DOE and EPA documents.

2.5.1 Regulatory requirements

The regulatory requirements for ground water and surface water sampling at the Grand Junction processing site are specified in 40 CFR Part 192 (1994) and are described in the draft WSAP guidance document (DOE, 1995).

2.5.2 Compliance monitoring

No compliance monitoring is required at the Grand Junction processing site.

2.5.3 Site characterization

Characterization of contaminant migration in the alluvial aquifer will be ongoing. Monitor wells within the area of contaminated ground water and near the maximum extent of contaminated ground water will be monitored to characterize background water quality further and assess any significant contaminant migration. These data eventually will support a selected remedial alternative. During the SOWP process, it may be necessary to install several additional downgradient monitor wells to determine the maximum extent of contamination.

Three alluvial monitor wells (GRJ-01-1000 through -1002) and three staff gages (429, 430, and 431 [one in the Colorado River on the U.S. 50 bridge and two in on-site wetland ponds]) (Figure 1.2) installed in the fall of 1994 monitor ground water and surface water level fluctuations in the site vicinity. These long-term, continuous ground water level data are collected along with water quality data from the on-site ponds to study the relationship between surface and ground water at the site. Water level and water quality data may be used in future ground water modeling to establish boundary conditions in the Grand Junction processing site vicinity. Modeling results will help demonstrate and document the potential remedial alternative of natural flushing.

Recent sampling of surface water (conducted in January 1995) from on-site wetland ponds indicates that contaminants in the ponds are concentrated seasonally due to evaporation and low hydraulic conductivity of alluvial silt deposits.

2.6 DATA QUALITY REQUIREMENTS

Data quality requirements define the manner in which samples are collected, handled, and analyzed. The objectives include:

- Defining analytical support levels.
- Following standard procedures for water sampling, preservation, transport, and various other field procedures.
- Performing activities in accordance with QA and QC protocols.
- Providing analytical data validation.

Data quality requirements to be followed during data collection and evaluation are stated in the WSAP guidance document (DOE, 1995) and applicable SOPs (JEG, n.d.).

Data quality requirements are consistent for both the Grand Junction processing site and the Cheney disposal site, which is discussed in detail in Section 3.0.

2.7 SAMPLING PLAN

This section presents the sampling locations, analytes (including field analyses), and sampling frequencies for the upcoming 2 years, as well as projected sampling needs for an additional 5 years. Sections 2.7.4 and 2.7.5 apply to both the Grand Junction processing site and the Cheney disposal site. Therefore, information from Sections 2.7.4 and 2.7.5 will not be repeated in Section 3.0, which discusses the Cheney disposal site. The projected end point for the sampling activities is when federal and state regulatory agencies accept the ground water compliance strategy. Also presented are the data evaluation methods and response to anomalous data (Sections 2.7.4 and 2.7.5).

2.7.1 Sampling locations

Table 1.1 lists all existing monitor wells. Ground water contamination at the site is restricted to the alluvial aquifer. Therefore, contaminated ground water and background ground water will be monitored in the shallow, unconfined aquifer.

Site-related impacts to water quality have been observed in the alluvial aquifer (wells GRJ-01-0590, -0736, -0740, -0742, -1000, -1001, and -1002) within the area of identified contamination. These wells will be monitored to detect changes in concentrations of site-related contaminants in ground water. Such changes could signal changes in the hydrologic flow regime on the site or provide information on movement, dispersion, and attenuation of site-related contaminants. Also, while not necessarily expected, increases in the concentrations of site-related contaminants could affect risk assessment interpretation. On-site wells 1000 through 1002 and off-site well 0746 are equipped with data loggers that record water levels six times a day.

Background water quality in the unconfined aquifer will be monitored in two wells (GRJ-01-0745 and -0746). This will allow identification of nonsite-related changes in ground water quality. In addition, further sampling of both 0745 and 0746 will provide a better understanding of the range of back ground water quality in the alluvial aquifer.

No known private supply wells are completed in the alluvial aquifer within the area impacted by tailings seepage. Therefore, no routine sampling of private wells will occur.

