INTERNATIONAL
URANIUM (USA)
CORPORATION

[illegible]

May 26, 1999

Via Federal Express Overnight Mail

Mr. N. King Stablein, Acting Branch Chief
High-Level Waste and Uranium Recovery
Projects Branch
Division of Waste Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
White Flint North, Mail Stop [illegible]
11545 Rockville Pike
Rockville, MD 20852

Re: White Mesa Mill Reclamation Plan Revision [illegible]
SUA-1358
Docket No. 40-8681

Dear Mr. Stablein:

Enclosed are three copies of the White Mesa Mill Reclamation Plan, Revision [illegible]. This update of the Reclamation Plan has been revised to incorporate changes and clarifications developed through formal NRC questions and responses. A [illegible] meeting was held in March of this year to further clarify outstanding issues. Your staff was most helpful throughout this process.

Included in the binder pocket of the Reclamation Plan is an [illegible] which details by page and section number the changes to the original plan [illegible]. This will hopefully expedite the final review of the Reclamation Plan.

The Reclamation Plan also includes a copy of the current [illegible] which was previously submitted to the NRC on February [illegible] annual surety update. This cost estimate reflects a total [illegible] of $[illegible]. We are requesting that the White Mesa Mill surety [illegible] estimate as soon as the enclosed Reclamation Plan is approved.

If you or any of your staff have any questions, please feel free to call.

Very truly yours,

[illegible]

Harold R. Roberts
Executive Vice President

HRR:pt

Ronald F. Berg
William S. Dean
David C. Eckenlund
Robert A. Hembree
Earl L. Hogden
Chad E. Meyer
Michelle R. Rehmann
[illegible]

Reclamation Plan

White Mesa Mill

Blanding, Utah

Source Material License No. SUA-1358

Docket No. 40-8681

Revision 2.0

May 1999

Prepared By
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TABLE OF CONTENTS

Page No.

TABLE OF CONTENTS (continued)

Page No.

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

Page No.

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF FIGURES

LIST OF FIGURES (continued)

LIST OF FIGURES (continued)

LIST OF ATTACHMENTS

LIST OF APPENDICES
(Previously Submitted with Revision 1.0, February 28, 1997)

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INTRODUCTION

This document prepared by International Uranium (USA) Corporation ("IUSA"), presents IUSA's plans and estimated costs for the reclamation of Cells 1-I, 2, 3, and 4, and for decommissioning of the White Mesa Mill.

The uranium processing sections of the mill will be decommissioned as follows:

The uranium and vanadium processing areas of the mill, including all equipment, structures and support facilities will be decommissioned and disposed of in tailings or buried on site as appropriate. All equipment, including tankage and piping; agitation; process control instrumentation and switchgears; and contaminated structures; will be cut up, removed, and buried in tailings prior to final cover placement. Concrete structures and foundations will be demolished and removed or covered with soil as appropriate. These decommissioned areas would include, but not be limited to, the following:

- Coarse ore bin and associated equipment, conveyors and structures.
- Grind circuit including semi-autogenous grind (SAG) mill, screens, pumps and cyclones.
- Three pre-leach tanks to the east of the mill building, including all associated tankage, agitation equipment, pumps, and piping.
- Seven leach tanks inside the main mill building, including all associated agitation equipment, pumps and piping.
- Counter-current decantation (CCD) circuit including all thickeners and equipment, pumps and piping.
- Uranium precipitation circuit, including all thickeners, pumps and piping.
- Two yellowcake dryers and all mechanical and electrical support equipment, including uranium packaging equipment.
- Clarifiers to the west of the mill building including the preleach thickener and claricone.
- Boiler and all ancillary equipment and buildings.

- Entire vanadium precipitation, drying, and fusion circuit.
- All external tankage not included in the above list including: reagent tanks for the storage of acid, ammonia, kerosene, water, or dry chemicals; and the vanadium oxidation circuit.
- Uranium and vanadium solvent extraction (SX) circuit including all SX and reagent tankage, mixers and settlers, pumps, and piping.
- SX building.
- Mill building.
- Office building.
- Shop and warehouse building.
- Sample plant building.

The sequence of demolition would proceed so as to allow the maximum use of support areas of the facility, such as the office and shop areas. It is anticipated that all major structures and large equipment will be demolished with the use of hydraulic shears. These will speed the process, provide proper sizing of the materials to be placed in tailings, and reduce exposure to radiation and other safety hazards during the demolition. Any uncontaminated or decontaminated equipment to be considered for salvage will be released in accordance with the NRC document, Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct or Source Materials, dated September, 1984, and in compliance with the conditions of Source Material License SUA-1358. As with the equipment for disposal, any contaminated soils from the mill area will be disposed of in the tailings facilities in accordance with Section 4.0 of Attachment A, Plans and Specifications.

The estimated reclamation costs for surety are summarized as follows:

White Mesa Reclamation
Cost Summary

Direct Costs		
Mill Decommissioning		1,505,166
Cell 1 Reclamation		933,169
Cell 2 Reclamation		1,082,869
Cell 3 Reclamation		1,565,444
Cell 4A Reclamation		120,128
Misc. Items (Project General)		1,939,480
	Subtotal Direct:	$7,146,257
Profit Allowance	10%	714,626
Contingency	15%	1,071,939
Licensing and Bonding	2%	142,925
Long Term Care Fund		606,721
	Total Surety Requirement:	$9,682,467

REPORT ORGANIZATION

General site characteristics pertinent to the reclamation plan are contained in Section 1.0. Descriptions of the facility construction, operations and monitoring are given in Section 2.0. The current environmental monitoring program is described in Section 2.3. Seismic risk was assessed in Section 2.6.3.

The Reclamation Plan including descriptions of facilities to be reclaimed and design criteria, is presented in Section 3.0. Section 3.0 Attachments A through H are the Plans and Specifications, Quality Plan for Construction Activities, Cost Estimates, and supplemental testing and design details.

Supporting documents (previously submitted), which have been reproduced as appendices for ease of review, include:

- Semi-Annual Effluent Report, White Mesa Mill, SUA-1358, Docket No. 40-8681 (July through December 1995) and Semi-Annual Effluent Report, White Mesa Mill, SUA-1358, Docket No. 40-8681 (January through June 1996) Energy Fuels Nuclear, Inc.

- Hydrogeologic Evaluation of White Mesa Uranium Mill, July 1994, Titan Environmental Corporation (Titan)

- Points of Compliance, White Mesa Uranium Mill, September 1994, Titan

- Tailings Cover Design, White Mesa Mill, October 1996, Titan

- Neshaps Radon Flux Measurement Program, White Mesa Mill, [illegible], October [illegible], Tellco Environmental

1.0 SITE CHARACTERISTICS

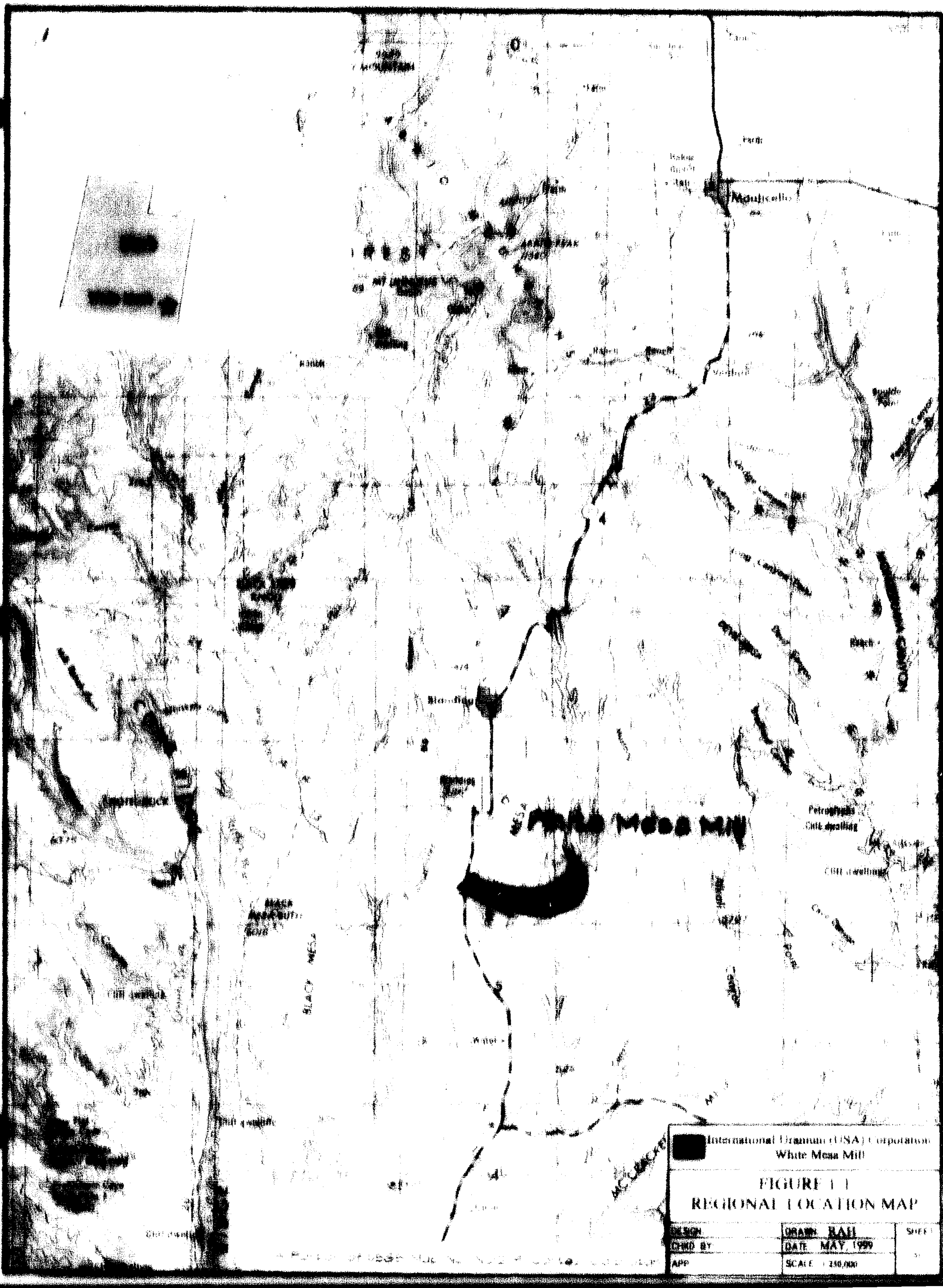
The White Mesa Mill is located in southeastern Utah (see Figure 1-1), approximately six miles south of Blanding, Utah (see Figure 1-2).

The Environmental Report (ER) (Dames and Moore 1978b) has been reproduced, with minor revisions, to describe site characteristics. The Final Environmental Statement (Final ES, U.S. NRC, 1979) has also been used, where noted below, for descriptions of the preoperational environment. Section 1.0, Site Characteristics, contains certain pertinent sections reproduced from the Final ES with minor changes in syntax. Where these sections were reproduced, the ER or Final ES section numbers are referenced in parentheses after the section title.

Section 1.6.1, Regional Geology, and Section 1.6.2, Blanding Site Geology, were reproduced from the ER with minor changes in syntax. Section 1.6.3, Seismic Risk Assessment, summarizes the results of static and pseudostatic analyses performed in September of 1996. Additional Probabilistic Risk Assessment was performed in April 1999, as it relates to the potential for liquefaction of the tailings sands. This Assessment is included as Attachment F to this Plan. These analyses were based on the most recent data available as well as previously collected data, and were used to establish the stability of the side slopes of the tailings soil cover. Complete details of the tailings cover design are provided in Appendix D, Tailings Cover Design, White Mesa Mill (Titan Environmental Corporation, 1996).

