UMTRA PROJECT WATER SAMPLING AND ANALYSIS PLAN

AMBROSIA LAKE, NEW MEXICO

February 1994

INTENDED FOR PUBLIC RELEASE

This report has been reproduced from the best available copy. Available in paper copy and microfiche.

Number of pages in this report: 46

DOE and DOE contractors can obtain copies of this report from:

**Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831
(615) 576-8401**

This report is publicly available from:

**National Technical Information Service
Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4650**

**UMTRA PROJECT WATER SAMPLING AND
ANALYSIS PLAN**

AMBROSIA LAKE, NEW MEXICO

February 1994

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

**Prepared for
U.S. Department of Energy
UMTRA Project Office
Albuquerque, New Mexico**

**Prepared by
Jacobs Engineering Group Inc.
Albuquerque, New Mexico**

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

872

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
1.0 INTRODUCTION	1-1
1.1 Purpose	1-1
1.2 Site location	1-1
1.2.1 Surrounding land use	1-1
1.2.2 Surrounding water use	1-1
1.3 Site history	1-4
1.4 Site status	1-4
1.5 Sampling plan summary	1-4
2.0 SITE CHARACTERISTICS	2-1
2.1 Physiographic setting	2-1
2.2 Geology	2-1
2.3 Hydrology	2-3
2.3.1 Ground water	2-3
2.3.2 Surface water	2-4
2.4 Water quality	2-4
2.4.1 Background ground water quality	2-4
2.4.2 Point-of-compliance wells	2-13
2.4.3 Plume delineation wells	2-13
2.4.4 Surface water sampling locations	2-15
2.5 Site conceptual model	2-15
3.0 DATA COLLECTION OBJECTIVES	3-1
3.1 Regulatory requirements	3-1
3.2 Compliance monitoring	3-1
3.3 Site characterization	3-1
3.4 Risk evaluation considerations	3-1
4.0 DATA QUALITY OBJECTIVES	4-1
4.1 Analytical methods, holding times, and detection limits	4-1
4.2 Sample filtration	4-1
4.3 Sample preservation and shipment	4-1
4.4 Chain-of-custody procedures	4-1
4.5 Sample collection methods	4-6
5.0 SAMPLING PLAN	5-1
5.1 Sampling locations and sequence	5-1
5.2 Constituent selection	5-1
5.3 Sampling frequency	5-1
5.4 Data interpretation methods	5-1
5.5 Response to anomalous data	5-2

TABLE OF CONTENTS (Concluded)

<u>Section</u>	<u>Page</u>
6.0 LIST OF CONTRIBUTORS	6-1
7.0 REFERENCES	7-1

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1.1 Location of Ambrosia Lake UMTRA site	1-2
1.2 Ambrosia Lake UMTRA site and surrounding area	1-3
1.3 Locations of monitor wells and Ann Lee Mine, Ambrosia Lake site, New Mexico	1-7
2.1 Generalized geologic cross section, Ambrosia Lake UMTRA site	2-2
2.2 Sulfate isopleth map for ground water in the alluvium, Ambrosia Lake site, New Mexico	2-14
2.3 Molybdenum isopleth map for ground water in the alluvium, Ambrosia Lake site, New Mexico	2-16
2.4 Uranium isopleth map for ground water in the alluvium, Ambrosia Lake site, New Mexico	2-17
2.5 Sulfate isopleth map for ground water in the Tres Hermanos-C2 Sandstone, Ambrosia Lake site, New Mexico	2-18

LIST OF TABLES

<u>Table</u>	<u>Page</u>
1.1 Monitor wells included in scheduled July 1994 ground water sampling, Ambrosia Lake UMTRA site	1-6
1.2 Analytes of concern	1-6
2.1 Monitor well information, Ambrosia Lake UMTRA site	2-5
2.2 Westwater Canyon background water quality	2-11
4.1 Sampling preservation techniques and holding times	4-2
4.2 UMTRA Project detection limits and techniques	4-4

LIST OF ACRONYMS AND ABBREVIATIONS

<u>Acronym</u>	<u>Definition</u>
COC	chain of custody
DOC	dissolved organic carbon
EPA	U.S. Environmental Protection Agency
ft	foot
gpd	gallons per day
km	kilometer
L/day	liters per day
m	meter
MCL	maximum concentration limit
mg/L	milligrams per liter
mi	mile
NEPA	National Environmental Policy Act
PEIS	programmatic environmental impact statement
RAP	remedial action plan
SOP	standard operating procedure
SPEAR	software program for environmental analysis and reporting
TAC	Technical Assistance Contractor
TDS	total dissolved solids
UMTRA	Uranium Mill Tailings Remedial Action
UMTRCA	Uranium Mill Tailings Radiation Control Act
UNC	United Nuclear Corporation
USGS	U.S. Geological Survey
WSAP	water sampling and analysis plan

1.0 INTRODUCTION

1.1 PURPOSE

This water sampling and analysis plan (WSAP) provides the basis for ground water sampling at the Ambrosia Lake Uranium Mill Tailings Remedial Action (UMTRA) Project site during fiscal year 1994. It identifies and justifies the sampling locations, analytical parameters, detection limits, and sampling frequency for the monitoring locations and will be updated annually.

1.2 SITE LOCATION

The Ambrosia Lake site is in McKinley County, New Mexico, about 40 kilometers (km) (25 miles [mi]) north of Grants, New Mexico, and 1.6 km (1 mi) east of New Mexico Highway 509 (Figure 1.1). The town closest to the tailings pile is San Mateo, about 16 km (10 mi) southeast (Figure 1.2). The former mill and tailings pile are in Section 28, and two holding ponds are in Section 33, Township 14 North, Range 9 West. The site is shown on the U.S. Geological Survey (USGS) map (USGS, 1980). The site is approximately 2100 meters (m) (7000 feet [ft]) above sea level.

1.2.1 Surrounding land use

Primarily rural, McKinley County is sparsely populated. The largest city in the area, Grants, had a population of 8965 in 1983. The surrounding land is used for uranium mining and milling, dryland farming, ranching, and some commercial timber production. The UMTRA Project site is within the Ambrosia Lake mining district, which is near the center of the Grants mineral belt. The immediate area includes several uranium mills, tailings piles and other mine-waste piles, and mine shafts and vents. During the late 1970s, the Grants region supplied more than 40 percent of the uranium concentrate produced in the United States.

The Quivira tailings pile and uranium mill (Kermac Nuclear Fuels) is within 1.6 km (1 mi) south and west of the Ambrosia Lake site. More than 12 former uranium mines are within an 8-km (5-mi) radius of the site. The closest residence is approximately 8 km (5 mi) south of the site.

1.2.2 Surrounding water use

Ground water in the Ambrosia Lake area is used by the uranium mining industry and for domestic and ranch supplies. The shallow water-bearing zones (alluvium and Tres Hermanos Sandstones) within an 8-km (5-mi) radius of the site contain no domestic wells or stock wells (DOE, 1991). Wells within this radius are completed in a deeper zone (the Westwater Canyon Member of the Morrison Formation), obtaining water from depths of 100 to greater than 240 m (300 to more than 800 ft). San Mateo is the nearest municipality operating a public water supply (DOE, 1991).

FIGURE 1.1
LOCATION OF AMBROSIA LAKE UMTRA SITE

LEGEND

- DOMESTIC OR STOCK WELL
- X UNDERGROUND MINE

1 0 1 2 3 MILES

1 0 1 2 3 4 5 KILOMETERS

MODIFIED FROM DOE, 1991.