Ground water samples will be collected in order of increasing contamination (Table 2.3) to minimize the possible effects of equipment contamination.

Up to four rounds of surface water samples will be collected over the next 2 years from the eight ponds (2001 through 2007) constructed along the southern boundary of the processing site.

The purpose of the sampling is to characterize the possible effects of ground water discharge to the ponds. Preliminary sampling has detected constituents (including cadmium, molybdenum, and uranium) related to site contamination. Further sampling is required to determine the seasonal fluctuations of these constituents. Ponds are to be sampled in reverse order (2007 through 2000).

Sampling of the eight ponds potentially may be discontinued prior to the end of the 2-year period as a result of sediment buildup in the ponds. The recent high stage of the Colorado River (June 1995) indicated a high potential for the ponds to wash out.

Table 2.3 Order for sampling and summary of ground water monitor wells to be sampled, Grand Junction, Colorado, site

Well ID	Aquifer	Sampling justification
GRJ-01-0745	Unconfined	Monitor concentrations in background
GRJ-01-0746 ^a	Unconfined	Monitor concentrations in background
GRJ-01-0742	Unconfined	Monitor concentrations of contaminants
GRJ-01-0590	Unconfined	Monitor concentrations of contaminants
GRJ-01-0736	Unconfined	Monitor concentrations of contaminants
GRJ-01-0740	Unconfined	Monitor concentrations of contaminants
GRJ-01-1000 ^a	Unconfined	Characterize post-surface remediation on site ground water
GRJ-01-1001 ^a	Unconfined	Characterize post-surface remediation on site ground water
GRJ-01-1002 ^a	Unconfined	Characterize post-surface remediation on site ground water

^aWell contains data logger.

2.7.2 Analyte selection

Analytes to be measured in ground water include major elements and field parameters as indicators of general water quality and constituents identified as site-related contaminants or contaminants of potential concern in ground water (DOE, 1994a). Measured field parameters are alkalinity, pH, specific conductance, temperature, oxidation-reduction potential, and dissolved oxygen. Laboratory measurements are ammonium, arsenic, cadmium, calcium, chloride, fluoride, iron, magnesium, manganese, molybdenum, nickel, nitrate, radium (Ra)-226, potassium, selenium, sodium, sulfate, TDS, uranium, vanadium, and zinc. In general, ground water samples will be filtered. Table 2.4 lists the analytes to be monitored for in ground water and the justification for their sampling.

Analytes to be measured in surface water are constituents associated with ground water contamination and generally will be similar to those measured in surface water over the next 2 years. After this period, surface water sampling results will be assessed to determine which analytes can be deleted from the list.

2.7.3 Sampling frequency

Monitoring wells and surface water will be sampled semiannually over the next 2 years. Semiannual sampling is recommended because 1) the site is near the Colorado River and the potential for seasonal influences is strong, and 2) because several recent on-site and potential off-site activities or land use changes have the potential to impact the ground water regime. These activities include:

- On-site excavation and grading related to the flood control levy construction.
- Potential pond construction west of the site.
- Construction of on-site ponds in wetlands near the river.

Table 2.4 Summary of field parameters and laboratory analytes to be measured in ground water and surface water, Grand Junction, Colorado, site

Analyte	Ground water	Surface water
FIELD MEASUREMENTS		
Alkalinity	X	X
Dissolved oxygen	X	
Oxidation-reduction potential (Eh)	X	
pH	X	X
Temperature	X	X
Turbidity	X	X
LABORATORY MEASUREMENTS		
<i>Filtered samples</i>		
Ammonium	X	X
Arsenic	X	X
Bromide	X	X
Cadmium	X	X
Calcium	X	X
Chloride	X	X
Cobalt	X	X
Copper	X	X
Fluoride	X	X
Iron	X	X
Magnesium	X	X
Manganese	X	X
Molybdenum	X	X
Nitrate	X	X
Nickel	X	X
Potassium	X	X
Radium-226	X	X
Radium-228	X	X
Selenium	X	X
Sodium	X	X
Sulfate	X	X
Total dissolved solids	X	X
Uranium	X	X
Vanadium	X	X
Zinc	X	X

Semiannual monitoring of ground water and surface water during this period will provide information on impacts (or lack of impacts) to ground water and surface water from these activities.