The Semi Annual Effluent Report for July through December, 1996 (EFN, 1996) is reproduced in Appendix A. Subsequent Semi Annual Effluent Reports through December of 1998 have been submitted to the NRC in compliance with License requirements. Many of the graphs in the Semi

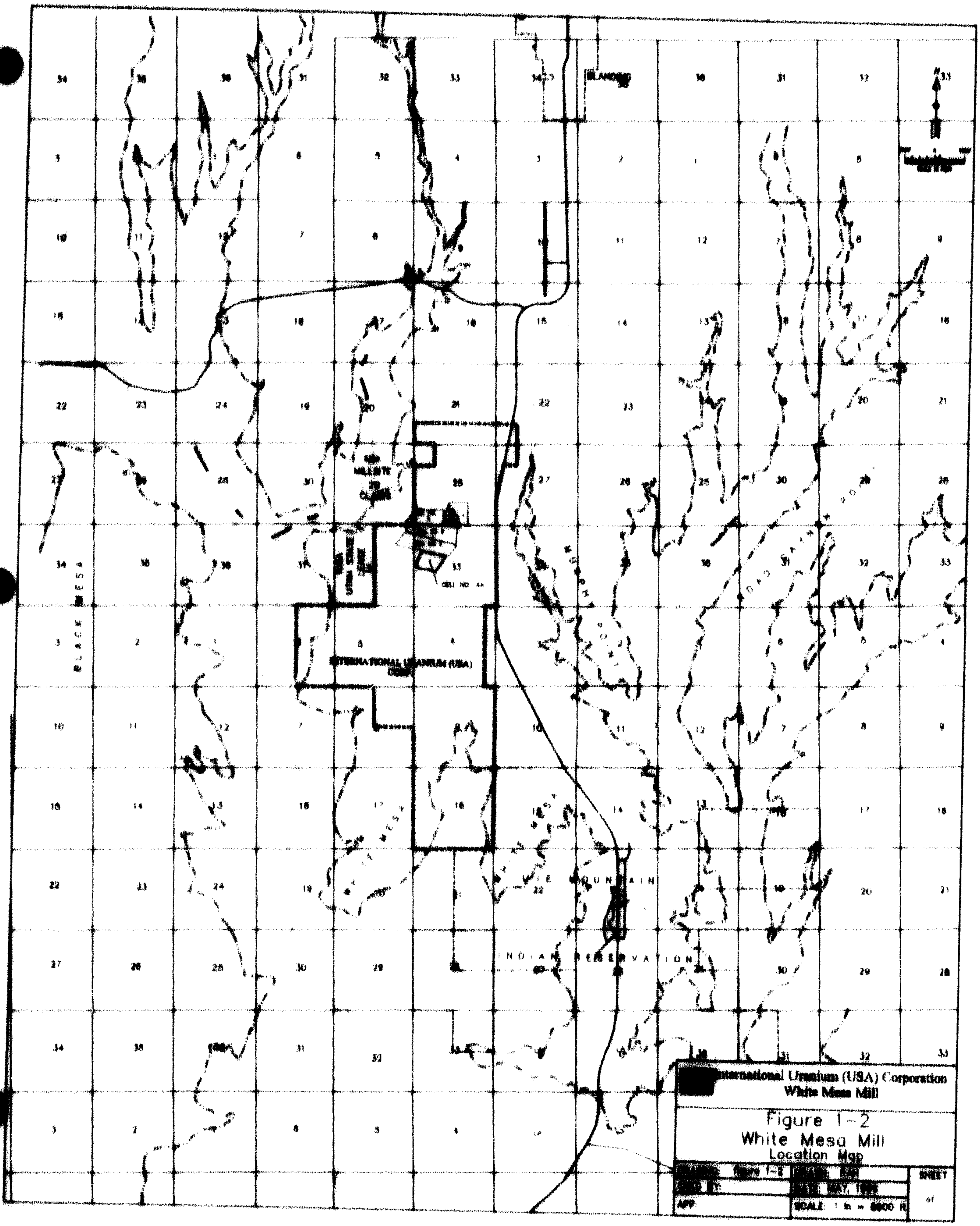
Annual Effluent Report show data from late 1979 or early 1980 to the present. The word "current" is used to describe these data and/or updates. The Hydrogeologic Evaluation of White Mesa Uranium Mill (Titan, 1994) is reproduced in Appendix B. Points of Compliance, White Mesa Mill (Titan, 1994) is reproduced in Appendix C. Tailings Cover Design, White Mesa Mill (Titan, 1996) is reproduced in Appendix D. Appendix E is the most recently completed radon monitoring report. All of these Appendices were previously submitted.



International Uranium (USA) Corporation
White Mesa Mill

FIGURE 1.1
REGIONAL LOCATION MAP

DESIGN	DRAWN RAH	SHEET
CHKD BY	DATE MAY, 1999	
APP	SCALE 1:250,000	



International Uranium (USA) Corporation
White Mesa Mill

Figure 1-2
White Mesa Mill
Location Map

1.1 CLIMATE

Text on climate and associated tables are adapted, with minor revisions, from the Final ES. New table numbers are added to the text below to correspond to sections in this Reclamation Plan, but the original table numbers from the Final ES are cited on the modified tables, for ease of reference.

1.1.1 General Influences (Final ES Section 2.1.1)

Although varying somewhat with elevation and terrain in the vicinity of the site, the climate can generally be described as semiarid. Skies are usually clear with abundant sunshine, precipitation is light, humidity is low, and evaporation is high. Daily ranges in temperature are relatively large, and winds are normally light to moderate. Influences that would result in synoptic meteorological conditions are relatively weak; as a result, topography and local micrometerological effects play an important role in determining climate in the region.

Seasons are well defined in the region. Winters are cold but usually not severe, and summers are warm. The normal mean annual temperature reported for Blanding, Utah, is about 50° F (10° C), as shown in Table 1.1-1 (Table 2.1 in the Final ES). January is usually the coldest month in the region, with a normal mean monthly temperature of about 27° F (-3° C). Temperatures of 0° F (-18° C) or below may occur in about two of every three years, but temperatures below -15° F (-26° C) are rare. July is generally the warmest month, having a normal mean monthly temperature of about 73° F (23° C). Temperatures above 90° F (32° C) are not uncommon in the summer and are reported to occur about 34 days a year; however, temperatures above 100° F (38° C) occur rarely

1.1.2 Precipitation (Final ES Section 2.1.2)

Precipitation in the vicinity of the White Mesa Uranium Project is light (Table 1.1-2) (Final ES Table 2.2). Normal annual precipitation is about 12 inches (30 cm). Most precipitation in the area is rainfall, with about 25 percent of the annual total in the form of snowfall.

There are two separate rainfall seasons in the region. The first occurs in late summer and early autumn when moisture-laden air masses occasionally move in from the Gulf of Mexico, resulting in showers and thunderstorms. The second rainfall period occurs during the winter when Pacific storms frequent the region.

1.1.3 Winds (Final ES Section 2.1.3)

Wind speeds are generally light to moderate at the site during all seasons, with occasional strong winds during late winter and spring frontal activity and during thunderstorms in the summer. Southerly wind directions are reported to prevail throughout the year.

1.1.4 Storms (Final ES Section 2.1.4)

Thunderstorms are frequent during the summer and early fall when moist air moves into the area from the Gulf of Mexico. Related precipitation is usually light, but a heavy local storm can produce over an inch of rain in one day. The maximum 24-hour precipitation reported to have fallen during a 30-year period at Blanding was 1.98 inches (5.02 cm). Hailstorms are uncommon in this area. Although winter storms may occasionally deposit comparable amounts of moisture, maximum short-term precipitation is usually associated with summer thunderstorms.

Tornadoes have been observed in the general region, but they occur infrequently. Strong winds can occur in the area along with thunderstorm activity in the spring and summer. The White Mesa site is susceptible to occasional dust storms, which vary greatly in intensity, duration, and time of occurrence. The basic conditions for blowing dust in the region are created by wide areas of exposed dry topsoil and strong, turbulent winds. Dust storms usually occur following frontal passages during the warmer months and are occasionally associated with thunderstorm activities.

TABLE 1.1-1

Temperature means and extremes at Blanding, Utah[a]

Month	Means						Extremes					
	Daily maximum		Daily minimum		Monthly		Record highest		Year	Record lowest		Year
	°C	°F	°C	°F	°C	°F	°C	°F		°C	°F	
January	3.9	39.1	-9.1	15.6	-2.6	27.4	16	60	1956	-27	-17	1937
February	6.5	43.7	-6.4	20.4	0.1	32.1	19	67	1932	-31	-23	1933
March	11.1	51.9	-3.3	26.1	3.9	39.0	22	72	1934	17	2	1948
April	17.0	62.6	0.9	33.7	8.9	48.1	28	82	1943	12	11	1936
May	22.2	71.9	5.2	41.3	13.7	56.6	33	92	1951	-5	23	1933
June	28.2	82.8	9.6	49.2	18.9	66.0	38	100	1954	-2	28	1947
July	31.7	89.1	13.8	56.9	27.8	73.0	39	103	1931	2	36	1934
August	30.3	86.5	13.1	55.5	21.7	71.0	37	98	1954	6	42	1950
September	26.2	79.3	8.7	47.7	17.6	63.6	35	95	1948	-2	29	1934
October	19.0	66.2	2.7	36.9	10.9	51.6	32	90	1937	-10	14	1935
November	10.4	50.8	-4.4	24.1	3.1	37.5	21	69	1934	-22	-7	1931
December	5.3	41.6	-7.4	18.6	1.1	30.1	16	61	1949	-24	-11	1935
Annual	17.7	63.8	1.9	35.5	9.8	49.7	39	103	July 1931	-31	-23	February 1933

[a]Period of record: 1931-1960 (30 years).

Source: Adapted from U. S. NRC (1979) Final Environmental Statement, Page 2-2, Table 2.1.
Original Source: Plateau Resources, Limited, *Application for Source Material License,* Table 2.2-1, p. 2-6, Apr. 3, 1978.

TABLE 1.1-2

Precipitation means and extremes at Blanding, Utah[a]

	Total						
Month	Mean monthly		Maximum monthly		Greatest daily		Year
	cm	in.	cm	in.	cm	in.	
January	3.04	1.20	10.31	4.06	2.64	1.04	1952
February	2.95	1.16	4.39	1.73	2.62	1.03	1937
March	2.38	0.94	5.00	1.97	2.54	1.00	1937
April	2.18	0.86	5.41	2.13	2.69	1.06	1957
May	1.63	0.64	5.11	2.01	2.39	0.94	1947
June	1.39	0.55	5.51	2.17	3.56	1.40	1938
July	2.13	0.84	7.79	3.07	3.35	1.32	1930
August	3.02	1.19	12.59	4.96	5.03	1.98	1951
September	3.02	1.19	9.60	3.78	3.07	1.21	1933
October	3.51	1.38	16.79	6.61	3.94	1.55	1940
November	1.88	0.74	5.21	2.05	2.41	0.95	1946
December	3.20	1.26	9.29	3.66	3.56	1.40	1931

[a]Period of record: 1931-1960 (30 years).

Source: Adapted from U. S. NRC (1979) Final Environmental Statement, Page 2-2, Table 2.2.
Original Source: Plateau Resources, Limited, *Application for Source Material License*, Table 2.2-2, p. 2-8. Apr 3, 1978.

1.2 TOPOGRAPHY

The following text is reproduced from Section 2.3 of the Final ES.

The site is located on a "peninsula" platform tilted slightly to the south-southeast and surrounded on almost all sides by deep canyons, washes, or river valleys. Only a narrow neck of land connects this platform with high country to the north, forming the foothills of the Abajo Mountains. Even along this neck, relatively deep stream courses intercept overland flow from the higher country. Consequently, this platform (White Mesa) is well protected from runoff flooding, except for that caused by incidental rainfall directly on the mesa itself. The land on the mesa immediately surrounding the White Mesa site is relatively flat.

1.3 ARCHEOLOGICAL RESOURCES

The following discussion of archeological sites is adapted from Section 2.5.2.3 of the Final ES.

1.3.1 Archeological Sites

Archeological surveys of portions of the entire project site were conducted between the fall of 1977 and the spring of 1979. The total area surveyed contained parts of Section 21, 22, 27, 28, 32, and 33 of T37S, R22E, and encompassed 2,000 acres (809 ha), of which 200 acres (81 ha) are administered by the U. S. Bureau of Land Management and 320 acres (130 ha) are owned by the State of Utah. The remaining acreage is privately owned. During the surveys, 121 sites were recorded and all were determined to have an affiliation with the San Juan Anasazi who occupied this area of Utah from 0 A.D. to 1300 A.D. All but 22 of the sites were within the project boundaries.

Table 1.3-1, adapted from Final ES Table 2.18, summarizes the recorded sites according to their probable temporal positions. The dates of occupation are the best estimates available, based on professional experience and expertise in the interpretation of archeological evidence. Available evidence suggests that settlement on White Mesa reached a peak in perhaps 800 A.D. Occupation remained at approximately that level until some time near the end of Pueblo II or in the Pueblo II/Pueblo III transition period. After this period, the population density declined sharply, and it may be assumed that the White Mesa was, for the most part, abandoned by about 1250 A.D.

Archeological test excavations were conducted by the Antiquities Section, Division of State History, in the spring of 1978, on 20 sites located in the area later to be occupied by tailings cells 2, 3 and 4. Of these sites, 12 were deemed by the State Archeologist to have significant National Register potential and four possible significance. The primary determinant of significance in this study was the presence of structures, though storage features and pottery artifacts were also common.

In the fall of 1978, a surface survey was conducted on much of the previously unsurveyed portions of the proposed mill site. Approximately 45 archeological sites were located during this survey, some of which are believed to be of equal or greater significance than the more significant sites form the earlier study. Determination of the actual significance of all untested sites would require additional field investigation.

TABLE 1.3-1

Distribution of Recorded Sites According to Temporal Position

Temporal position	Approximate dates (A.D.)*a*	Number of sites
Basket Maker III	575-750	2
Basket Maker III/Pueblo I	575-850	27
Pueblo I	750-850	12
Pueblo I/Pueblo II	850-950	13
Pueblo II	950-1100	14
Pueblo II/Pueblo III	1100-1150	12
Pueblo III	1150-1250	8
Pueblo II+	*b*	5
Multicomponent	*c*	3
Unidentified	*d*	14

a Includes transitional periods.

b Although collections at these locations were lacking in diagnostic material, available evidence indicates that the site would have been used or occupied no earlier than 900 A.D. and possibly later.

c Ceramic collections from each of these sites indicate an occupation extending from Pueblo I through Pueblo II and into Pueblo III.

d These sites did not produce evidence strong enough to justify any identification.