FIGURE 1.2
AMBROSIA LAKE UMTRA SITE AND SURROUNDING AREA

1.3 SITE HISTORY

Phillips Petroleum operated the mill from June 1958 to March 1963, when the United Nuclear Corporation (UNC) assumed operation for 1 month. The mill used a carbonate process employing caustic soda (NaOH) and carbon dioxide (CO₂); NaOH and a water leaching process removed vanadium from 2.7 million tonnes (3 million tons) of ore, producing approximately the same amount of tailings. Some 360,000 tonnes (400,000 tons) of tailings were used as mine backfill.

When UNC resumed operations in 1971, the mill used a resin ion exchange facility in its solution mining process. Water pumped from the lower levels of the Westwater Canyon Formation from the Ann Lee, Sandstone, and Section 27 mines was passed through the ion exchange facility and then was returned to the upper levels of the same formation in those mines. This process continued through spring 1983.

A heap leaching process also was used at the Section 27 mine, approximately 1.6 km (1 mi) east of the mill, from July 1980 through spring 1983. Ore placed over drain pads was leached with water from the Section 27 mine. The leachate was collected and piped to the ion exchange facility.

1.4 SITE STATUS

All residual radioactive materials are being consolidated in an on-site disposal cell scheduled for completion in August 1995. An environmental assessment (DOE, 1987) and a remedial action plan (RAP) (DOE, 1991) were completed for the site in 1987 and 1991, respectively. The risk evaluation is scheduled for completion in mid-1994. The ground water programmatic environmental impact statement (PEIS) is in progress and is scheduled for completion in draft form for public review by mid-1994. The site-specific UMTRA Groundwater Remediation Program National Environmental Policy Act (NEPA) documents will follow the completion of the PEIS.

The uppermost water-bearing units at the Ambrosia Lake site (the alluvium and Tres Hermanos-C Sandstones) are incapable of sustaining a well yield greater than 570 liters per day (L/day) (150 gallons per day [gpd]) (DOE, 1991), thus meeting the supplemental standards for Class III ground water based on an insufficient yield of ground water.

1.5 SAMPLING PLAN SUMMARY

Ground water sampling is scheduled for July 1994, and once in 1995 just before the completion of surface remediation activities. This is the last ground water sampling event related to the surface remediation program for the Ambrosia Lake site.

Filtered samples will be taken from all existing monitor wells and analyzed for the following:

- Chemical constituents in the tailings pore fluids that exceeded the proposed U.S. Environmental Protection Agency (EPA) maximum concentration limit (MCL) (40 CFR Part 192 [1991]; DOE, 1991).
- Chemical constituents that exceeded the proposed EPA MCLs in ground water samples from the last two sampling events.
- Chemical constituents detected in ground water samples from the last two sampling events that do not have specific MCLs but are listed in the proposed standards (and exceeded the laboratory detection limit by at least a factor of 3).
- Tailings pore fluid indicator parameters. These are chemical constituents characteristic of tailings pore fluids that do not have specific or proposed MCLs (e.g., sulfate).

Table 1.1 lists monitor wells included in the July 1994 sampling schedule.
Table 1.2 lists analytes of concern. Figure 1.3 shows monitor well locations.

Changes to previous sampling plan

The most recent samples were collected in November and December 1992, when all existing locations at the site were sampled. The samples were analyzed for the constituents listed in Table 1.2, plus some additional parameters. This proposed fiscal year 1994 sampling plan is unchanged, except that some of the parameters analyzed in 1992 will not be analyzed in July 1994 because they were below or only slightly above detection limits in the last two sampling events.

Table 1.1 Monitor wells included in scheduled July 1994 ground water sampling, Ambrosia Lake UMTRA site

Monitor wells	Screened zone
674	Alluvium
675	Mancos shale
676	Tres Hermanos-C2
677	Tres Hermanos-C2
678	Tres Hermanos-B
679	Tres Hermanos-A
680	Dakota sandstone
681	Tres Hermanos-B
778	Tres Hermanos-C1
779	Tres Hermanos-C2
781	Alluvium
785	Tres Hermanos-C2
786	Tres Hermanos-C1
787	Tres Hermanos-C2
792	Alluvium
793	Alluvium

Table 1.2 Analytes of concern

Previous MCL exceedances	Detected, but no MCL	Indicator parameters
Arsenic	Cyanide	Alkalinity
Barium	Fluoride	Ammonium
Chromium	Nickel	Calcium
Gross alpha	Sulfide	Chloride
Lead	Zinc	Gross beta
Molybdenum		Iron
Nitrate		Magnesium
Radium-226		Manganese
Radium-228		pH
Selenium		Phosphate
Uranium		Potassium
		Specific conductance
		Silica
		Sodium
		Sulfate
		Total dissolved solids

MODIFIED FROM DOE, 1991.

FIGURE 1.3
LOCATIONS OF MONITOR WELLS AND ANN LEE MINE
AMBROSIA LAKE SITE, NEW MEXICO

2.0 SITE CHARACTERISTICS

2.1 PHYSIOGRAPHIC SETTING

The Ambrosia Lake site is in northwestern New Mexico, on the southern edge of the San Juan Basin portion of the Colorado Plateau. Called the "Navajo section" by Fenneman (1931), the site is in one of several northwest-trending, cuesta-bounded strike valleys characteristic of the region (DOE, 1991). The site is within the Ambrosia Lake Valley and west of San Mateo mesa, a northwest-trending cuesta. It also is within the Arroyo del Puerto drainage basin, which slopes down toward the southeast. The site area has no perennial streams.

2.2 GEOLOGY

The following geologic units are penetrated by boreholes at the site, in descending order:

- Alluvium - Alluvial and eolian deposits of clay, silt, sand, and gravel.
- Mancos Shale - Dark gray, calcareous marine shale containing four silty sandstone interbeds, known as the Tres Hermanos-C1, -C2, -B, and -A Sandstones.
- Dakota Sandstone - Fine- to medium-grained sandstone, probably representative of a marine and near-shore zone.
- Morrison Formation - Interbedded mudstones, siltstones, and sandstones divided into three members.
 - Brushy Basin. Mudstones and sandstones that contain uranium ore in some areas.
 - Westwater Canyon. Sandstones and mudstones containing most of the uranium ore mined in the area. The Westwater Canyon Member is also the primary aquifer for the area.
 - Recapture. Interbedded shale, siltstone, and sandstone.

Beneath the site, all geologic units except the alluvium dip northeast approximately 2 degrees. The alluvium was deposited nearly horizontally on top of the Mancos Shale. Figure 2.1 is a geologic cross section of the Ambrosia Lake UMTRA Project site.

FIGURE 2.1
GENERALIZED GEOLOGIC CROSS SECTION
AMBROSIA LAKE UMTRA SITE

2.3 HYDROLOGY

2.3.1 Ground water

The hydrogeologic units are described below in descending order.

Alluvium

The only ground water in this unit is from the discharge associated with mining activities. An aquifer test (DOE, 1991) shows the alluvium is incapable of a sustained yield of 570 L/day (150 gpd). The unit is considered a Class III aquifer, based on limited yield.

Mancos Shale

Tres Hermanos-C1 and -C2 Sandstone units are only partially saturated in the tailings pile vicinity. Ground water appears to flow northeast, in the direction of the active mines that had been dewatered. An aquifer test described in the RAP (DOE, 1991) shows these units are incapable of a sustained yield of 570 L/day (150 gpd). Therefore, ground water in these units is considered Class III, based on limited yield.