Sampling will be conducted once during December and once during June, corresponding to the seasonal periods of high and low water levels, respectively, in the unconfined aquifer (DOE, 1995).

If, after 2 years, water quality has remained relatively stable and no additional construction activities occur on the site or downgradient, annual sampling of ground water is recommended for the next 5 years.

If it can be shown that surface water locations 2000 through 2007 will be characterized sufficiently after 2 years of semiannual sampling; surface water sampling at those locations may cease. If seasonal buildup of contaminants in on-site ponds increases, semiannual sampling of ponds should be continued. As stated previously, if additional ponds are constructed on the site or in the park located downgradient, these surface features should be added to the list of sampling locations to identify site-related impacts.

2.7.4 Data evaluation methods

Sampling results will be compared with previous historical data and with background to determine changes or time-trends in concentrations of site-related contaminants. Decreases or increases in constituent concentrations will be evaluated to determine:

- If evidence exists for increased or decreased contamination levels in ground water or surface water that would affect the conclusions of the BLRA (in preparation).
- If evidence exists of contaminated ground water moving into areas not previously identified as being contaminated.
- If evidence exists of changes in the ground water flow regime related to construction activities or irrigation.

2.7.5 Response to anomalous data

Data that lie outside of historical ranges will be assessed to determine if any value is reasonably expected given the standard deviation of previous sampling rounds or the existence of trends. If the value is not reasonably expected, field blank and equipment blank analyses will be checked for possible sample contamination, and field and laboratory records will be checked for a possible sampling or transcription error. If these are not the cases, any remaining sample will be reanalyzed to determine if the value is an analytical error. If the anomalous data cannot be shown to be caused by sampling or analytical errors, the well will be resampled for the anomalous parameter during the next sampling event.

3.0 CHENEY DISPOSAL SITE

3.1 SITE BACKGROUND INFORMATION

3.1.1 Surrounding land use

The Cheney disposal site is within a Bureau of Land Management grazing allotment designated for cattle. Grazing is the primary land use within a 3-mi (5-km) site radius.

Several residences are within 3 mi (5 km), northeast (upgradient) of the site. A zone of irrigated agricultural land begins about 2 mi (3 km) north of the site in the valley of Kannah Creek.

3.1.2 Surrounding water use

No registered wells or shallow wells are within a 2-mi (3-km) radius of the Cheney disposal site. Existing and anticipated ground water use in the Cheney disposal site vicinity is minimal because the current low population density in the area results in a low demand for water; shallow ground water is limited; and the quality of the shallow ground water is too poor for domestic use (DOE, 1991).

3.2 GEOLOGY AND HYDROLOGY

3.2.1 Physical setting

The Cheney site is situated on a broad pediment surface on the western flank of the Grand Mesa, east of the Gunnison River (Figure 1.1). The moderately sloping surface consists of alluvium, colluvium, and terrace gravels.

3.2.2 Geology

The Cheney site can be divided into four separate stratigraphic zones (Figure 3.1):

- A surficial layer of unconsolidated deposits consisting of alluvium, colluvium, and terrace gravels collectively referred to as alluvium.
- The upper, weathered zone of the Mancos Shale.
- The lower, less weathered portion of the Mancos Shale.
- The Dakota Sandstone and all other deeper formations.

The Cheney site is underlain by 5 to 40 ft (1.5 to 12 m) of alluvium. Landslides, slumps, and mudflows have greatly influenced the alluvial composition. Rapidly eroding sedimentary units along the flanks of the Grand Mesa have caused mass wasting, particularly slumping. Debris movement from the high parts of the mesa

Figure 3.1
Generalized Geologic Cross Section of the Cheney Disposal Cell

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onto the surrounding slopes and stream valleys has resulted in a highly heterogenous surficial mantle that may include clay, sand, gravels, cobbles, or boulders.