Source: Adapted from Dames & Moore (1978b) (ER), Table 2.3-2, U. S. NRC (1979) Final Environmental Statement, Page 2-20, Table 2.18, and from supplementary reports on project archeology.

Pursuant to 10 CFR Part 63.3, the NRC submitted on March 28, 1979, a request to the Keeper of the National Register for a determination of eligibility for the area which had been surveyed and tested. The area contained 112 archeological sites and six historical sites. The determination by the Keeper of the National Register on April 6, 1979, was that the White Mesa Archeological District is eligible for inclusion in the National Register.

1.3.2 Current Status of Excavation

Archeological investigations for the entire mill site and for Cells 1-I through Cell 4 were completed with the issuance of four separate reports covering 30 sites, excluding re-investigations. (Lindsay 1978, Nielson 1979, Casjens et al 1980, and Agenbroad et al 1981).

The sites reported as excavated are as follows:

6380	6394	6437
6381	6395	6684
6384	6396	6685
6385	6397	6686
6386	6403	6697
6387	6404	6698
6388	6420	6699
6391	6429	6754
6392	6435	6757
6393	6436	7754

Sites for which excavation has not been required are:

6379	6441	7658	7690
6382	6443	7659	7691
6405	6444	7660	7693

The sites remaining to be excavated are (continued):

6408	6445	7661	7696
6421	6739	7665	7700
6427	6740	7668	7752
6430	7653	7675	7876
6431	7655	7684	8014
6432	7656	7687	
6439	7657	7689	

1.4 SURFACE WATER

The following description of undisturbed surface water conditions is adapted from Section 2.6.1 of the Final ES. Since construction, the mill has been designed to prevent runon or runoff of storm water. No perennial surface water drainages exist on the site. The description of surface water quality in subsection 1.4.2 reflects baseline sampling performed in July 1977 - March 1978. Continuous monitoring of surface water is not possible due to lack of streamflow.

1.4.1 Surface Water Description (Final ES Section 2.6.1.1)

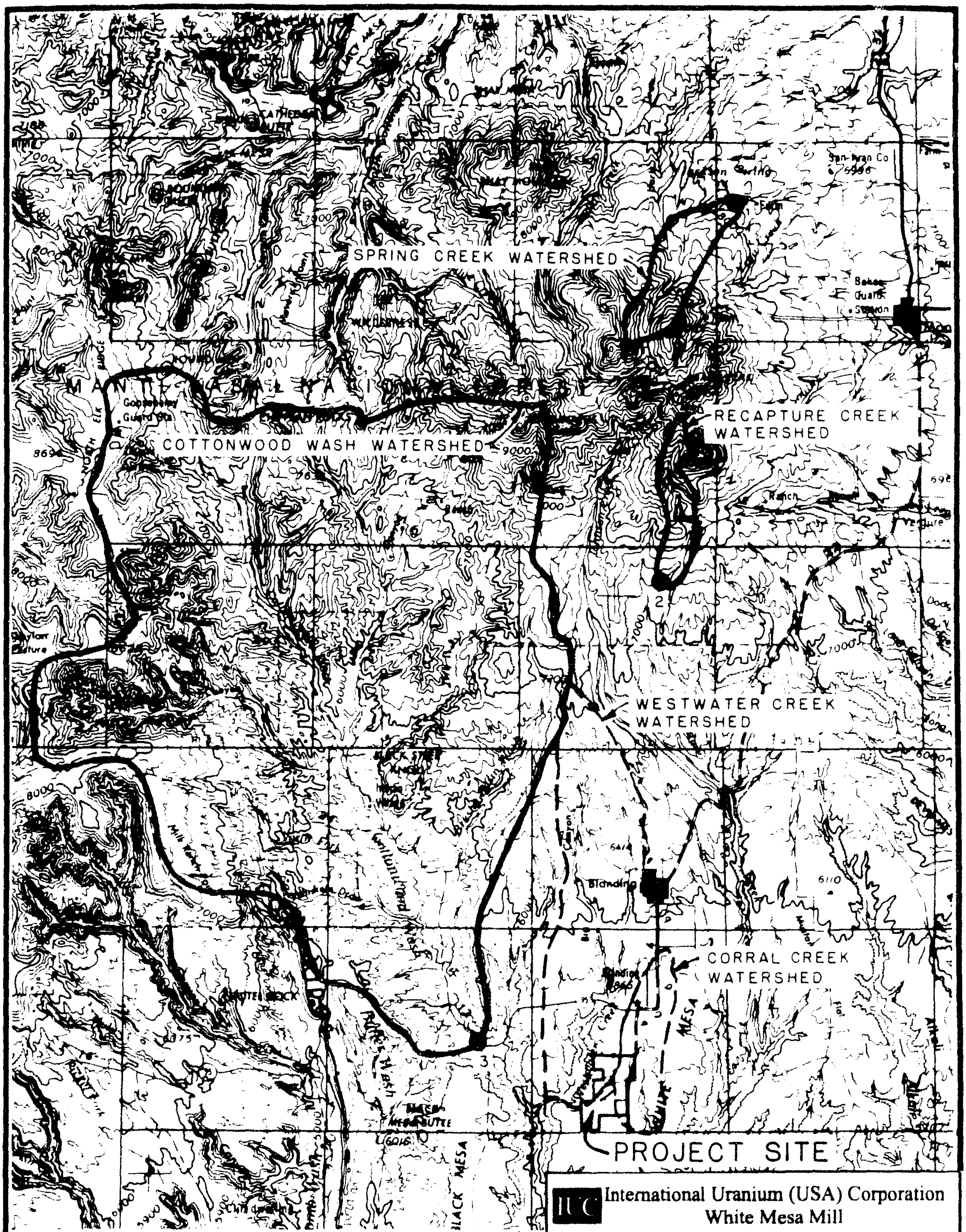
The mill site is located on White Mesa, a gently sloping (1% SSW) plateau that is physically defined by the adjacent drainages which have cut deeply into regional sandstone formations. There is a small drainage area of approximately 62 acres (25 ha) above the site that could yield surface runoff to the site. Runoff from the project area is conducted by the general surface topography to either

Westwater Creek, Corral Creek, or to the south into an unnamed branch of Cottonwood Wash. Local porous soil conditions, topography and low acreage annual rainfall [11.8 inches (30 cm)] cause these streams to be intermittently active, responding to spring snowmelt and local rainstorms (particularly thunderstorms). Surface runoff from approximately 384 acres (155 ha) of the project site drains westward and is collected by Westwater Creek, and runoff from another 384 acres (155 ha) drains east into Corral Creek. The remaining 713 acres (289 ha) of the southern and southwestern portions of the site drain indirectly into Cottonwood Wash (Dames & Moore, 1978b, p. 2-143). The site and vicinity drainages carry water only on an intermittent basis. The major drainages in the project vicinity are depicted in Figure 1.4-1 and their drainages tabulated in Table 1.4-1. Total runoff from the site (total yield per watershed area) is estimated to be less than 0.5 inch (1.3cm) annually (Dames & Moore, 1978b, p. 2-143).

There are no perennial surface waters on or in the vicinity of the project site. This is due to the gentle slope of the mesa on which the site is located, the low average annual rainfall of 11.8 inches (29.7 cm) per year at Blanding (Dames & Moore, 1978b, p. 2-168), local soil characteristics and the porous nature of local stream channels. Prior to construction, three small ephemeral catch basins were present on the site to the northwest and northeast of the scale house.

Corral Creek is an intermittent tributary to Recapture Creek. The drainage area of that portion of Corral Creek above and including drainage from the eastern portion of the site is about 5 square miles (13 km^2). Westwater Creek is also an intermittent tributary of Cottonwood Wash. The Westwater Creek drainage basin covers nearly 27 square miles (70 km^2) at its confluence with Cottonwood Wash 1.5 miles (2.5 km) west of the project site. Both Recapture Creek and Cottonwood Wash are similarly intermittently active, although they carry water more often and for longer periods of time due to their larger watershed areas. They both drain to the south and are

tributaries of the San Juan River. The confluences of Recapture Creek and Cottonwood Wash with the San Juan River are approximately 18 miles (29 km) south of the project site. The San Juan River, a major tributary for the upper Colorado River, has a drainage of 23,000 square miles (60,000 km^2) measured at the USGS gauge to the west of Bluff, Utah (Dames & Moore, 1978b, p. 2-130).



IUC International Uranium (USA) Corporation
White Mesa Mill

FIGURE 1.4-1
Drainage Map of the Vicinity of the White Mesa Mill

●[1] USGS GAUGE NO. 09376900
●[2] USGS GAUGE NO. 09378630
●[3] USGS GAUGE NO. 09378700

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TABLE 1.4-1

Drainage Areas of Project Vicinity and Region

Basin description	Drainage area	
	km^2	sq. miles
Corral Creek at confluence with Recapture Creek	15.0	5.8
Westwater Creek at confluence with Cottonwood Wash	68.8	26.6
Cottonwood Wash at USGS gage west of project site	<531	<205
Cottonwood Wash at confluence with San Juan River	<860	<332
Recapture Creek at USGS gage	9.8	3.8
Recapture Creek at confluence with San Juan River	<518	<200
San Juan River at USGS gage downstream at Bluff, Utah	<60,000	<23,000

Source: Adapted from Dames & Moore (1978b), Table 2.6-3

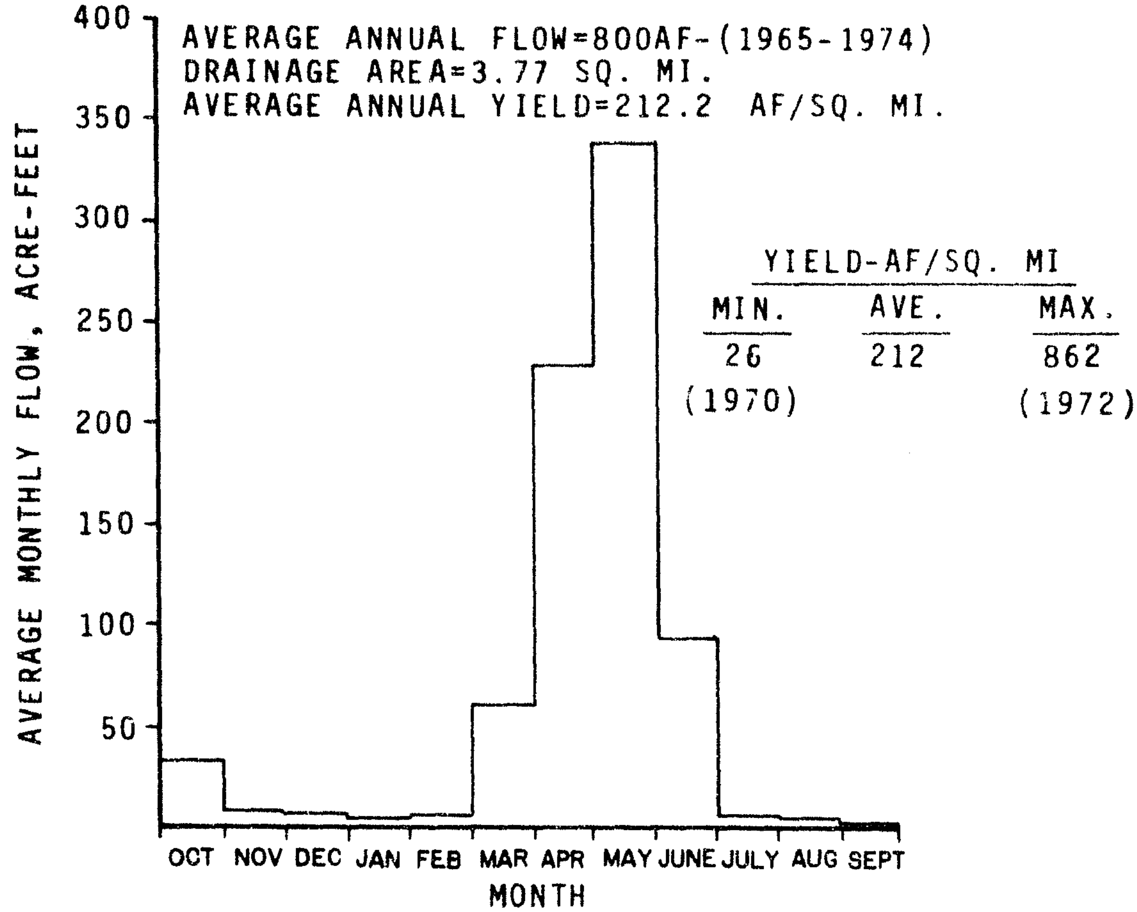
Storm runoff in these streams is characterized by a rapid rise in the flow rates, followed by rapid recession primarily due to the small storage capacity of the surface soils in the area. For example, on August 1, 1968, a flow of 20,500 cfs (581 m^3/sec) was recorded in Cottonwood Wash near Blanding. The average flow for that day, however, was only 4,340 cfs (123 m^3/sec). By August 4, the flow had returned to 16 cfs (0.5 m^3/sec) (Dames & Moore, 1978b, p. 2-135). Monthly streamflow summaries are presented in Figure 1.4-2 for Cottonwood Wash and Recapture Creek. Flow data are not available for the two smaller water courses closest to the project site, Corral Creek and Westwater Creek, because these streams carry water infrequently and only in response to local heavy rainfall and snowmelt, which occurs primarily in the months of April, August, and October. Flow typically ceases in Corral and Westwater Creeks within 6 to 48 hours after precipitation or snowmelt ends.