Aquifer tests were not performed on Tres Hermanos-B and -A Sandstone units. However, based on lithology and hydraulic conductivity testing, the water-bearing capacity of these units is not much greater than that of the Mancos Shale and could be considered Class III, based on limited yield.

The Mancos Shale units separating the Tres Hermanos Sandstones and the units above the Dakota Sandstone are continuous and act as aquitards because of their thickness and low hydraulic conductivity. The RAP (DOE, 1991) reports a hydraulic conductivity of 4.3×10^{-8} cm/s (1.2×10^{-4} ft/day) in undisturbed Mancos Shale probably is representative of the hydraulic conductivity.

Dakota Sandstone

The Dakota Sandstone is considered a secondary aquifer because of its relatively low yield (less than 10 gallons per minute) and poor water quality compared to the Westwater Canyon Member of the Morrison Formation (DOE, 1987).

Morrison Formation

The Brushy Basin Member acts as an aquitard between the Dakota Sandstone and Westwater Canyon Member.

The Westwater Canyon Member is the principal aquifer in the Ambrosia Lake mining district, and also is the major source of uranium ore. Mine dewatering began in the mid-1950s to facilitate ore removal from the Westwater Canyon Member. The ground water was discharged to surface drainages where it evaporated; some

infiltrated the shallower zones. Mine dewatering created a large ground water depression and ground water flow is probably toward the northeast (DOE, 1987).

Recapture Member

The Recapture Member acts as an aquitard beneath the Westwater Canyon member because of its low permeability and thickness of 50 m (150 ft) (DOE, 1987).

2.3.2 Surface water

The Ambrosia Lake tailings site lies in the drainage basin of the Arroyo del Puerto, an intermittent stream (DOE, 1987). Two unnamed drainage channels originate west (north ephemeral stream) and east (east ephemeral stream) of the site. No perennial streams are close to the site.

2.4 WATER QUALITY

Table 2.1 compares monitor well construction information for existing and abandoned wells. Some monitor wells were abandoned as part of surface remediation activities.

2.4.1 Background ground water quality

A hydrogeologic and geochemical evaluation of the water in the uppermost units (alluvium and Tres Hermanos-C Sandstones) at the site demonstrates that this water originates from mining and milling operations; therefore the existing water quality is representative of background (DOE, 1991). The RAP (DOE, 1991) gives the following description of background ground water quality. Table D.8.8 (DOE, 1991) is presented in this document as Table 2.2. Citations (e.g., "Bostick, 1985," "Section D.8.8") are references within the RAP (DOE, 1991).

Background groundwater quality in the alluvium/weathered Mancos Shale and the Tres Hermanos-C Sandstone at the Ambrosia Lake site is considered existing water quality because mining and milling activities have created the conditions of saturation (Bostick, 1985). Groundwater within the alluvium/weathered Mancos Shale has been demonstrated through geochemical modeling to be derived from reinfiltration of mine dewatering discharge or tailings seepage (Section D.8.8).

Because there was originally no measurable water in the alluvium, preoperational water quality data are not available for the Ambrosia Lake site. It is only possible to establish existing water quality as background for the isolated pocket of saturation within the alluvium/weathered Mancos Shale. Furthermore, the existing level of saturation in the alluvium/weathered Mancos Shale will probably not be sustained after remedial actions are completed. The concept of background water quality applies only to a sustainable aquifer with upgradient groundwater flow and the alluvium/weathered Mancos Shale are not aquifers. Existing water quality is therefore characterized in Section D.8.7, Extent of Existing Contamination.

Table 2.1 Monitor well information, Ambrosia Lake UMTRA site

Location ID	North coordinate (ft)	East coordinate (ft)	Ground elevation (ft MSL)	Borehole depth (ft)	Borehole diameter (inches)	Casing elevation (ft MSL)	Casing depth (ft)	Casing diameter (inches)	Screen beginning depth (ft)	Screen length (ft)	Flow	Formation of completion
0568	51550.00	50990.00	6961.30	129	-	6981.30	129	4	-	-	N	TB
0569	49990.00	51010.00	6915.70	165	-	6917.70	165	8	60	-	D	TR
0570	51730.00	47650.00	6963.80	58	-	6965.80	58	4	20	38	N	TB
0571	57190.00	47500.00	6967.40	482	-	6969.40	474	4	400	75	N	TR
0572	52200.00	51100.00	6978.60	245	-	6980.60	245	6	40	-	N	TR
0583	45780.00	57270.00	6894.60	226	-	6896.60	226	4	86	-	N	KD
0584	45290.00	56310.00	6894.50	191	-	6896.50	191	4	55	-	N	KD
0585	56520.00	47090.00	6967.80	390	-	6969.80	388	4	330	30	N	KD
0586	53590.00	48410.00	6948.40	319	-	6950.40	319	4	225	70	N	KD
0587	54400.00	51480.00	6945.00	88	-	6947.00	88	4	40	48	N	KD
0588	51630.00	50720.00	6979.10	257	-	6981.10	257	6	88	-	N	KD
0589	50500.00	54790.00	6916.60	290	-	6918.60	210	8	210	-	N	KD
0590	51910.00	54880.00	6938.50	300	-	6940.50	300	4	20	-	N	KD
0591	50580.00	55640.00	6921.00	286	-	6923.00	286	6	20	-	N	KD
0592	48150.00	56680.00	6913.00	272	-	6915.00	272	4	20	-	N	KD
0593	52240.00	45590.00	6990.50	341	-	6992.50	341	6	20	-	N	KD
0594	31650.00	72440.00	-	95	-	-	95	5	85	5	N	AL
0595	30640.00	67540.00	-	90	-	-	90	5	80	10	N	AL
0596	20790.00	64530.00	-	32	-	-	32	5	15	10	N	AL
0597	19350.00	65380.00	-	32	-	-	32	5	15	10	N	AL
0607	53870.00	59200.00	6991.36	50	8	-	43	4	34	6	O	AL
0608	53790.00	60785.00	6989.29	60	8	-	60	4	42	15	O	AL
0609	55335.00	60670.00	7000.89	35	8	-	30	4	17.5	10	O	AL
0610	54890.00	59915.00	6996.19	40	8	-	40	4	28	10	O	AL
0611	54970.00	59090.00	6993.99	36	8	-	15	4	5	7	O	TA

Table 2.1 Monitor well information, Ambrosia Lake UMTRA site (Continued)