Beneath the alluvium is 700 to 750 ft (210 to 220 m) of Mancos Shale, which overlies the Dakota Sandstone Formation. The Mancos Shale Formation is a gray marine shale with a few thin limestone and sandstone beds. Among the consolidated sedimentary formations, only the Mancos Shale Formation and the Dakota Sandstone Formation are of interest with respect to the tailings disposal. The Mancos Shale Formation generally is recognized as having a low permeability (Cooley et al., 1969; Lohman, 1965) that can provide a barrier to downward migration of contamination. The Dakota Sandstone Formation is the uppermost aquifer beneath the disposal site. Regionally, the Mancos Shale Formation is an aquitard, and the Dakota Sandstone Formation is not a highly productive aquifer and contains water of poor quality.

3.2.3 Ground water hydrology

Three hydrostratigraphic zones contain ground water at the Cheney disposal site: the alluvial paleochannels, the unweathered Mancos Shale Formation, and the Dakota Sandstone Formation. Age dating, hydraulic testing, and chemical analyses, however, indicate very little if any hydraulic interconnection among these units.

Alluvial paleochannels

Ground water in the Cheney disposal site vicinity occurs in paleochannels near the basal portion of the alluvium. However, detailed field investigations identified a large area suitable for the disposal cell that is devoid of water-filled paleochannels. The bedrock contour map (Figure 3.2) illustrates the results of 1989 investigations to determine the presence and pathways of shallow paleochannel ground water. Three separate ground water flow systems were identified.

The northernmost paleochannel system (system I) was found to be the only system in which flow is sustained downgradient to the west of the disposal cell footprint. The southernmost tributary of system I passes within approximately 100 ft (30 m) of the northwestern corner of the disposal cell footprint. At the time of the Cheney site characterization, the paleochannel systems flowing east (system II) and along the southern margin (system III) of the footprint stopped conducting water before they reached the disposal cell's eastern boundary. Systems II and III were found to be within 2600 ft (790 m) of the footprint. Surface geophysics originally was used to define the deeply incised paleochannels of systems II and III. Paleochannel system III was found to be dry at the southeastern tip of the cell footprint (DOE, 1991). Water is assumed to percolate into the unweathered Mancos Shale Formation in the Cheney disposal cell vicinity (DOE, 1991).

In November 1994, after construction of the Cheney disposal cell, two monitor wells were installed near the cell, one near the northwestern corner (GRJ-03-0731) and one near the southwestern corner (GRJ-03-0732). These wells are not considered to be compliance wells. The wells were installed as a best management

Figure 3.2
Bedrock Contour Map Showing Water-Filled Paleochannels
Cheney Disposal Site, Colorado

Source: DOE, 1991.

practice to characterize ground water flow and water quality within the paleochannels. Figure 1.3 shows the well locations.

Two TUBER ground water level recording data loggers were installed in paleochannel wells GRJ-03-0731 and -0732 at the Cheney disposal site in December 1994. A review of water level hydrographs for wells 0731 and 0732 (Figure 3.3) indicates that the two wells are completed in different hydrologic conditions.

Well GRJ-03-0731 (the northwestern [paleochannel] well) initially was completed dry on 8 November 1994. The well was completed into competent Mancos Formation to a depth of approximately 33 ft (10.0 m), about 7 ft (2.0 m) below the bottom of the water-bearing channel. The well was screened from 17.5 to 32.5 ft (5.3 to 9.9 m). The hydrograph for well 0731 indicates that the well held approximately 6 ft (2 m) of water on 7 December 1994, 1 month after the well's completion. Another 4.57 ft (1.39 m) of water drained from the gravel channel into the well between 7 December 1994 and 9 January 1995. Over this period, the cyclic flow rate at which water filled the well averaged approximately 0.10 gallons (gal) (0.40 liters [L]) per day. The cyclic nature of flow through the paleochannel is evidenced by hourly water level measurements sometimes showing no increase or possibly decreasing over several days. The rate of flow into the well following sampling on 9 January 1995 appears to have increased slightly, perhaps due to storage from the surrounding sand pack. In early February, the water level appeared to have stabilized somewhat at about 21.5 ft (6.5 m) below ground surface. Since early February the water level in well 0731 has been rising slightly, perhaps due to a seasonal water level increase. Although periodic fluctuations are still apparent. The temperature log for well 0731 shows no significant fluctuation, indicating that the paleochannel does not receive large quantities of recharge from precipitation or runoff.