1.4.2 Surface Water Quality (Final ES Section 2.6.1.2)

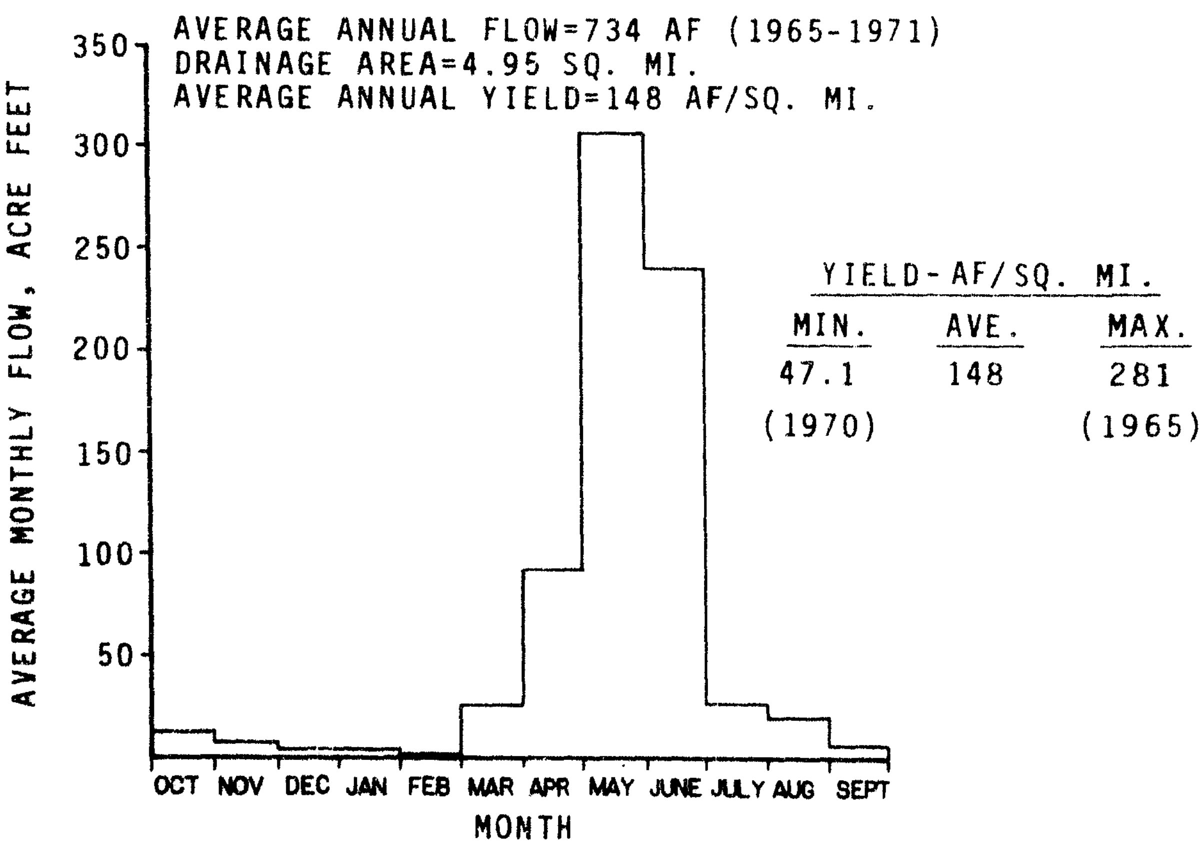
Sampling of surface water quality in the project vicinity began in July 1977 and continued through March 1978. Baseline data describe and evaluate existing conditions at the project site and vicinity. Sampling of the temporary on-site surface waters (two catch basins) has been attempted but without success because of the lack of naturally occurring water in these basins. The basin to the northeast of the mill site has been filled with well water to serve as a nonpotable water source during construction of office and laboratory buildings in conjunction with the mill (approximately six months). This water has not been sampled but presumably reflects the poor quality associated with local groundwater. Sampling of ephemeral surface waters in the vicinity was possible only during major precipitation events, as these streams are normally dry at other times.

The locations of the surface water sample sites are presented in Figure 1.4-3. The water quality values obtained for these sample sites are given in Dames & Moore (1978b) Table 2.6-7, and U.S. NRC (1979) Table 2.22. Water quality samples were collected during the spring at several intermittently active streams that drain the project area. These streams include Westwater Creek (S1R, S9) Corral Creek below the small irrigation pond (S3R), the junction of Corral Creek and Recapture Creek (S4R), and Cottonwood Creek (S8R). Samples were also taken from a surface pond southeast of the mill (S5R). No samples were taken at S2R on Corral Creek or at the small wash (S6R) located south of the site.

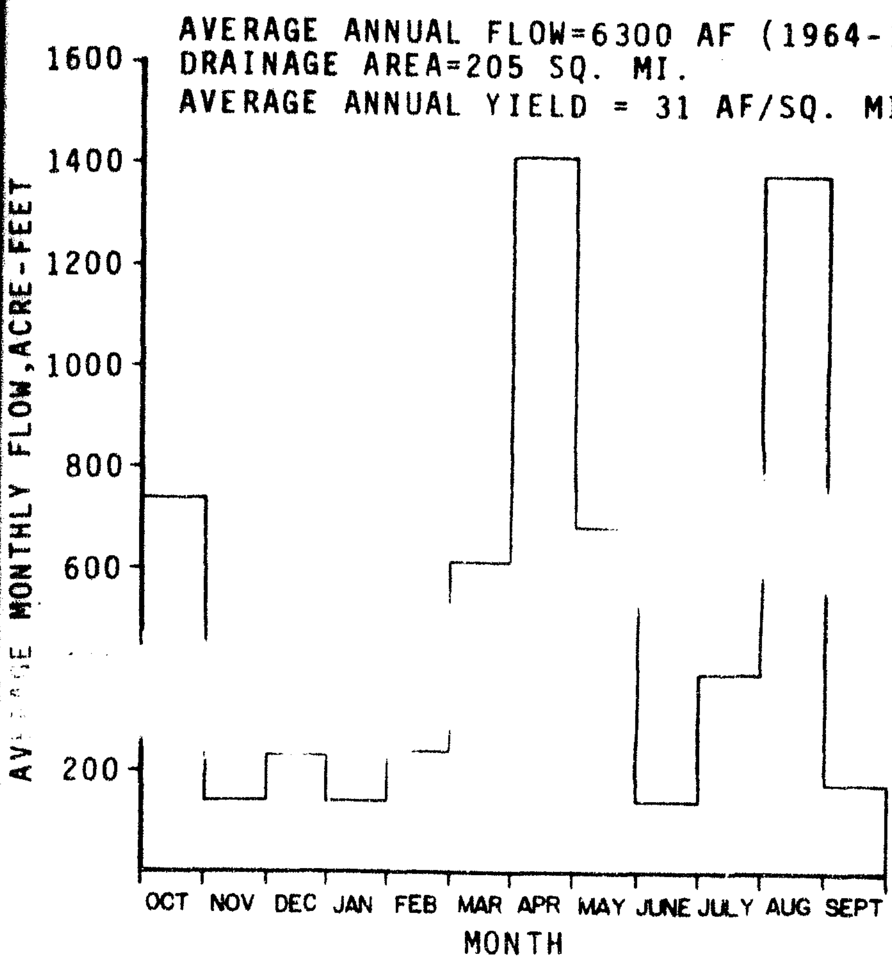
Surface water quality in the vicinity of the mill is generally poor. Waters in Westwater Creek (S1R and S9) were characterized by high total dissolved solids (TDS; mean of 674 mg/liter) and sulfate levels (mean 117 mg of SO_4 per liter). The waters were typically hard (total hardness measured as $CaCO_3$; mean 223 mg/liter) and had an average pH of 8.25. Estimated water velocities for Westwater Creek averaged 0.3 fps (0.08 m/sec) at the time of sampling.



RECAPTURE CREEK NEAR BLANDING
USGS GAUGE 09378630



SPRING CREEK ABOVE DIVERSIONS,
NEAR MONTICELLO
USGS GAUGE 09376900



COTTONWOOD WASH NEAR BLANDING
USGS GAUGE 09378700

YIELD-AF/SQ. MI.		
MIN.	AVE.	MAX.
6.7 (1969)	31	100 (1972)

NOTES

1. FOR THE LOCATION OF WATERCOURCES SUMMARIZED, SEE PLATE
2. SOURCE OF DATA. WATER RESOURCES DATA RECORDS. COMPILED AND PUBLISHED BY USGS

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International Uranium (USA) Corporation White Mesa Mill		
FIGURE 1.4-2 Stream Flow Summary in the Vacinity of Blanding, Utah		
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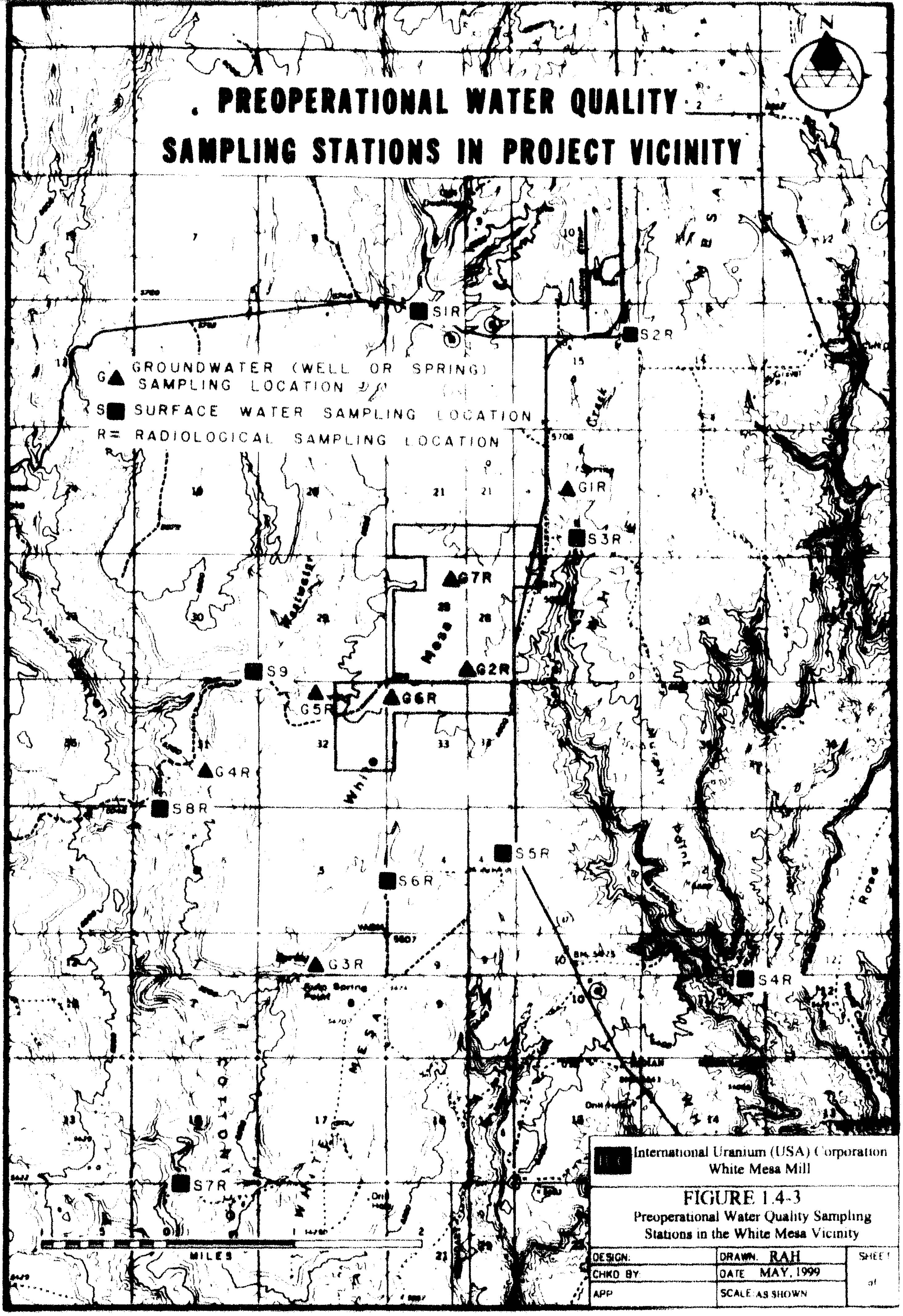

International Uranium (USA) Corporation
White Mesa Mill

FIGURE 1.4-3
Preoperational Water Quality Sampling Stations in the White Mesa Vicinity

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Samples from Cottonwood Creek (S8R) were similar in quality to Westwater Creek water samples, although the TDS and sulfate levels were lower (TDS averaged 264 mg/liter; SO_4 averaged 40 mg/liter) during heavy spring flow conditions [80 fps (24 m/sec) water velocity].

The concentrations of TDS increased downstream in Corral Creek, averaging 3,180 mg/liter at S3R and 6,660 mg/liter (one sample) at S4R. Total hardness averaged in excess of 2,000 mg/liter, and pH values were slightly alkaline. Estimated water velocities in Corral Creek were typically less than 0.1 fps (0.03 m/sec) during sampling.