Location ID	North coordinate (ft)	East coordinate (ft)	Ground elevation (ft MSL)	Borehole depth (ft)	Borehole diameter (inches)	Casing elevation (ft MSL)	Casing depth (ft)	Casing diameter (inches)	Screen beginning depth (ft)	Screen length (ft)	Flow	Formation of completion
0612	53240.00	58920.00	6965.14	37.5	8	-	37	4	-	-	O	AL
0613	54150.00	58910.00	6976.97	40	8	-	43	4	-	-	O	AL
0614	53310.00	59345.00	6965.57	42	-	6953.40	43	-	-	-	O	NR
0615	53300.00	59550.00	6964.53	35	-	6950.00	37	-	-	-	O	NR
0616	53320.00	60365.00	6964.06	22.6	-	6950.80	24	-	-	-	O	NR
0617	47910.00	64300.00	6939.60	29	8	6941.60	31	4	19	10	D	AL
0618	48650.00	63910.00	6951.90	34	8	6953.90	36	4	24	10	D	AL
0619	50910.00	64040.00	6965.70	29	8	6967.70	31	4	19	10	C	AL
0620	52040.00	60740.00	6951.90	34	8	6953.90	36	4	14	10	C	AL
0642	53913.10	60205.30	6988.70	9	4	8989.70	12	1.25	11	0.5	O	TA
0643	53918.90	60205.80	6988.70	18	4	6991.30	22	1.25	20	0.5	N	TA
0644	53948.50	59996.50	6989.20	10	4	6990.20	12	1.25	10	0.5	O	TA
0645	53954.30	59997.20	6989.10	18	4	6991.80	22	1.25	20	0.5	O	TA
0650	49990.00	51010.00	6915.70	85.75	6	-	-	-	-	-	N	AL
*0674	-	-	6669.50	49	10	6972.00	53	4	46.5	10	D	AL
*0675	-	-	6962.10	35	10	6966.00	38	4	32.5	10	D	KM
*0676	-	-	6989.70	120	8	6991.80	122	4	117.5	20	C	TT
*0677	-	-	6999.20	172	8	7001.60	173	4	170	20	C	TT
*0678	-	-	6962.10	262.5	8	6963.20	263	4	260	20	C	TB
*0679	-	-	6982.10	362	8	6983.60	363	4	360	20	D	TR
*0680	-	-	6963.70	350	8	6965.70	3	4	330	20	U	KD
*0681	-	-	7007.70	235	8	7002.50	30	4	230	30	C	TB
0706	53612.00	59942.00	6990.45	55	-	-	45	4	35	10	O	AL
0707	53788.00	60309.00	99999.99	70	-	-	70	4	50	20	O	TA
0708	53295.00	59872.00	6964.01	40	-	-	40.5	4	30	10	D	TO

Table 2.1 Monitor well information, Ambrosia Lake UMTRA site (Continued)

Location ID	North coordinate (ft)	East coordinate (ft)	Ground elevation (ft MSL)	Borehole depth (ft)	Borehole diameter (inches)	Casing elevation (ft MSL)	Casing depth (ft)	Casing diameter (inches)	Screen beginning depth (ft)	Screen length (ft)	Flow	Formation of completion
0709	55212.00	60324.00	7003.53	35	-	-	34	4	-	-	U	AL
0710	55599.00	61272.00	6997.70	40	-	-	43	4	33	10	U	AL
0711	44620.00	58430.00	6888.10	85	-	6890.10	85	4	-	-	U	TB
0712	58780.00	53420.00	6044.60	88	-	6046.60	88	4	20	68	N	AL
0713	59395.00	50400.00	6942.10	80	-	6944.10	80	4	40	40	N	AL
0714	50050.00	53110.00	6916.90	30	-	6918.90	28	4	28	-	N	AL
0715	50680.00	52310.00	6920.90	15	-	6922.90	12	4	12	-	N	AL
0716	48800.00	53510.00	6922.90	24	-	6924.90	22	4	22	-	N	AL
0717	48090.00	53510.00	6920.20	18	-	6921.20	17	4	17	-	N	KM
0718	51470.00	56950.00	6930.50	60	-	6932.50	-	4	-	-	N	AL
0719	47800.00	54605.00	6905.10	35	-	6907.10	25	3	-	-	N	AL
0720	49600.00	54110.00	6910.20	140	-	6912.20	27	3	-	-	N	AL
0721	51090.00	48190.00	6999.70	240	-	7001.70	238	4	185	35	N	TR
0722	47820.00	59070.00	6916.00	176	-	6918.00	176	8	60	-	U	TR
0723	48190.00	56540.00	6913.00	272	-	6915.00	272	6	-	-	N	KD
0724	49715.00	56105.00	6921.00	286	-	6923.00	286	6	-	-	N	KD
0725	51880.00	54950.00	6938.50	300	-	6940.50	300	6	-	-	N	KD
0726	53980.00	48560.00	6948.20	210	-	6950.20	210	4	160	25	N	TR
0727	68980.00	55960.00	7124.30	819	-	7126.30	819	4	718	82	N	JM
0728	52550.00	44940.00	6999.00	350	-	7001.00	340	4	255	-	N	KD
0729	53350.00	53510.00	6945.00	81	-	6947.00	81	6	51	30	N	AL
0731	54635.30	59790.70	6990.70	8	4	6993.70	13	1.25	12	0.5	O	TA
0733	54423.50	59788.90	6987.80	10	4	6991.90	16	1.25	15	0.5	O	TA
0734	54285.10	60397.40	6988.60	9	4	6989.80	11	1.25	10	0.5	O	TA
0736	53874.00	59800.60	6989.00	11	4	6992.00	16	1.25	15	0.5	O	TA

Table 2.1 Monitor well information, Ambrosia Lake UMTRA site (Continued)

Location ID	North coordinate (ft)	East coordinate (ft)	Ground elevation (ft MSL)	Borehole depth (ft)	Borehole diameter (inches)	Casing elevation (ft MSL)	Casing depth (ft)	Casing diameter (inches)	Screen beginning depth (ft)	Screen length (ft)	Flow	Formation of completion
0737	54291.30	60397.30	6988.90	14	4	6989.90	16	1.25	15	0.5	O	TA
0738	54297.20	60397.60	6988.50	18	4	6990.30	22	1.25	20	0.5	O	TA
0739	53797.40	60811.60	6989.70	25	4	6991.20	27	1.25	26	0.5	O	TA
0741	54186.90	60807.20	6988.60	8	4	6991.60	13	1.25	12	0.5	O	TA
0742	53787.30	60189.00	6988.10	21	4	6989.70	26	1.25	25	0.5	O	TA
0743	53782.50	60188.60	6988.20	16	4	6991.20	21	1.25	20	0.5	O	TA
0744	53777.70	60189.40	6988.10	12	4	6990.10	16	1.25	15	0.5	O	TA
0746	54193.00	60806.80	6988.30	13	4	6989.40	16	1.25	15	0.5	O	TA
0747	53990.50	60805.10	6988.80	37.5	4	6991.40	41	1.25	40	0.5	O	AL
0748	53985.90	60803.60	6988.70	34.5	4	6991.70	37.5	1.25	36.5	0.5	O	AL
0749	53981.30	60802.20	6988.90	29.5	4	6989.70	31	1.25	30	0.5	O	AL
0750	53977.50	60801.10	6988.60	24	4	6989.50	26	1.25	25	0.5	O	TA
0751	53972.80	60799.40	6988.30	19	4	6989.20	21	1.25	20	0.5	O	TA
0752	53802.60	60808.10	6997.40	19	4	6998.30	21	1.25	20	0.5	O	TA
0757	53632.90	60214.80	6991.70	26	4	-	-	-	-	-	O	AL
0759	53623.20	60219.30	6992.00	15	4	-	-	-	-	-	O	TA
0762	53520.50	59201.60	6989.60	4	4	6990.80	-	-	-	-	N	NR
0763	53523.50	59197.40	6989.20	6	4	6990.10	-	-	-	-	N	NR
0764	53527.00	59193.50	6989.50	9	4	6990.30	-	-	-	-	N	NR
0765	53511.00	59197.90	6989.40	14	4	6990.40	-	-	-	-	N	NR
0766	53515.70	59194.30	6989.20	19	4	6990.40	-	-	-	-	N	NR
0767	53520.50	59190.20	6989.50	24	4	6990.70	-	-	-	-	N	NR
0768	53318.30	59946.90	6962.90	6.5	4	6963.80	-	-	-	-	N	NR
0769	53324.60	59945.80	6963.40	9.5	4	6964.40	-	-	-	-	N	NR
0770	53330.10	59945.40	6963.80	14.5	4	6965.00	-	-	-	-	N	NR