Well GRJ-03-0732 (the southwestern well) was constructed similarly to 0731. However, water was encountered immediately at approximately 19 to 20 ft (5.7 to 6.1 m) below ground surface during borehole drilling on 2 November 1994.

The hydrograph for well 0732 indicates rapid recovery of the well, compared with well 0731, following purging on 9 January 1995. The water level trend for well 0732 indicates a slight decrease from installation to mid-March, when the water level increased about 1 ft (.03 m). Since this increase, the water level again has been slowly decreasing.

The temperature log for well 0732 also shows no significant variation, suggesting that the well is not receiving significant surface runoff.

Increased water level and water quality data from wells 0731 and 0732 are needed to characterize the paleochannels sufficiently.

Figure 3.3
Ground Water Level Hydrographs for Cheney Disposal Site Wells 0731 and 0732

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Mancos Shale Formation

Ground water in the Mancos Shale Formation occurs in unweathered, discontinuous zones separated both laterally and vertically by large regions of unsaturated rock. The highly fractured, weathered Mancos Shale was found to be unsaturated in all excavations and drill cuttings from more than 100 boreholes.

Dakota Sandstone Formation

Low-porosity beds of unsaturated Mancos Shale and sandstone confine ground water in the Dakota Sandstone Formation. Although ground water is encountered in the upper Dakota Sandstone Formation, data suggest that it exists mostly in discontinuous fractures. Upon well completion, ground water levels in the monitor wells rose more than 360 ft (110 m) above the elevation at which ground water was encountered, indicating the presence of substantial confining pressures in the Dakota Sandstone Formation.

Hydraulic characteristics

The horizontal hydraulic conductivities of the alluvium, weathered Mancos Shale, and unweathered Mancos Shale are approximately 5.5×10^{-6} ft (1.7×10^{-4} cm) per second, 1.7×10^{-6} ft (5.1×10^{-5} cm) per second, and 8.8×10^{-8} ft (2.7×10^{-6} cm) per second, respectively (DOE, 1991).

No analysis was performed to evaluate the yield from the Dakota Sandstone Formation. However, drilling records for a 1760-ft (530-m)-deep construction water supply well estimate its yield at 5 to 10 gal (20 to 40 L) per minute.

3.2.4 Surface water hydrology

The Cheney disposal site is on a drainage divide that slopes southwest gently at approximately 2 percent. Total relief across the proposed disposal area is approximately 60 ft (20 m). The pediment surface on which the site is located forms a divide between two small ephemeral washes, one approximately 88 ft (27 m) north of the proposed pile location and one approximately 1700 ft (500 m) south. These washes merge with Indian Creek 0.1 to 0.5 mi (0.2 to 0.8 km) below the site. Indian Creek flows into Kannah Creek 4 to 5 mi (6 to 8 km) below the ephemeral wash confluences, and Kannah Creek empties into the Gunnison River approximately 2 mi (3 km) below the Indian Creek confluence.

An area of approximately 240 ac (100 ha) drains toward the Cheney disposal site. Slopes in the watershed range from 2 to 5 percent. Elevations range from approximately 5250 to 5600 ft (1600 to 1700 m) above mean sea level.

Past field reconnaissance showed no evidence of ground water discharge from the paleochannels to the surface in the disposal site vicinity.