The spring sample collected a the surface pond south of the project site (S5R) indicated a TDS concentration of less than 300 mg/liter. The water was slightly alkaline with moderate dissolved sulfate levels averaging 42 mg/liter.

During heavy runoff, the concentration of total suspended solids in these streams increased sharply to values in excess of 1,500 mg/liter (U.S. NRC 1979, Table 2.22). High concentrations of certain trace elements were measured in some sampling areas. Levels of mercury (total) were reported as high as 0.002 mg/liter (S3R, 7/25/77; S8R, 7/25/77). Total iron measured in the pond (S5R, 11/10/77) was 9.4 mg/liter. These values appear to reflect groundwater quality in the vicinity and are probably due to evaporative concentration and not due to human perturbation of the environment.

1.5 GROUNDWATER

The following descriptions of groundwater occurrence and characteristics in and around the White Mesa Mill is a summary and compilation of information contained in documents previously submitted to and reviewed by the U.S. NRC. These include the Final ES, the Hydrogeologic

Evaluation of White Mesa Uranium Mill ("Hydrogeologic Evaluation") (Titan, 1994a), Points of Compliance, White Mesa Uranium Mill ("POC") (Titan, 1994b), the Semi-Annual Effluent Report's through December 1998.

The Hydrogeologic Evaluation referenced numerous technical studies: Regional geologic and geohydrologic data were obtained primarily from U.S. Geologic Survey (U.S.G.S.) and State of Utah publications; Site-specific information was obtained from the 1978 Environmental Report (Dames & Moore); a 1992 groundwater study report submitted to the NRC by Umetco; a 1991 groundwater hydrology report on White Mesa prepared by Hydro-Engineering; and reports by D'Appolonia (1981, 1982, and 1984). See the Hydrogeologic Evaluation, transmitted herewith in its entirety as Appendix B, for complete data tables, lists of references, and technical details described in this section.

This section is primarily an adaptation of the Hydrogeologic Evaluation. For ease of reference, a copy of the Hydrogeologic Evaluation is included as Appendix B previously submitted to the NRC. The POC is included as Appendix C also previously submitted. The Hydrogeologic Evaluation focused on description and definition of the site hydrostratigraphy, and occurrence of groundwater as it relates to the natural and manmade safeguards which protect groundwater resources from potential leakage of tailings cells at the site. The POC summarized and statistically analyzed the available groundwater database, and proposed a revised groundwater monitoring and data review program.

The findings of the Hydrogeologic Evaluation indicated that the tailings located in the existing disposal cells are not impacting groundwater at the site. In addition, it does not appear that future impacts to groundwater would be expected as a result of continuing operations.

These conclusions are based on chemical and hydrogeologic data which show that:

1. The chemistry of perched groundwater encountered below the site does not show concentrations or increasing trends in concentrations of constituents that would indicate seepage from the existing disposal cells;

2. The useable aquifer at the site is separated from the facility by about 1,200 feet of unsaturated, low-permeability rock,

3. The useable aquifer is under artesian pressure and, therefore, has an upward pressure gradient which would preclude downward migration of constituents into the aquifer; and

4. The facility has operated for a period of 19 years and has caused no discernible impacts to groundwater during this period.

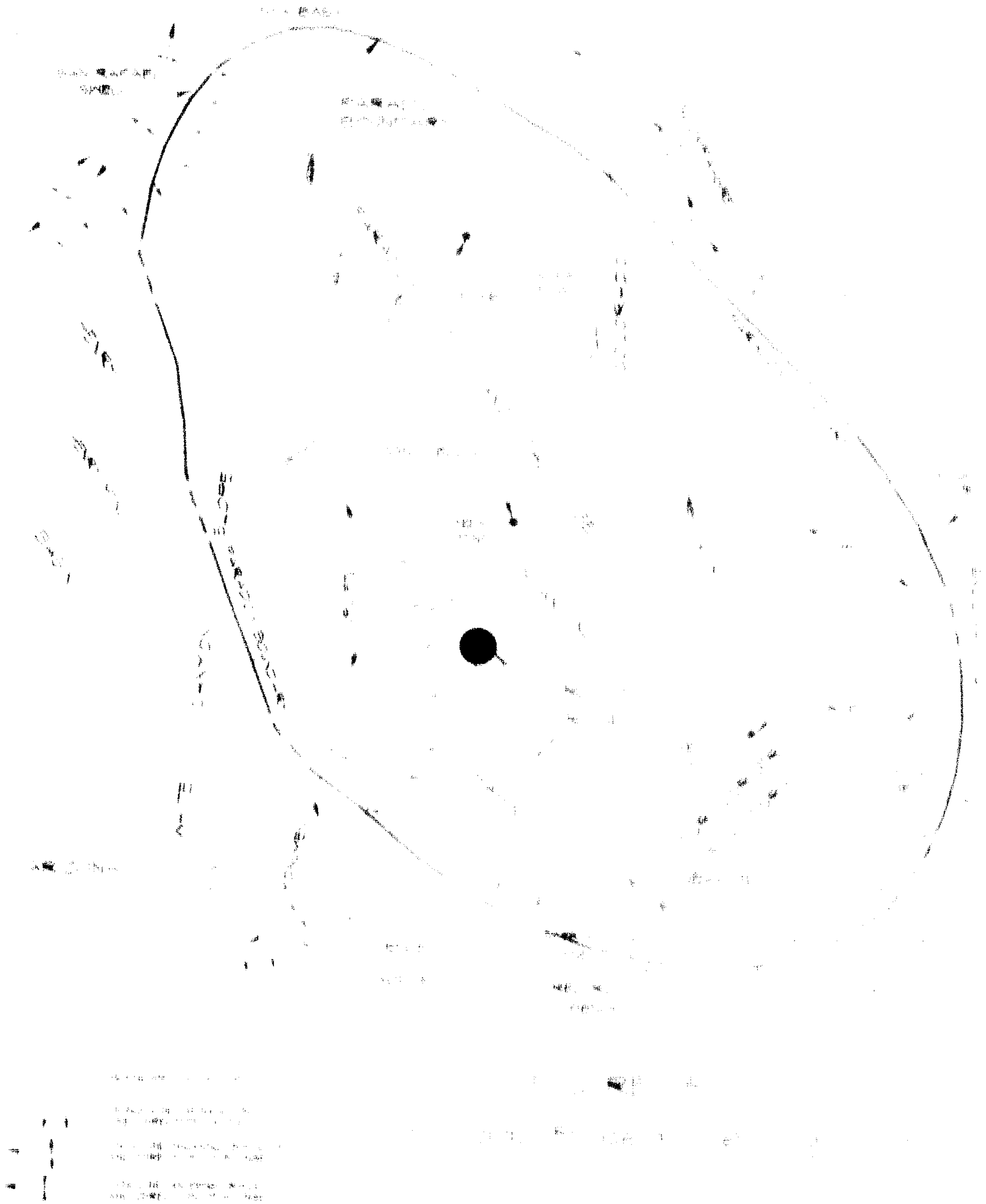
Continued monitoring of groundwater at the site are performed to verify that past, current, and future operations will not impact groundwater. The existing monitoring program and results are presented in the Semi-annual Effluent reports which are regularly submitted to the NRC

1.5.1 Site Description

As shown on Figure 1.1-2, White Mesa Uranium Mill is located in southeastern Utah, approximately six miles south of the town of Blanding. It is situated on White Mesa, a flat area bounded on the east by Corral Canyon, to the west by Westwater Creek, and to the south by Cottonwood Canyon. The site consists of the uranium processing mill, and four engineered lined tailings disposal cells.

1.5.2 Geologic Setting

The White Mesa Uranium Mill site is located near the western edge of the Blanding Basin within the Canyon Lands section of the Colorado Plateau physiographic province (Figure 1.5-1, Hydrogeologic Evaluation Figure 1.1). The Canyon Lands have undergone broad, fairly horizontal uplift and subsequent erosion which have produced the region's characteristic topography represented by high plateaus, mesas, buttes and deep canyons incised into relatively flat lying sedimentary rocks of pre-Tertiary age. Elevations range from approximately 3,000 feet in the bottoms of the deep canyons along the southwestern margins of the region to more than 11,000 feet in the Henry, Abajo and La Sal mountains located to the northwest and northeast of the facility. With the exception of the deep canyons and isolated mountain peaks, an average elevation slightly in excess of 5,000 feet persists over most of the Canyon Lands. The average elevation at the White Mesa Uranium Mill is 5,600 feet mean sea level (MSL).



1.5.2.1 Stratigraphy

Rocks of Upper Jurassic and Cretaceous age are exposed in the canyon walls in the vicinity of the White Mesa Uranium Mill site. These rock units (Figure 1.5-2, Hydrogeologic Evaluation Figure [illegible]) include, in descending order, the following: Eolian sand of Quaternary Age and varying thickness overlies the Dakota sandstone and Mancos shale on the mesa. A thin deposit of talus derived from rock falls of Dakota sandstone and Burro Canyon formation mantle the lower valley flanks. Underlying these units are the Cretaceous Age erosional remnants of Mancos shale, Dakota Sandstone and Burro Canyon formation. Erosional remnants of Mancos shale are only found north of the Mill site. The Brushy Basin, Westwater Canyon, Recapture and Salt Wash Members of the upper Jurassic Age Morrison formation are encountered below the Burro Canyon formation. The Summerville formation, Entrada Sandstone and Navajo Sandstone are the deepest units of concern encountered at the site.

1.5.2.[illegible] Local Geologic Structure

In general, the rock formations of the region are flat-lying with dips of [illegible] to [illegible] degrees. The rock formations are incised by streams that have formed canyons between intervening areas of broad mesas and buttes. An intricate system of deep canyons along and across hog backs and cuestas has resulted from faulting, upwarping and dislocation of rocks around the intrusive rock masses, such as the Abajo Mountains. Thus the region is divided up into numerous hydrological areas controlled by structural features.

The strata underlying White Mesa have a regional dip of 1/2 to 1 degrees to the south; however, local dips of 5 degrees have been measured. Haynes, et al (1972) includes a map showing the structure at the base of the Dakota formation. Approximately 25 miles to the north, the Abajo Mountains, formed by igneous intrusions, have caused local faulting, upwarping, and displacement of the sedimentary section. However, no faults have been mapped in the immediate vicinity of White Mesa.

1.5.3 Hydrogeologic Setting

On a regional basis, the formations that are recognized as aquifers are: Cretaceous-age Dakota Sandstone and the upper part of the Morrison formation of late Jurassic age, the Entrada Sandstone, and the Navajo Sandstone of Jurassic age; the Wingate Sandstone and the Shinarump Member of the Chinle formation of Triassic age; and the DeChelle Member of the Cutler formation of Permian age.

Recharge to aquifers in the region occurs by infiltration of precipitation into the aquifers along the flanks of the Abajo, Henry and La Sal Mountains and along the flanks of folds, such as Comb Ridge Monocline and the San Rafael Swell, where the permeable formations are exposed at the surface (Figure 1.5-1, Hydrogeologic Evaluation Figure 1.1).

Seventy-six groundwater appropriation applications, within a five-mile radius of the Mill site, are on file with the Utah State Engineer's office. A summary of the applications is presented in Table 1.5-1 and shown on Figure 1.5-3. The majority of the applications is by private individuals and for wells drawing small, intermittent quantities of water, less than eight gpm, from the Burro Canyon formation. For the most part, these wells are located upgradient (north) of the White Mesa Uranium

Mill site. Stockwatering and irrigation are listed as primary uses of the majority of the wells. It is important to note that no wells completed in the perched groundwater of the Burro Canyon formation exist directly downgradient of the site within the five-mile radius. Two water wells which available data indicate are completed in the Entrada/Navajo sandstone (Clow, 1997), exist approximately 4.5 miles southeast of the site on the Ute Mountain Ute Reservation. These wells supply domestic water for the Ute Mountain Ute White Mesa Community, situated on the mesa along Highway 191 (see Figure 1.5-3). Data supplied by the Tribal Environmental Programs Office indicate that both wells are completed in the Entrada/Navajo sandstone, which is approximately 1,200 feet below the ground surface. Insufficient data are available to define the groundwater flow direction in the Entrada/Navajo sandstone in the vicinity of the mill.