Table 2.1 Monitor well information, Ambrosia Lake UMTRA site (Continued)

Location ID	North coordinate (ft)	East coordinate (ft)	Ground elevation (ft MSL)	Borehole depth (ft)	Borehole diameter (inches)	Casing elevation (ft MSL)	Casing depth (ft)	Casing diameter (inches)	Screen beginning depth (ft)	Screen length (ft)	Flow	Formation of completion
0771	53335.60	59944.30	6964.00	19.5	4	6965.00	-	-	-	-	N	NR
0772	53341.90	59943.90	6963.60	24.5	4	6964.50	-	-	-	-	N	NR
0773	55311.50	61688.90	7006.20	137	7.87 5	7007.70	139	4	132	5	D	TO
0774	55293.90	61735.90	7006.60	255	7.87 5	7007.40	257	4	250	5	C	TB
0775	55689.60	59342.70	6996.50	240	8	6998.70	97	4	90	5	D	TT
0776	55720.50	59423.30	6997.00	50	8	6999.10	52	4	45	5	U	AL
0777	52881.70	60119.80	6961.30	230	8	6963.20	160	4	153	5	U	TB
*0778	52911.50	60205.40	6961.20	37	8	6962.70	39	4	30	5	D	TO
*0779	52914.00	60284.70	6961.70	62	8	6964.00	64	4	57	5	D	TT
0780	53252.80	59057.60	6966.00	45	8	6968.50	45	4	38	5	D	AL
*0781	53253.50	59156.30	6965.10	170	8	6968.40	42	4	35	5	D	AL
0782	55221.40	58792.80	6989.70	120	8	6991.80	72	4	65	5	C	TT
0783	55219.10	58714.40	6990.70	50	8	6993.20	52	4	45	5	C	AL
0784	54129.00	58763.80	6974.80	55	8	6977.30	57	4	50	5	D	TT
*0785	52770.80	58816.50	6959.20	45	8	6961.30	47	4	40	5	D	TT
*0786	52888.50	59760.90	6961.50	40	8	6963.40	37	4	30	5	D	TO
*0787	52842.60	61202.90	6969.20	80	8	6971.30	82	4	75	5	D	TT
0788	52792.20	61119.30	6967.50	30	8	6969.80	32	4	25	5	D	AL
0789	56058.40	59620.50	7001.80	226	8	7003.90	228	4	216	10	D	TB
0790	56135.90	59590.20	7002.90	30	8	7004.90	32	4	25	5	U	AL
0791	55739.90	60567.00	6998.80	115	8	7000.80	117	4	110	5	D	TO
*0792	55724.90	60649.10	6999.00	20	8	7001.10	22	4	15	5	U	AL
*0793	55493.00	60225.70	6996.60	28	8	6998.60	30	4	23	5	U	AL

Table 2.1 Monitor well information, Ambrosia Lake UMTRA site (Concluded)

Location ID	North coordinate (ft)	East coordinate (ft)	Ground elevation (ft MSL)	Borehole depth (ft)	Borehole diameter (inches)	Casing elevation (ft MSL)	Casing depth (ft)	Casing diameter (inches)	Screen beginning depth (ft)	Screen length (ft)	Flow	Formation of completion
0794	52684.60	59429.70	6961.90	22	8	6964.20	24	4	17	5	D	AL
0796	52337.40	58319.60	6955.10	23	8	6957.30	25	4	18	5	D	AL
0797	53366.20	61327.70	6969.70	21.5	8	6972.00	23.5	4	16.5	5	C	AL
0798	53471.00	62021.20	6978.20	20	8	6980.40	22	4	15	5	C	AL
0799	54621.70	61167.60	6980.70	12	8	6982.80	14	4	7	5	C	AL

*Existing TAC monitor wells; other monitor wells are non-TAC or are decommissioned.

*Data not available.

MSL - Mean sea level.

NOTES:

Formation of completion code: AL - alluvium, JM - Westwater Canyon Member, KD - Dakota Sandstone, KM - Mancos Shale, NR - no recovery of data for classifying, TA - uranium mill tailings, TB - Tres Hermanos-B Sandstone, TO - Tres Hermanos-C1 Sandstone, TR - Tres Hermanos-A Sandstone, TT - Tres Hermanos-C2 Sandstone.

Flow relationship code: C - cross gradient, D - downgradient, U - upgradient, O - on site, N - unknown.

Table 2.2 Westwater Canyon background water quality

Constituent ^a	UNC		Ann Lee Mine		Quivira Section 30 W. Mine
	Sample date				
	10/27/77	11/17/78	11/07/79	06/21/82	05/13/83
Aluminum	NA	NA	<0.250	<0.100	0.37
Ammonia	0.015	0	0.05	NA	NA
Arsenic	<0.005	<0.005	0.009	0.006	0.27
Barium	0.27	0.074	<0.100	<0.100	<0.02
Bicarbonate	NA	228	174	317	730
Cadmium	<0.001	<0.001	NA	<0.01	0.024
Calcium	NA	150	194	265	720
Chloride	108	97.5	188	210	470
Chromium	NA	NA	NA	<0.100	0.078
Cobalt	NA	NA	NA	NA	0.059
Copper	NA	NA	NA	<0.025	0.066
Conductivity ^b	2657	2241	3288	3250	NA
Iron	NA	NA	NA	0.23	0.21
Lead	NA	<0.005	<0.005	<0.010	0.48
Magnesium	NA	NA	45.3	43	410
Manganese	NA	NA	NA	NA	7.2
Mercury	NA	NA	NA	<0.002	NA
Molybdenum	3.20	1.914	3.05	1.8	0.076
Nickel	NA	NA	NA	NA	0.140
Nitrate (as N)	0.11	<0.01	NA	<1.00	<1.00
pH ^c	8.08	NA	8.12	6.77	6.90
Potassium	NA	8.19	9.75	11	10
Selenium	0.268	0.171	0.122	0.13	0.30
Silver	NA	NA	NA	0.008	0.099
Sodium	428	421	511	510	410
Sulfate	1060	1115	1280	1460	2910
Total suspended solids	1.1	1.0	2.0	NA	NA
Total dissolved solids	1852	1903	2441	2660	5220
Vanadium	NA	<0.010	<0.010	0.010	NA
Zinc	NA	<0.100	<0.250	NA	0.22

Table 2.2 Westwater Canyon background water quality (Concluded)

Radionuclides ^d	UNC			Ann Lee Mine	Quivira Section 30 W. Mine
	Sample dates				
	10/27/77	11/17/78	11/07/79	06/21/82	05/13/83
Gross alpha	NA	0	0	NA	NA
Radium-226	29 ± 1	65 ± 1	19 ± 6	23	2.5
Radium-228	0 ± 2	NA	NA	0	2.5
Lead-210	17 ± 6	NA	NA	0	NA
Uranium	0.32	2.23	1.31	5.1	NA

Source: DOE, 1991.

^aIn milligrams per liter except as noted.

^bMicromhos.

^cStandard.

^dPicocuries per liter.

NA - Not analyzed.