3.3 WATER QUALITY

3.3.1 Background water quality

Alluvium

Background ground water quality in the alluvium has TDS concentrations ranging from approximately 600 to 1700 mg/L (DOE, 1991). Initial characterization efforts conducted prior to construction of the Cheney disposal cell indicated that average concentrations of hazardous constituents in the alluvium did not exceed the UMTRA MCLs (DOE, 1991). However, average concentrations of sulfate and TDS exceeded the EPA National Secondary Drinking Water Standards by factors of less than 2. Water quality results indicate that background ground water is a mixed cation-sulfate water quality type on a trilinear diagram.

Mancos Shale Formation

Background ground water quality in the Mancos Shale has elevated TDS levels. A relatively wide range (an order of magnitude) of TDS concentrations exists in the Mancos Shale Formation, from 873 to 7010 mg/L, and the average TDS concentration exceeds the EPA secondary drinking standard of 500 mg/L by five times (DOE, 1991). The average background selenium concentration slightly exceeds the proposed EPA MCL.

Dakota Sandstone Formation

Ground water in the Dakota Sandstone Formation has been determined Class III (limited-use) because TDS concentrations in background ground water exceed 10,000 mg/L (DOE, 1991). The Dakota Sandstone Formation is not considered a domestic water supply source. In addition, water within this unit contains natural gas and average concentrations of combined Ra-226 and -228 that exceed the proposed EPA MCL. Ground water in the Dakota Sandstone Formation at the disposal site is a sodium-bicarbonate type.

3.3.2 Preliminary (best management practice) ground water sampling results

Paleochannel well GRJ-03-0732 was sampled first in January 1995. Preliminary sampling results indicate that selenium and nitrate concentrations (0.232 mg/L and 174 mg/L, respectively) exceed UMTRA MCLs. The sulfate concentration in well 0732 was 3640 mg/L and the TDS concentration was 6420 mg/L. Further sampling and assessment are needed before the paleochannels can be characterized sufficiently.

3.4 SITE CONCEPTUAL MODEL

Approximately 3.1 million yd³ (2.4 million m³) of tailings were moved to the Cheney disposal site from spring 1991 to 1994. The DOE owns the Cheney disposal site.

The disposal cell was excavated into the Mancos Shale Formation, which has an approximate thickness of 700 ft (200 m) in the cell vicinity. This thick sequence of low-permeability shale hydrogeologically isolates the disposal cell from the Dakota Sandstone Formation. There is no compliance monitoring of the Cheney disposal cell due to this isolation and because ground water in the Dakota Sandstone Formation has been determined Class III (limited-use).

A deposit of sand, silt, gravel, and cobbles approximately 30 ft (9 m) thick overlies the Mancos Shale Formation. Paleochannels, which occur in the thin shallow deposit of alluvium and colluvium, contain small amounts of water. As a best management practice, the DOE installed two shallow monitor wells (GRJ-03-0731 and -0732), one at the northwestern corner and one at the southwestern corner (crossgradient and downgradient, respectively) of the disposal cell, to monitor ground water quality and any fluctuations in water levels.

Preliminary ground water level monitoring indicates that the paleochannels are situated in different hydrologic environments. Monitoring of the northwestern well indicates that the northwestern paleochannel contains very little water. Flow through the channel appears to stop completely for periods of several days. Monitoring of the southwestern well indicates that it contains more water and recovers very quickly following purging.

Additional water level and water quality data collection is needed before the paleochannels can be characterized sufficiently.

3.5 DATA COLLECTION OBJECTIVES

DCOs identify the reasons for collecting data, which include regulatory requirements, compliance monitoring, site characterization, risk assessment, and other considerations. The DCOs for ground water monitoring at Cheney are as follows (DOE, 1994b):

- Detect ground water occurrences (if any) within the subject paleochannels.
- Upon detection, assess any fluctuations in water levels.
- Characterize water quality in paleochannels.

Data quality requirements define the manner in which samples are collected, handled, and analyzed. This includes:

- Defining analytical support levels.
- Following standard procedures for water sampling, preservation, transport, and various other field procedures.
- Performing in accordance with QA and QC protocols.
- Providing analytical data validation.