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Table 1.5-1
Wells Located Within A 5-Mile Radius of
The White Mesa Uranium Mill

Map No.	Water Right	SEC	TWP	RNG	CFS	USE	Depth (ft.)
1	Nielson, Norman and Richard C.	11	37S	22E	0.015	IDS	150-200
2	Guymon, Willard M.	10	37S	22E	0.015	S	82
3	Nielson, J. Rex	10	37S	22E	0.015	IDS	160
4	Nielson, J. Rex	10	37S	22E	0.013	S	165
5	Lyman, Fred S.	10	37S	22E	0.022	IDS	120
6	Plateau Resources	15	37S	22E	0.015	O	740
7	Plateau Resources	15	37S	22E	0.015	O	135
8	Nielson, Norman and Richard C.	14	37S	22E	0.015	IS	150-200
9	Lyman, George F.	15	37S	22E	0.015	S	135
10	Holt, N.E., McLaws, W.	15	37S	22E	0.007	S	195
11	Perkins, Dorothy	21	37S	22E	0.015	S	150
12	Energy Fuels Nuclear, Inc.	21	37S	22E	0.6	O	1600
13	Energy Fuels Nuclear, Inc.	22	37S	22E	1.11	O	1820
14	Utah Launch Complex	27	37S	22E	0.015	D	650
15	Energy Fuels Nuclear, Inc.	28	37S	22E	1.11	O	1885
16	Energy Fuels Nuclear, Inc.	28	37S	22E	1.11	O	1850
17	Energy Fuels Nuclear, Inc.	28	37S	22E	0.015	DSO	1800
18	Energy Fuels Nuclear, Inc.	28	37S	22E	0.6	O	1600
19	Jones, Alma U.	33	37S	22E	0.015	S	200
20	Energy Fuels Nuclear, Inc.	33	37S	22E	0.6	O	1600
21	BLM	8	37S	22E	0.01	S	170
22	Halliday, Fred L.	11	37S	22E	0.015	IS	180
23	Perking, Paul	2	37S	22E	0.015	ID	180
24	Redd, James D.	2	37S	22E	0.1	ID	200
25	Brown, Aroe G.	1	37S	22E	0.015	IS	210
26	Brown, George	1	37S	22E	0.015	IDS	140

Table 1.5-1
Wells Located Within A 5-Mile Radius of
The White Mesa Uranium Mill
(continued)

Map No.	Water Right	SEC	TWP	RNG	CFS	USE	Depth (ft.)
27	Brown, Llo M.	1	37S	22E	0.004	IDS	141
28	Rentz, Alyce M.	1	37S	22E	0.015	ID	180
29	Rogers, Clarence	2	37S	22E	0.015	S	142
30	Perkins, Dorothy	2	37S	22E	0.015	S	100-200
31	Brandt J.R. & C.J.	1	37S	22E	0.015	IDS	160
32	Montella, Frank A.	3	37S	22E	0.015	IDO	190
33	Snyder, Bertha	1	37S	22E	0.1	IDS	196
34	Martineau, Stanley D.	1	37S	22E	0.015	ID	160
35	Kirk, Ronald D. & Catherine A.	1	37S	22E	0.015	IDS	160
36	Palmer, Ned J. and Marilyn	1	37S	22E	0.015	IDS	0
37	Grover, Jess M.	1	37S	22E	0.015	S	160
38	Monson, Larry	1	37S	22E	0.015	IDS	140
39	Neilson, Norman and Richard	1	37S	22E	0.015	IS	132
40	Watkins, Henry Clyde	1	37S	22E	0.015	IS	150
41	Shumway, Glen & Eve	15	37S	22E	0.015	IS	60
42	Energy Fuels Nuclear, Inc. (not drilled)	21	37S	22E	0.600	O	1600
43	Energy Fuels Nuclear, Inc. (#1)	28	37S	22E	1.100	O	1860
44	Watkins, Ivan R.	1	37S	22E	0.200	S	185
45	Waukesha of Utah	3	37S	22E	0.015	D	226
46	Simpson, William	3	37S	22E	0.030	ID	180
47	Guyman, Willard M.	2	37S	22E	0.030	S	164
48	Harrieson, Lynda	2	37S	22E	0.012	IDS	---
49	Hurst, Reed	2	37S	22E	0.015	D	100-300
50	Kaer, Alvin	2	37S	22E	0.015	IDS	100-300
51	Heiner, Gerald B.	2	37S	22E	0.015	ID	75
52	Laws, James A.	2	37S	22E	0.015	IDS	100-300

Table 1.5-1
Wells Located Within A 5-Mile Radius of
The White Mesa Uranium Mill
(continued)

Map No.	Water Right	SEC	TWP	RNG	CFS	USE	Depth (ft.)
53	Laws, J. Parley	2	37S	22E	0.015	IDS	
54	Anderson, Dennis & Edith	2	37S	22E	0.015	IDS	160
55	Guymon, Eugene	2	37S	22E	0.100	IDS	130
56	Guymon, Eugene	2	37S	22E	0.015	S	130
57	Guymon, Dennis & Doris	2	37S	22E	0.030	IDS	210
58	Guymon, Eugene	2	37S	22E	0.115	IDS	100-200
59	Guymon, Eugene	2	37S	22E	0.115	IDS	100-200
60	Perkins, Dorothy	2	37S	22E	0.015	IDS	140
61	Watkins, Ivan R.	1	37S	22E	0.015	IDS	145
62	Roper, Lloyd	34	36S	22E	0.015	ID	180
63	Smith, Lee & Marylynn	34	36S	22E	0.060	IDS	170
64	McDonald, Kenneth P.	34	36S	22E	0.015	IDS	734
65	Brake, John	34	36S	22E	0.015	ID	250
66	Brake, John	34	36S	22E	0.015	IS	150
67	Redd, Parley V. & Reva V.	34	36S	22E	0.015	IS	200
68	C & C Construction	34	26S	22E	0.015	IS	190
69	Guymon, Dean W.	3	37S	22E	0.015	IDS	180
70	Phillips, Elizabeth Ann Hurst	34	36S	22E	0.015	I	165
71	Howe, Leonard R.	3	37S	22E	0.015	O	160
72	Shumway, Mark Eugene	3	37S	22E	0.015	ID	
73	Shumway, Mark Eugene	3	37S	22E	0.015	IDS	150
74	Lyman, Henry M.	3	37S	22E	0.100	IDS	200
75	Uta Mountain Ute	23	38S	22E	0.535	D	-
76	Ute Mountain Ute	23	38S	22E	0.1606	D	1515

Notes:

D - Domestic
I - Irrigation
S - Stockwatering
O - Industrial
SEC - Section
TWP - Township
RNG - Range
CFS - Cubic Feet Per Second

The well yield from wells completed in the Burro Canyon formation within the White Mesa site is generally lower than that obtained from wells in this formation upgradient of the site. For the most part, the documented pumping rates from on-site wells completed in the Burro Canyon formation are less than 0.5 gpm. Even at this low rate, the on-site wells completed in the Burro Canyon formation are typically pumped dry within a couple of hours.

This low productivity suggests that the White Mesa Uranium Mill is located over a peripheral fringe of perched water; with saturated thickness in the perched zone discontinuous and generally decreasing beneath the site, and with conductivity of the formation being very low. These observations have been verified by studies performed for the U.S. Department of Energy's disposal site at Slick Rock, which noted that the Dakota Sandstone, Burro Canyon formation, and upper claystone of the Brushy Basin Member are not considered aquifers due to the low permeability, discontinuous nature, and limited thickness of these units (U.S. DOE, 1993).

1.5.3.1 Hydrostratigraphy

The site stratigraphy is described above in Section 1.5.2.1. The detailed site stratigraphic column with descriptions of each geologic unit is provided on Figure 1.5-2. The following discussion, adapted from the Hydrogeologic Evaluation, focuses on those geologic units at or in the vicinity of the site which have or may have groundwater present.

The presence of groundwater within and in proximity to the site has been documented in three strata: the Dakota Sandstone, the Burro Canyon formation, and the Entrada/Navajo Sandstone. The Burro Canyon formation hosts perched groundwater over the Brushy Basin Member of the Morrison formation at the site.

The Entrada/Navajo Sandstones form one of the most permeable aquifers in the region. This aquifer is separated from the Burro Canyon formation by the Morrison formation and Summerville formation. Water in this aquifer is under artesian pressure and is used by the site's operator for industrial needs and consumption. The artesian conditions present in this aquifer are discussed in Section 1.5.6.4.

Geologic cross sections which illustrate the stratigraphic position of the Entrada/Navajo Sandstone aquifer and intervening strata are shown on Figures 1.5.3-1, 1.5.3-2, and 1.5.3-3 (from Hydrogeologic Evaluation Figures 2.1, 2.2, and 2.3, respectively). The summary of the borehole information supporting the site's stratigraphy, description of the drilling information and boring logs are presented in Appendix A of the Hydrogeologic Evaluation. With the exception of six deep water supply wells installed at various locations around the site and completed in Entrada/Navajo Sandstone, all of the boring data are from wells drilled through the Dakota/Burro Canyon Sandstones and terminated in the Brushy Basin Member. The drilling and logging data indicate that the physical characteristics of the bedrock vary considerably, both vertically and laterally. The following sections discuss the relevance of those strata and their physical characteristics to the site's hydrogeology.

Dakota Sandstone

The Dakota Sandstone is a low- to moderately-permeable formation that produces acceptable quality water at low production rates. Water from this formation is typically used for stock water and/or irrigation.

The Dakota Sandstone is the uppermost stratum in which the tailings disposal cells are sited. At the ground surface, the Dakota Sandstone is overlain by a veneer of reddish-brown clayey or sandy silts

with a thickness of up to 10 feet and extends to depths of 43 to 66 feet below the surface (D'Appolonia, 1982). The Dakota Sandstone at this site is typically composed of moderately hard to hard sandstones with random discontinuous shale (claystone) and siltstone layers. The sandstones are moderately cemented (upper part of formation) to well cemented with kaolinitic clays. The claystones and siltstones are typically 2 to 3 feet thick, although boring WMMW-19 encountered a siltstone layer having a thickness of 8 feet at 33 to 41 feet below the ground surface.

Porosity of the Dakota Sandstone is predominately intergranular. Laboratory tests performed (see Table 1.5.3.1-1, from Hydrogeologic Evaluation Table 2.1) show the total porosity of the sandstone varies from 13.4 to 26.0 percent with an average value of 19.9 percent. The formation is very dry to dry with volumetric water contents varying from 0.6 to 7.1 percent with an average value of 3.0 percent. Saturation values for the Dakota Sandstone vary from 3.7 to 27.2 percent. The hydraulic conductivity values as determined from packer tests range from 9.12E-04 centimeters per second (cm/sec) to 2.71E-06 cm/sec with a geometric mean of 3.89E-05 cm/sec (Dames & Moore, 1978; Umetco, 1992). A summary of hydraulic properties of the Dakota Sandstone is presented in Table 1.5.3.1-2 (Hydrogeologic Evaluation Table 2.2).

Table 1.5.3.1-1
Properties of the Dakota/Burro Canyon Formation
White Mesa Uranium Mill

Formation	Well No. and Sample Interval		Moisture Content (Percent)	Mosture Content Volumetric	Dry Unit Weight (lbs/cu ft)	Porosity (Percent)	Particle Sp. Gr.	Saturation (Percent)	Retained Moisture (Percent)	Liquid Limit (Percent)	Plastic Limit (Percent)	Plasticity Index (Percent)	Rock Type
Dakota	WMMW-16	26.4' - 38.4'	1.5	3.3	135.2	17.9	2.64	18.2	5.1				Sandstone
	WMMW-16	37.8' - 38.4'	0.4	0.8	127.4	22.4	2.63	3.7	6.3				Sandstone
	WMMW-17	27.0' - 27.5'	0.3	0.6	138.8	13.4	2.57	4.8	5.1				Sandstone
	WMMW-17	49.0' - 49.5'	3.6	7.1	121.9	26.0	2.64	27.2	9.6				Sandstone
Burro Canyon	WMMW-16	45.0' - 45.5'	5.6	12.6	140.9	16.4	2.70	77.2		29.6	15.4	14.2	Sandy Mudstone
	WMMW-16	47.5' - 48.0'	2.6	5.9	142.8	12.0	2.60	48.9	4.4				Sandstone
	WMMW-16	53.5' - 54.1'	0.7	1.4	129.0	19.9	2.58	7.1	6.4				Sandstone
	WMMW-16	60.5' - 61.0'	0.1	0.2	117.9	27.3	2.61	0.8	9.9				Sandstone
	WMMW-16	65.5' - 66.0'	2.6	5.5	131.5	19.3	2.62	28.2	7.1				Sandstone
	WMMW-16	73.0' - 73.5'	0.1	0.3	130.3	20.6	2.63	1.3	5.5				Sandstone
	WMMW-16	82.0' - 82.4'	0.1	0.1	134.3	18.5	2.64	0.6	4.8				Sandstone
	WMMW-16	90.0' - 90.7'	0.1	0.3	161.5	2.0	2.64	12.8	0.9				Sandstone
	WMMW-16	91.1' - 91.4'	5.2	9.8	118.1	29.1	2.67	33.8		33.7	16.2	17.5	Claystone
	WMMW-17	104.0' - 104.5'	0.2	0.4	161.4	1.7	2.67	26.6	0.8				Sandstone
Average:			**1.65**	**3.4**	**135**	**17.6**	**2.63**	**21**	**5.5**				

Adapted from: Table 2.1, Hydrogeologic Evaluation.