Groundwater within the Tres Hermanos-C Sandstone at the Ambrosia Lake site is recharged primarily from seepage from the alluvium in the subcrop area. The extent of recharge from the alluvium will diminish after remedial action. Existing levels of saturation within the Tres Hermanos-C Sandstone may decrease as groundwater continues to drain into mine shafts and vent holes. However, the Tres Hermanos-C Sandstone may eventually repressurize, if the current trend of reducing mine dewatering persists. Some repressurization will probably occur by groundwater flow through mine shafts and vent holes completed in the Westwater Canyon Member up through the hydrostratigraphic section. Because levels of saturation are variable, there is no upgradient groundwater underflow and sources of recharge may change with time, existing water quality in the Tres Hermanos-C Sandstone must also be defined as background (Section D.8.7).

Present background groundwater quality of the Westwater Canyon Member has been identified in the Ambrosia Lake region by samples from mine water discharge (Table D.8.8). Water quality in the Westwater Canyon member has changed as a result of commingling of seepage from overlying formations down mine shafts and vent holes. Kelly (1980) found groundwater from the Westwater Canyon Member to be a sodium bicarbonate type (Figure D.8.18). The percentage of sulfate in mine water discharges from the Ann Lee Mine became higher over the period from 1963 to 1979, which may reflect the influence of seepage from the overlying Dakota Formation and tailings seepage within the Tres Hermanos-C Sandstone flowing down mine shafts and vent holes into the Westwater Canyon Member. Concentrations of cadmium, chromium, lead, molybdenum, selenium, silver, and uranium, and activities of radium-226 and -228 exceed the EPA MCLs in the Westwater Canyon Member. It is necessary to determine background water quality for the Westwater Canyon Member, because most of the existing saturation in the Tres Hermanos-C Sandstone will drain into the Westwater Canyon Member through mine shafts and vent holes. The effects of the proposed remedial action on water quality in the Westwater Canyon Member, are discussed in Section D.8.8.4.

2.4.2 Point-of-compliance wells

Point-of-compliance wells at the Ambrosia Lake site were not recommended as part of the approval groundwater compliance strategy, which is supplemental standards. This is based on ground water in the uppermost geologic units that is considered to be Class III because of limited well yield.

2.4.3 Plume delineation wells

Alluvium

Because all alluvium ground water at this site is associated with mining and milling operations, plume delineation wells are defined as any alluvial well containing water (historically, monitor wells 620, 674, 706, 792, and 793). Figure 2.2 shows the

FIGURE 2.2
SULFATE ISOPLETH MAP FOR GROUND WATER IN THE ALLUVIUM
AMBROSIA LAKE SITE, NEW MEXICO

plume represented by sulfate concentrations, based on 1985 and 1989 data (years with the greatest number of wells in service) and Figures 2.3 and 2.4 show the plume represented by molybdenum and uranium. A comparison with 1991 and 1992 data (for wells that have not been abandoned) shows sulfate concentrations remain relatively constant.

Tres Hermanos-C Sandstone units

As in the alluvium, water in the Tres Hermanos-C Sandstone units results from mining and milling operations. Therefore, any Tres Hermanos-C Sandstone well containing water is considered a plume delineation well. Figure 2.5 shows the plume represented by sulfate concentrations from samples taken during 1989. In general, more recent sampling events (1991 and 1992) show decreased sulfate concentrations.

Tres Hermanos-B and -A and Dakota Sandstone units

Because these units are hydrogeologically isolated from the upper and lower units, water quality is considered unaffected by mining and milling operations. Therefore, these units contain no plume delineation wells.

Westwater Canyon Member

The water quality of the Westwater Canyon Member demonstrates the widespread impact of mining activities and the presence of uranium ore in the aquifer. This unit contains no plume delineation wells because it is hydrogeologically separated from UMTRA site-related contamination.

2.4.4 Surface water sampling locations

Surface water samples will not be taken. Due to the arid climate, no perennial streams are nearby.

2.5 SITE CONCEPTUAL MODEL

The Ambrosia Lake UMTRA Project site is within the Grants mineral belt. The site and surrounding areas have been mined extensively for uranium since the mid-1950s. Ground water in the uppermost geologic units (alluvium and Tres Hermanos-C Sandstones) within the area of the UMTRA site is a result of mining and milling operations associated with the UMTRA site. This water is highly mineralized, reflecting the quality of mill tailings and mine discharge water. The ground water in the uppermost units is of poor quality and is not a likely water source because of the low yield to wells. The ground water is Class III, based on low yield (less than 570 L/day [150 gpd]).

Beneath the upper units are three other water-bearing units: the Tres Hermanos-B, Tres Hermanos-A, and Dakota Sandstone. These units are hydrogeologically isolated from the UMTRA-related activities and nearby mining and milling

FIGURE 2.3
MOLYBDENUM ISOPLETH MAP FOR GROUND WATER IN THE ALLUVIUM
AMBROSIA LAKE SITE, NEW MEXICO

MODIFIED FROM DOE, 1991.

FIGURE 2.4
URANIUM ISOPLETH MAP FOR GROUND WATER IN THE ALLUVIUM
AMBROSIA LAKE SITE, NEW MEXICO

FIGURE 2.5
SULFATE ISOPLETH MAP FOR GROUND WATER IN THE
TRES HERMANOS-C2 SANDSTONE
AMBROSIA LAKE SITE, NEW MEXICO

MODIFIED FROM DOE, 1991.

operations. Water quality in these lower units reflects natural conditions. The Dakota Sandstone is considered a secondary aquifer for the area due to the relatively low yield (45 liters per minute [10 gallons per minute]) compared to the deeper Westwater Canyon Member. The hydraulic characteristics of the Tres Hermanos-B and -A units are not significantly different from the surrounding confining units and, therefore, yield to wells is probably less than 570 L/day (150 gpd).

The Westwater Canyon Member is the major uranium ore-producing unit and the major aquifer for the area. Water quality reflects the widespread regional influence of mining and widespread ambient contamination caused by naturally occurring uranium ore. Ground water flow is probably southeast, influenced by mine dewatering.

Land use in the site area is limited to mining, milling, and low-density grazing. No water supply wells within an 8-km (5-mi) radius of the site tap a contaminated zone. Due to the arid climate, no perennial streams are nearby (DOE, 1991).

3.0 DATA COLLECTION OBJECTIVES

3.1 REGULATORY REQUIREMENTS

Regulations for UMTRA site health and environmental protection standards are defined in 40 CFR Part 192 (1991). Additional regulations regarding ground water and surface water monitoring are included in proposed regulations (52 FR 36000 [1987]). The authorizing statute for the UMTRA Project, the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978 (42 USC 7901 *et seq.*), requires using the 1987 proposed regulations until the 1991 regulations are published in final form.

Regulations for the following needs are specified in 40 CFR Part 192 (1991):

- Protect ground water.
- Determine background ground water quality.
- Identify the presence, constituent concentrations, and movement of any plumes.
- Monitor disposal cell performance.

3.2 COMPLIANCE MONITORING

Compliance monitoring at the site is not required because first, the uppermost water-bearing units are considered Class III due to limited yield, and second, the deeper units are hydrogeologically separated from the upper units and are unaffected by tailings disposal. The purpose for the previous monitoring, and the monitoring recommended in this WSAP, is to evaluate any potential changes in ground water quality related to surface remediation activities. The July 1994 sampling recommended in this WSAP will be performed about one year before surface remediation activities are complete in August 1995 and is the next-to-last regularly scheduled sampling event for surface activities at the Ambrosia Lake site. The last scheduled sampling event for surface activities at the site is anticipated to occur in July 1995, immediately prior to the completion of surface remediation activities.