DQOs to be followed during data collection and evaluation activities are given in the WSAP guidance document (DOE, 1995), QAIP (DOE, 1993) and applicable SOPs (JEG, n.d.), and DOE and EPA documents.

3.5.1 Regulatory requirements

The regulatory requirements for ground water sampling at the Cheney disposal site are specified in 40 CFR Part 192 (1994) and are described in the draft WSAP guidance document (DOE, 1995).

3.5.2 Best management practice monitoring

Ground water in the uppermost aquifer (Dakota Sandstone Formation) beneath the Cheney disposal site is not a current or potential source of drinking water and meets the EPA criterion for Class III (limited-use) designation because the TDS concentration is in excess of 10,000 mg/L (40 CFR §192.11(e)(1)). Postclosure monitoring of ground water in the uppermost aquifer is not proposed due to the Class III designation. Also, any ground water at depth is protected because it is hydrogeologically isolated from potential seepage of leachate from the disposal cell by approximately 750 ft (230 m) of confining shales and sandstones of the Mancos Shale Formation, and there is an upward vertical gradient due to confinement of ground water in the Dakota Sandstone Formation.

Small quantities of ground water occur in alluvial paleochannels near the upper surface of the eroded and weathered Mancos Shale Formation bedrock (Figure 3.2).

An indirect monitoring program (consisting of periodic water quality and water level monitoring of two shallow wells [GRJ-03-0731 and -0732] [Figure 1.3]), implemented as a best management practice, aids in confirming proper operation of the disposal cell and protecting human health and the environment to the extent required and practical.

3.5.3 Site characterization

No future site characterization activities currently are planned for the Cheney disposal site other than water level and water quality monitoring of paleochannel wells GRJ-03-0731 and -0732.

Semiannual sampling should be conducted during December and June, corresponding to the seasonal periods of low and high regional surface runoff, respectively.

3.6 WATER SAMPLING PLAN

This section presents the Cheney disposal site sampling locations, analytes (including field analyses), and sampling frequencies for the upcoming 2 years. It also includes the projected sampling needs for an additional 5 years. Sections 2.7.4 and 2.7.5 present data evaluation methods and response to anomalous data for the Cheney disposal site. The projected end point for the monitoring activities is

when the paleochannels have been characterized sufficiently to account for seasonal changes in water levels and water quality.

3.6.1 Sampling locations

Table 1.1 lists monitor wells at the Cheney disposal site. Wells GRJ-03-0731 and -0732 will be monitored to characterize ground water quality and water level fluctuations sufficiently in the paleochannels. Ground water samples will be collected in order of anticipated potential for increasing contamination to minimize possible effects of equipment contamination. Table 3.1 presents this order.

Table 3.1 Order for sampling and summary of ground water monitor wells to be sampled, Cheney disposal site, near Grand Junction, Colorado

Well ID	Location	Sampling justification
GRJ-03-0731	Northwestern paleochannel	Characterize ground water in paleochannel
GRJ-03-0732	Southwestern paleochannel	Characterize ground water in paleochannel

3.6.2 Analyte selection

Analytes to be measured in paleochannel ground water include those presented in Table 2.4. At the end of 2 years (in 1997), field parameters and laboratory analyses should be reevaluated to include only those analytes needed to characterize the paleochannels further.

3.6.3 Sampling frequency

Monitoring wells will be sampled twice a year for the next 2 years. Semiannual sampling is recommended because seasonal influences on water level and water quality within the paleochannels require further characterization.

Sampling will be conducted once during December and once during June, corresponding to periods of low and high regional surface runoff.

If after 2 years, ground water quality and water levels remain relatively stable and no additional construction activities are on the site, annual sampling of ground water is recommended for the next 5 years. If, however, ground water quality or water levels are highly variable, semiannual sampling of ground water should continue for a minimum of 2 more years to provide information on possible changes in the ground water regime.

4.0 LIST OF CONTRIBUTORS

The following individuals contributed to the preparation of this document.

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