Table 1.5.3.1-2
Summary of Hydraulic Properties
White Mesa Mill

Boring/Well Location	Test Type	Interval (ft. - ft.)	Document Referenced		Hydraulic Conductivity (ft./yr.)	Hydraulic Conductivity (cm./sec.)
Soils						
6	Laboratory Test	9	D&M		1.2E+01	1.2E-05
7	Laboratory Test	4.5	D&M		1.0E+01	1.0E-05
10	Laboratory Test	4	D&M		1.2E+01	1.2E-05
12	Laboratory Test	9	D&M		1.4E+02	1.4E-04
16	Laboratory Test	4.5	D&M		2.2E+01	2.1E-05
17	Laboratory Test	4.5	D&M		9.3E+01	9.0E-05
19	Laboratory Test	4	D&M		7.0E+01	6.8E-05
22	Laboratory Test	4	D&M		3.9E+00	3.8E-06
			Geometric Mean		2.45E+01	2.37E-05
Dakota Sandstone						
No. 3	Injection Test	28-33	D&M	(1)	5.68E+02	5.49E-04
No. 3	Injection Test	33-42.5	D&M		2.80E+00	2.71E-06
No. 12	Injection Test	16-22.5	D&M		5.10E+00	4.93E-06
No. 12	Injection Test	22.5-37.5	D&M		7.92E+01	7.66E-05
No. 19	Injection Test	26-37.5	D&M		7.00E+00	6.77E-06
No. 19	Injection Test	37.5-52.5	D&M		9.44E+02	9.12E-04
			Geometric Mean		4.03E+01	3.89E-05
Burro Canyon Formation						
No. 3	Injection Test	42.5-52.5	D&M		5.80E+00	5.61E-06
No. 3	Injection Test	52.5-63	D&M		1.62E+01	1.57E-05
No. 3	Injection Test	63-72.5	D&M		5.30E+00	5.13E-06
No. 3	Injection Test	72.5-92.5	D&M		3.20E+00	3.09E-06

Table 1.5.3.1-2
Summary of Hydraulic Properties
White Mesa Mill
(continued)

Boring/Well Location		Test Type	Interval (ft. - ft.)		Document Referenced		Hydraulic Conductivity (ft./yr.)	Hydraulic Conductivity (cm./sec.)
No. 3		Injection Test	92.5-107.5		D&M		4.90E+00	4.74E-06
No. 3		Injection Test	122.5-142		D&M		6.00E+01	5.80E-07
No. 9		Injection Test	27.5-42.5		D&M		2.70E+00	2.61E-06
No. 9		Injection Test	42.5-59		D&M		2.00E+00	1.93E-06
No. 9		Injection Test	59-82.5		D&M		7.00E+01	6.77E-07
No. 9		Injection Test	82.5-107.5		D&M		1.10E+00	1.06E-06
No. 9		Injection Test	107.5-132		D&M		3.00E+01	2.90E-07
No. 12		Injection Test	37.5-57.5		D&M		9.01E+01	8.70E-07
No. 12		Injection Test	57.5-82.5		D&M		1.40E+00	1.35E-06
No. 12		Injection Test	82.5-102.5		D&M		1.07E+01	1.03E-05
No. 28		Injection Test	76-87.5		D&M		4.30E+00	4.16E-06
No. 28		Injection Test	87.5-107.5		D&M		3.00E+01	2.90E-07
No. 28		Injection Test	107.5-132.5		D&M		2.00E+01	1.93E-07
WMMW1	(7)	Recovery	92-112		Peel	(2)	3.00E+00	2.90E-06
WMMW3	(7)	Recovery	67-87		Peel		2.97E+00	2.87E-06
WMMW5	(7)	Recovery	95.5-133.5		H-E		1.31E+01	1.27E-05
WMMW5	(7)	Recovery	95.5-133.5		Peel		2.10E+01	2.03E-05
WMMW11	(7)	Recovery	90.7-130.4		H-E	(3)	1.23E+03	1.19E-03
WMMW11	(7)	Single well drawdown	90.7-130.4		Peel		1.63E+03	1.58E-03
WMMW12	(7)	Recovery	84-124		H-E		6.84E+01	6.61E-05
WMMW12	(7)	Recovery	84-124		Peel		6.84E+01	6.61E-05
WMMW14		Single well drawdown	90-120	(5)	H-E		1.21E+03	1.16E-03
WMMW14		Single well drawdown	90-120	(6)	H-E		4.02E+02	3.88E-04
WMMW15		Single well drawdown	99-129		H-E		3.65E+01	3.53E-05
WMMW15	(7)	Recovery	99-129		Peel		2.58E+01	2.49E-05
WMMW16		Injection Test	28.5-31.5		Peel		9.42E+02	9.10E-04
WMMW16		Injection Test	45.5-51.5		Peel		5.28E+01	5.10E-05

Table 1.5.3.1-2
Summary of Hydraulic Properties
White Mesa Mill
(continued)

Boring/Well Location	Test Type	Interval (ft. - ft.)	Document Referenced		Hydraulic Conductivity (ft./yr.)	Hydraulic Conductivity (cm./sec.)
WMMW16	Injection Test	65.5-71.5	Peel		8.07E+01	7.80E-05
WMMW16	Injection Test	85.5-91.5	Peel		3.00E+01	2.90E-05
WMMW17	Injection Test	45-50	Peel		3.10E+00	3.00E-06
WMMW17	Injection Test	90-95	Peel		3.62E+00	3.50E-06
WMMW17	Injection Test	100-105	Peel		5.69E+00	5.50E.06
WMMW18	Injection Test	27-32	Peel		1.14E+02	1.10E-04
WMMW18	Injection Test	85-90	Peel		2.69E+01	2.60E-05
WMMW18	Injection Test	120-125	Peel		4.66E+00	4.50E-06
WMMW19	Injection Test	55-60	Peel		8.69E+00	8.40E-06
WMMW19	Injection Test	95-100	Peel		1.45E+00	1.40E-06
			Geometric Mean		1.05E+01	1.01E-05
Entrada/Navajo Sandstones						
WW-1	Recovery		D Appolonia	(4)	3.80E+02	3.67E-04
WW-1	Multi-well drawdown		D'Appolonia		4.66E+02	4.50E-04
WW-1,2,3	Multi-well drawdown		D'Appolonia		4.24E+02	4.10E-04
			Geometric Mean		4.22E+02	4.08E-04

Notes:
(1) D&M = Dames & Moore, Environmental Report, White Mesa Uranium Project, January, 1978.
(2) Peel = Peel Environmental Services, UMETCO Minerals Corp., Ground Water Study, White Mesa Facility, June 1994.
(3) H-E= Hydro-Engineering, Ground-Water Hydrology at the White Mesa Tailings Facility, July, 1991.
(4) D'Appolonia, Assessment of the Water Supply System, White Mesa Project, Feb. 1981.
(5) Early test data.
(6) Late test data.
(7) Test data reanalyzed by TEC.

Adapted from: Table 2.2, Hydrogeologic Evaluation.

Burro Canyon Sandstone

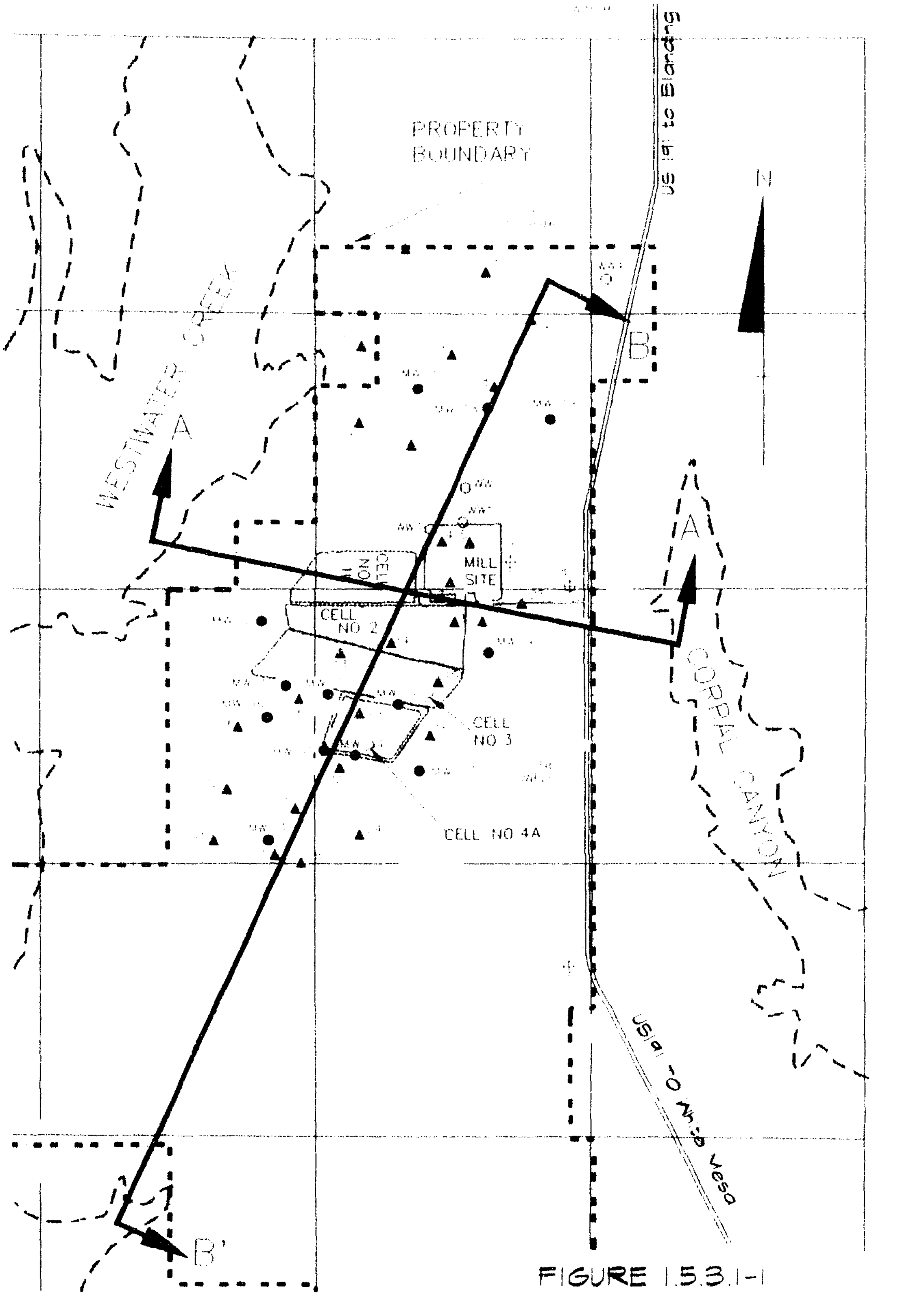
Directly below the Dakota Sandstone, the borings encountered sandstones and random discontinuous shale layers of the Burro Canyon formation to depths of 91 to 141 feet below the site. The importance of this stratum to the site's hydrogeology is that it hosts perched water beneath the site. Beneath the Burro Canyon formation, the Brushy Basin Member is composed of variegated bentonitic mudstone and siltstone; its permeability is lower than the overlying Burro Canyon formation and prevents downward percolation of groundwater (Haynes, et al, 1972). Observed plasticity of claystones (Umetco, 1992) forming the Brushy Basin Member indicates low potential for open fractures which could increase permeability. Section 1.5.3.2 contains a summary of a drilling program carried out in response to agency requests to obtain additional hydrogeologic data.

Previous investigators have seldom made a distinction between the Dakota and Burro Canyon Sandstones. However, examination of borehole cuttings, cores and geophysical logging methods has allowed separation of the two formations. Although similar to the Dakota, the Burro Canyon formation varies from a very fine- to coarse-grained sandstone. The sand grains are generally poorly sorted. The coarse-grained layers also tend to be conglomeratic. The grains are cemented with both silica and kaolin, but silica-cemented sandstones are dominant. The formation becomes argillaceous near the contact with the Brushy Basin Member.

The saturated thickness in the Burro Canyon formation varies across the project area from 55 feet in the northern section to less than 5 feet in the southern area. Some wells are dry, which suggests that the zone of saturation is not continuous. Saturation ceases or is marginal along the western and southern section of the project. The extent toward the east is not defined, but its maximum extent is certainly not beyond the walls of Westwater Creek and Corral Canyons where the Burro Canyon

formation crops out. Perched groundwater elevations and saturated thickness of this formation are shown on Figures 1.5.3.1-4 and 1.5.3.1-5, respectively (from Hydrogeologic Evaluation Figures 2.4 and 2.5).

Hydraulic properties of this stratum have been determined from 12 single, well-pumping/recovery tests and from 30 packer tests. A summary of the hydraulic properties is given in Table 1.5.3.1-2 (Hydrogeologic Evaluation Table 2.2). These tests indicate the hydraulic conductivity geometric mean to be 1.0E-05 cm/sec. The physical properties of the Burro Canyon Sandstone are summarized in Table 1.5.3.1-1. Based on the core samples tested, the sandstones of the Burro Canyon formation vary in total porosity from 1.7 to 27.6 percent, the average being 16.0 percent. Volumetric water content in these sandstones ranges from 0.1 to 7.1 percent, averaging 2.2 percent, with the fine-grained materials having the higher moisture content. Porosities in the claystone layers vary from 16.4 to 29.1 percent with saturation values ranging from 33.8 to 77.2 percent.



▲ DAMES AND MOORE 1978 BORINGS

○ WATER SUPPLY WELLS D'APPOLONIA (1981)

● EXISTING MONITORING WELLS

⊕ EXISTING WATER SUPPLY WELLS

STOCK WELLS

FIGURE 1.5.3.1-1

White Mesa Mill
Site Plan Map showing
Monitor Wells and Borings

SCALE

2000 0 2000 4000 Feet

Brushy Basin Member

The Brushy Basin Member of the Morrison formation is the first aquitard isolating perched water in the Burro Canyon formation from the productive Entrada/Navajo Sandstones. The Brushy Basin Member, in contrast to the overlying Dakota Sandstone, is composed of bentonitic mudstone and claystone. Limited site-specific hydraulic property data are available for the Brushy Basin Member.