3.3 SITE CHARACTERIZATION

The July 1995 sampling event will complete water sampling for the surface remedial action program.

3.4 RISK EVALUATION CONSIDERATIONS

Risk evaluation requirements are unknown at this time.

4.0 DATA QUALITY OBJECTIVES

4.1 ANALYTICAL METHODS, HOLDING TIMES, AND DETECTION LIMITS

Analytical methods, holding times, and detection limits applicable to the sampling recommended in this WSAP are described in the statement of work for the UMTRA Project (TAC, 1993). Tables 4.1 and 4.2 list the analytical methods, holding times, and detection limits approved for and used by the UMTRA Project.

4.2 SAMPLE FILTRATION

Water samples follow UMTRA *Albuquerque Operations Manual* standard operating procedure (SOP) 16.2.1, "Sample Collection, Preservation, and Shipment of Water Samples" (JEG, n.d.), using an 0.45-micron filter. Samples for the following analyte bottles will be collected as filtered samples at the Ambrosia Lake site: A-1, M-2, radium-226 (Ra-226), radium-228 (Ra-228), gross alpha and gross beta (GA/B), and dissolved organic carbon (DOC).

Samples for the following analyte bottles will be collected as unfiltered samples: N-1, sulfide (S), and total cyanide (CN).

4.3 SAMPLE PRESERVATION AND SHIPMENT

Water, soil, and other environmental samples shall be preserved in accordance with the following SOPs (JEG, n.d.). Only water samples will be collected in the July 1994 sampling event.

14.5.1 "Procedures for Handling and Shipping of Geotechnical Samples."

16.2.1 "Sample Collection, Preservation and Shipment of Water Samples."

4.4 CHAIN-OF-CUSTODY PROCEDURES

All samples shall be shipped through a chain of custody (COC) as described in two SOPs (JEG, n.d.). SOP 16.2.10, "Packaging, Shipping, and Custody of Environmental Samples," describes COC procedures for water and other environmental samples (e.g., biological samples). SOP 14.5.1, "Procedures for Handling and Shipping of Geotechnical Samples," describes COC procedures for rock and soil samples. These SOPs shall be followed when samples specified in this WSAP are collected and shipped. The site manager and site hydrologist or geochemist must approve any deviation from these procedures and justify the deviation in a memo.

Table 4.1 Sampling preservation techniques and holding times

Bottle ID	Parameter	Volume/container	Preservation	Holding time ^a
A-1	Br, Cl, F, SO ₄ , SiO ₂	1-L plastic	None, 4°C	28 days
	TDS		None, 4°C	7 days
M-2	Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Mg, K, Mn, Mo, Na, Ni, Pb, Sb Se, Sn, Sr, Tl, U, V, Zn	500-mL plastic	HNO ₃ , pH < 2	180 days
	Hg		HNO ₃ , pH < 2	28 days
N-1	NH ₄ , NO ₃ , TKN PO ₄	500-mL plastic	H ₂ SO ₄ , pH < 2 4°C	28 days
CN	Total CN	1-L plastic	NaOH, pH > 12 4°C	14 days
S	Sulfide	2x500-mL plastic	NaOH, pH > 9 Zn acetate 4°C	7 days
DOC	DOC	500-mL amber glass	H ₂ SO ₄ , pH < 2 4°C	28 days
TOC	TOC	500-mL amber glass	H ₂ SO ₄ , pH < 2 4°C	28 days
Ra-226	Ra-226	2x1-L plastic	HNO ₃ , pH < 2	180 days
Ra-228	Ra-228	2x1-L plastic	HNO ₃ , pH < 2	180 days
Pb-210	Pb-210	1-L plastic	HNO ₃ , pH < 2	180 days
Po-210	Po-210	1-L plastic	HNO ₃ , pH < 2	180 days
Th-230	Th-230	1-L plastic	HNO ₃ , pH < 2	180 days
GA/B	Gross alpha, Gross beta, U	500-mL plastic	HNO ₃ , pH < 2	180 days

Table 4.1 Sample preservation techniques and holding times (Concluded)

<u>Key</u>	
Br - Bromine	Se - Selenium
Cl - Chloride	Sn - Tin
F - Fluorine	Sr - Strontium
SO ₄ - Sulfate	Tl - Thallium
SiO ₂ - Silica	U - Uranium
TDS - Total dissolved solids	V - Vanadium
Ag - Silver	Zn - Zinc
Al - Aluminum	Hg - Mercury
As - Arsenic	NH ₄ - Ammonium
B - Boron	NO ₃ - Nitrate
Ba - Barium	TKN - Total Kjeldahl nitrogen
Be - Beryllium	PO ₄ - Phosphate
Ca - Calcium	Total CN - Total cyanide
Cd - Cadmium	DOC - Dissolved organic carbon
Co - Cobalt	TOC - Total organic carbon
Cr - Chromium	Ra-226 - Radium-226
Cu - Copper	Ra-228 - Radium-228
Fe - Iron	Pb-210 - Lead-210
Mg - Magnesium	Po-210 - Polonium-210
K - Potassium	Th-230 - Thorium-230
Mn - Manganese	GA/B - Gross alpha and gross beta
Mo - Molybdenum	HNO ₃ - Nitric acid
Na - Sodium	H ₂ SO ₄ - Sulfuric acid
Ni - Nickel	C - Centigrade
Pb - Lead	NaOH - Sodium hydroxide
Sb - Antimony	

Source: TAC, 1993.

^aCalculated from date and time sample was taken.

Table 4.2 UMTRA Project detection limits and techniques

Parameter	Contract-required detection limit (mg/L)	Technique ^a
Aluminum	0.05	ICP-AES
Ammonium (as NH ₄)	0.10	Colorimetric
Antimony	0.003	GFAA, ICP-MS
Arsenic	0.005	GFAA, NaBH ₄
Barium	0.10	ICP-AES
Beryllium	0.005	ICP-AES
Boron	0.10	ICP-AES
Bromide	0.10	IC
Cadmium	0.001	GFAA, ICP-MS
Calcium	0.50	ICP-AES
Chloride	0.50	IC, colorimetric
Chromium	0.01	ICP-AES
Cobalt	0.05	ICP-AES
Copper	0.02	ICP-AES
Dissolved organic carbon	1.0	UV promoted oxidation-IR
Total cyanide	0.010	Colorimetric
Fluoride	0.10	ISE
Iron	0.03	ICP-AES
Lead	0.003	GFAA, ICP-MS
Magnesium	0.10	ICP-AES
Manganese	0.01	ICP-AES
Mercury	0.0002	CVAA
Molybdenum	0.01	ICP-AES
Nickel	0.04	ICP-AES
Nitrate (as NO ₃)	1.0	Colorimetric, IC
Potassium	0.10	ICP-AES, FAA
Selenium	0.005	GFAA, NaBH ₄
Silver	0.01	ICP-AES
Silica (as SiO ₂)	0.10	ICP-AES
Sodium	1.0	ICP-AES, FAA
Strontium	0.01	ICP-AES
Sulfate	1.0	IC
Sulfide	1.0	Titrimetric, colorimetric
Thallium	0.005	GFAA, ICP-MS

Table 4.2 UMTRA Project detection limits and techniques (Concluded)

Parameter	Contract-required detection limit (mg/L) ^a	Technique ^b
Tin	0.05	ICP-AES, GFAA, ICP-MS
Total dissolved solids	10	Gravimetric
Total Kjeldahl nitrogen	1.0	Colorimetric
Total organic carbon	1.0	UV promoted oxidation-IR
Total phosphorus (as PO ₄)	0.10	Colorimetric
Uranium	0.001	ICP-MS, fluorometric
Vanadium	0.01	ICP-AES
Zinc	0.05	ICP-AES
Radionuclides^c		
Gross alpha	1.0	PC
Gross beta	0.5	PC
Pb-210	1.5	LSc, PC
Po-210	1.0	AS, PC
Ra-226	1.0	AS, AS _c
Ra-228	1.0	PC
Th-230	1.0	AS

Key

AS	Alpha spectrometry
AS _c	Alpha scintillation
CVAA	Cold vapor atomic absorption spectroscopy
FAA	Flame atomic absorption spectroscopy
GFAA	Graphite furnace atomic absorption spectroscopy
IC	Ion chromatography
ICP-AES	Inductively coupled plasma-atomic emission spectroscopy
ICP-MS	Inductively coupled plasma-mass spectrometry
IR	Infrared
ISE	Ion specific electrode
LSc	Liquid scintillation
NaBH ₄	Sodium borohydride reduction atomic absorption spectroscopy
PC	Proportional counter
UV	Ultraviolet

^amg/L - milligrams per liter

^bWhen more than one technique is specified, the first technique listed is preferred.

^cLower limit of detection in picocuries per liter.

4.5 SAMPLE COLLECTION METHODS

Water and other environmental samples shall be collected according to the following SOPs (JEG, n.d.):

- 14.5.1 "Procedures for Handling and Shipping of Geotechnical Samples."
- 16.1.6 "Soil-Water Sampler Installation and Sample Collection."
- 16.1.10 "Field Measurements for Temperature, Conductivity, pH, Alkalinity, and Total Acidity."
- 16.1.11 "Sample Collection for Organic Substances."
- 16.1.13 "Field Measurement of Oxidation/Reduction Potential (ORP)."
- 16.1.14 "Field Determination of Dissolved Oxygen in Water Samples."
- 16.1.16 "(Alternate Method) Field Determination of Dissolved Oxygen."
- 16.1.21 "Measurement of Water Turbidity."
- 16.2.1 "Sample Collection, Preservation, and Shipment of Water Samples."
- 16.2.2 "Water Sampling for Tritium Analysis."
- 16.2.4 "Sampling Radon in Water."
- 16.2.5 "Monitor Well Sampling With an Electric Submersible Pump."
- 16.2.6 "Monitor Well Sampling With a Bladder Pump."
- 16.2.7 "Monitor Well Sampling With a Peristaltic Pump."
- 16.2.8 "Quality Control Samples for Water Sampling."
- 16.2.9 "Monitor Well Sampling With a Bailer."
- 16.3.1 "Inventory and Documentation of Damage and Repair of UMTRA Project Wells."

5.0 SAMPLING PLAN

5.1 SAMPLING LOCATIONS AND SEQUENCE

Figure 1.3 shows sampling locations. The sequence in which the monitor wells will be sampled progresses from the least contaminated to the most contaminated. The following sequence was determined from examining water quality data in the UMTRA Project software program for environmental analysis and reporting (SPEAR) (DOE, 1992) data base, using sulfate and uranium as indicators: 781, 681, 676, 677, 680, 792, 787, 793, 778, 786, 675, 779, 689, 674, 785, 678.

5.2 CONSTITUENT SELECTION

Samples from all monitor wells will be analyzed for the following:

- Chemical constituents in the tailings pore fluids that exceeded the proposed EPA MCLs (40 CFR Part 192 [1991]; DOE, 1991).
- Chemical constituents that exceeded the proposed EPA MCLs in ground water samples from the last two sampling events.
- Chemical constituents detected in ground water samples from the last two sampling events that do not have a specific MCL but are listed in the proposed standards (and exceeded the laboratory detection limit by at least a factor of 3).
- Tailings pore fluid indicator parameters.

Table 1.1 lists the monitor wells included in the July 1994 sampling schedule. Table 1.2 lists analytes of concern.

Analyte selection is based on the need to evaluate changes in water quality during disposal cell construction. With no surface water nearby, surface water sampling will not be conducted. Also, because ground water in the uppermost water-bearing units is Class III and the tailings have not affected water quality in the deeper zones, no point-of-compliance wells are planned.

5.3 SAMPLING FREQUENCY

Described in this WSAP, a round of sampling is planned for July 1994, and the final sampling is scheduled for July 1995, immediately before the scheduled completion of disposal cell construction. Ground water characterization needs will be defined after completion of the PEIS and site-specific NEPA documents.

5.4 DATA INTERPRETATION METHODS

Data interpretation will compare previous sampling results with the most recent results, focusing on identifying trends in water quality and water level elevations.

Trends in water quality will be used to evaluate the effects of surface remediation, if any, on water quality in the shallow water-bearing units. Trends in water levels will be used to evaluate the degree of saturation in the shallow zone.

5.5 RESPONSE TO ANOMALOUS DATA

Responses to anomalous data will follow SOPs 16.3.2, "Validation of Chemical Analysis Data," and 16.3.3, "Data Management" (JEG, n.d.). Potential responses to anomalous data include sample reanalysis and monitor well resampling.

6.0 LIST OF CONTRIBUTORS

The following individuals contributed to the preparation of this report.

Name	Contribution
A. Miller	Overall document responsibility; authorship
C. Yancey	Document review
A. Groffman	Geochemistry
A. Miller	Hydrogeology
WordCenter, Inc.	Text processing
B. Harvey	Graphic design
K. Walston, J. Torline	Technical editing

7.0 REFERENCES

- DOE (U.S. Department of Energy), 1992. Software Program for Environmental Analysis and Reporting (SPEAR) System, U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.
- DOE (U.S. Department of Energy), 1991. *Remedial Action Plan and Site Conceptual Design for Stabilization of the Inactive Uranium Mill Tailings Site at Ambrosia Lake, New Mexico*, UMTRA-DOE/AL-050516.0000, prepared by the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.
- DOE (U.S. Department of Energy), 1987. *Environmental Assessment, Remedial Action at the Ambrosia Lake Uranium Mill Tailings Site, Ambrosia Lake, New Mexico*, UMTRA-DOE/EA-0322, prepared by the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.
- Fenneman, N. M., 1931. *Physiography of the Western United States*, McGraw-Hill, New York, New York.
- JEG (Jacobs Engineering Group Inc.), n.d. *Albuquerque Operations Manual*, standard operating procedures, prepared by Jacobs Engineering Group Inc., Albuquerque, New Mexico, for the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.
- TAC (Technical Assistance Contractor, Jacobs Engineering Group Inc.), 1993. *Statement of Work, UMTRA Project TAC General Inorganic and Radiochemical Analyses*, February 12, 1993, prepared by Jacobs Engineering Group Inc. for the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.
- USGS (U.S. Geological Survey), 1980. U.S. Geological Survey map, Ambrosia Lake quadrangle, Ambrosia Lake, New Mexico, 7.5 minute series (topographic), N3522.5 - W10745/7.5, revised.

CODE OF FEDERAL REGULATIONS

- 40 CFR Part 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," 1991.

UNITED STATES CODE

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

FEDERAL REGISTER

52 FR 36000, "Standards for Remedial Actions at Inactive Uranium Processing Sites;
Proposed Rule," September 24, 1987.

END

**DATE
FILMED**
3 / 16 / 1944