The thickness of the Brushy Basin Member in this region reportedly varies from 200-450 feet (Dames & Moore, 1978). This stratum was penetrated by six water supply wells [see Figure 1.5.3.1-1 (Hydrogeologic Evaluation Figure 2.1)]and Appendix A of the Hydrogeologic Evaluation) and its thickness was estimated at 275 feet. Borings which terminate in the Brushy Basin Member encounter moderately plastic dark green to dark reddish-brown mudstones. Plastic bentonitic mudstone is not prone to develop fracturing. Hence, competency of this strata, as an aquitard, is very likely.

Entrada/Navajo Aquifer

Within and in proximity to the site, the Entrada/Navajo Sandstones are both prolific aquifers. Since site water wells are screened in both aquifers, they are, from a hydrogeologic standpoint, treated as a single aquifer. The Entrada/Navajo Sandstone is the first useable aquifer of significance documented within the project area. This aquifer is present at depths between 1,200 and 1,800 feet below the surface and is capable of delivering from 150 to 225 gpm of water per well (D'Appolonia, 1981).

Water is present under artesian pressure and is documented to rise by about 800 to 900 feet above the top of Entrada/Navajo Sandstone contact with the overlying Summerville formation. The static water level is about 400 to 500 feet below the surface (Figures 1.5.3.1-2 and 1.5.3.1-3). Section 1.5.6.4. provides a more detailed discussion regarding the artesian conditions of this formation.

The thickness of the strata separating this aquifer from water present in the Burro Canyon formation is about 1,200 feet. This confining layer is competent enough to maintain pressure of 900 feet of water or 390 pounds per square inch (psi) within the Entrada/Navajo Aquifer.

The positioning of this aquifer and its hydraulic head versus other strata is shown on Figures 1.5.3.1-2 and 1.5.3.1-3. In-situ hydraulic pressure of groundwater in the Entrada/Navajo Aquifer is strong evidence of the confining (i.e. "aquitard") properties of the overlying sedimentary section. Due to the presence of significant artesian pressure in this aquifer, any future hydraulic communication between perched water in the Burro Canyon formation and the Entrada/Navajo Aquifer is unlikely.

1.5.3.2 Data Collected in 1994

This subsection contains a summary of a 1994 drilling program carried out in response to a request by the U. S. Nuclear Regulatory Commission (NRC) and the U. S. Environmental Protection Agency (EPA) to further investigate the competence of the Brushy Basin member of the Morrison formation and to provide additional hydrogeologic data. Three vertical and four angle core holes were drilled.

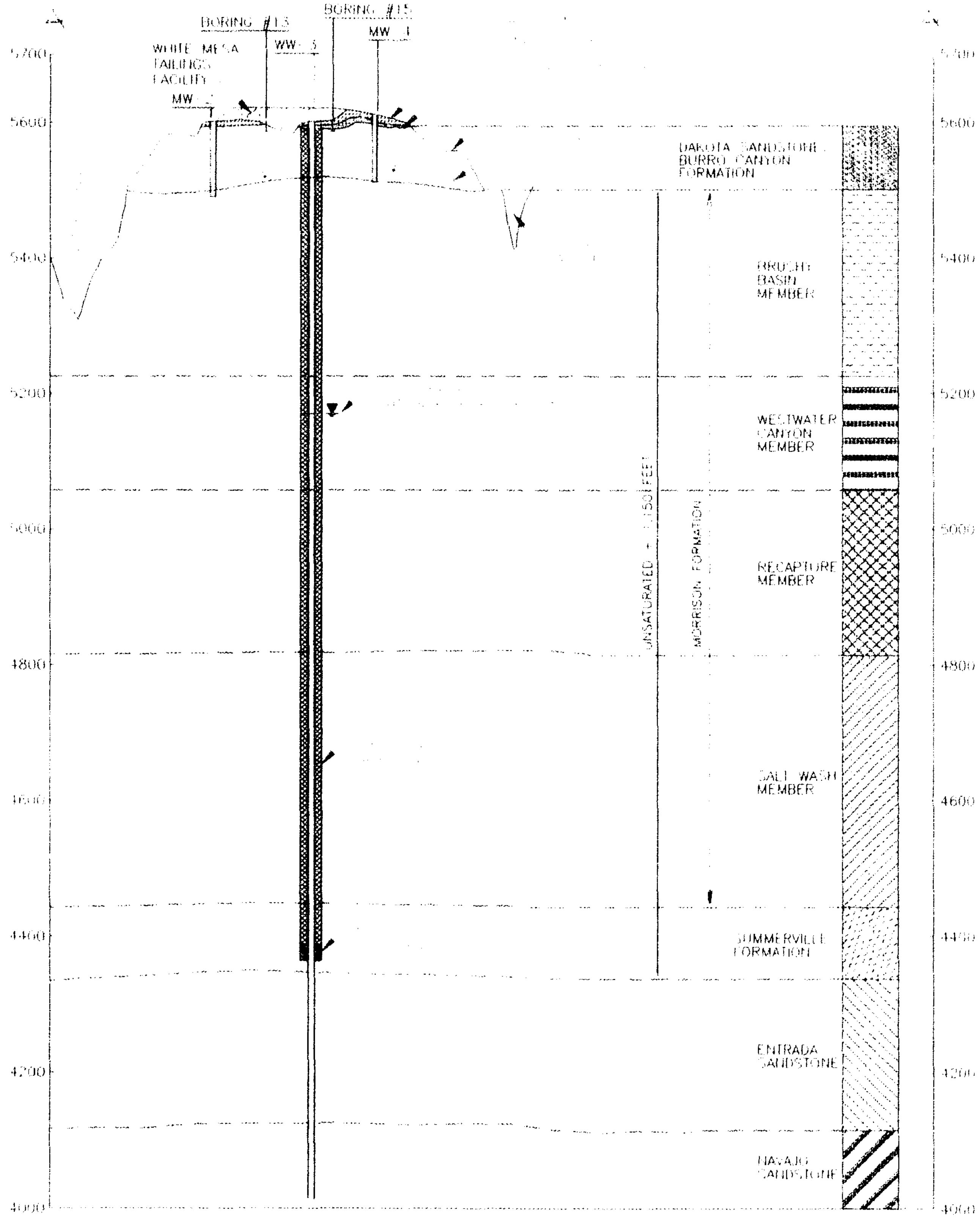


FIGURE 1.5.3.1-2

White Mesa Mill
Section A-A'

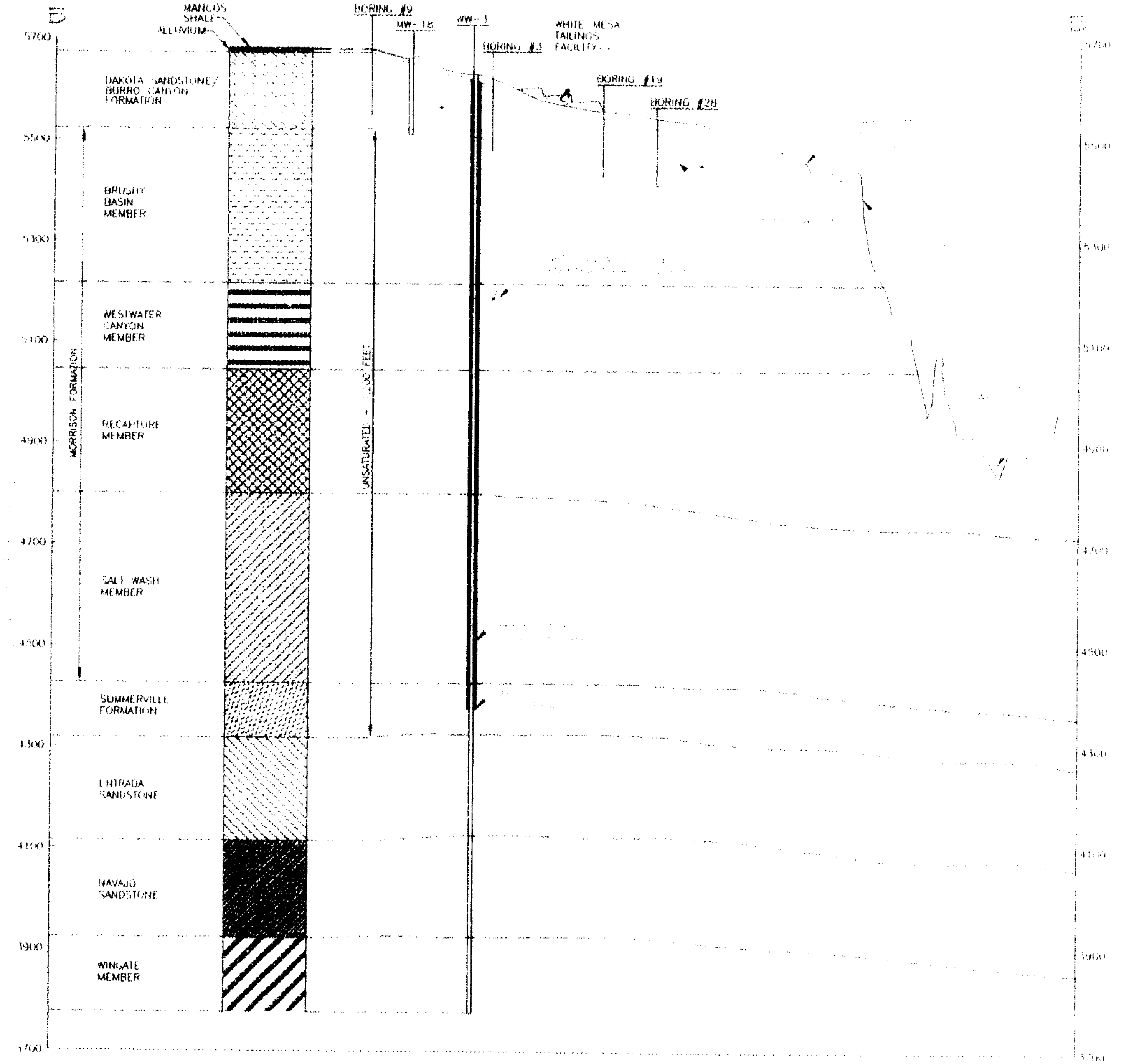


FIGURE 1.5.3.1-3
White Mesa Mill
Section B-B'

The three vertical holes (WMMW-20, WMMW-21, and WMMW-22) were drilled downgradient of the existing monitoring wells. Constant head packer tests were conducted over intervals within the Brushy Basin member to gain information about the horizontal hydraulic conductivity of this unit. Selected cores samples of the Brushy Basin member were analyzed for vertical hydraulic conductivities. The three vertical holes were drilled to sufficient depth to penetrate 20± feet of Brushy Basin Member. Four core holes were drilled along the edge of tailings ponds No. 3 and No. 4. The cores were examined to determine if open fractures were present. Few fractures were observed, and where noted, they were closed and infilled with gypsum. Packer tests were conducted during the drilling of the holes to gain further information about the hydraulic conductivity of the rocks.

Upon completion of drilling, all the geotechnical holes were logged using wireline geophysical methods. A video camera survey was performed in three of the four core holes. The holes were then plugged and abandoned.

Selected cores of the Brushy Basin from all the holes were sent for laboratory measurement of the vertical permeability. The results of these tests are presented in Table 1.5.3.2-1. The hydraulic conductivities calculated from these tests vary from 7.10E-06 cm/sec to 8.90E-04 cm/sec in the Dakota formation, from 9.88E-07 cm/sec to 7.70E-04 cm/sec in the Burro Canyon formation and from 2.30E-07 cm/sec to 1.91E-06 cm/sec in the Brushy Basin member. Three packer tests run within the Brushy Basin member yielded "No Take." Due to the low hydraulic conductivities, measurements could not be made with the equipment available. The hydraulic conductivities of these zones can be expected to be lower than the zones in which actual measurements were made. It can, therefore, be assumed that the hydraulic conductivities of these zones are less than 2.30E-07

cm/sec. Packer tests tend to reflect horizontal hydraulic conductivities which can be expected to be greater than vertical hydraulic conductivities of the same zone.

Slug tests were conducted in wells WMMW-20 and WMMW-22. The test results are shown in Table 1.5.3.2-1. A hydraulic conductivity of 3.14E-06 cm/sec was calculated for WMMW-20 and 9.88E-07 cm/sec (essentially 1.0E-06 cm/sec) for WMMW-22.

Cores from the Brushy Basin were sent to Western Engineers of Grand Junction, Colorado for horizontal and vertical permeability determination. The results of these tests are shown on Table 1.5.3.2-2. The vertical hydraulic conductivities of the cores vary from 5.95E-04 to 7.28E-11 cm/sec. The geometric mean of the vertical permeabilities is 1.23E-08 cm/sec.

For the few analyses conducted for horizontal permeabilities, the results ranged from 1.09E-07 to 6.14E-10 cm/sec and the geometric mean of these values was calculated to be 6.72E-09 cm/sec.

Packer tests were conducted over zones within the Dakota, Burro Canyon and Brushy Basin units. The cores and video surveys of the drill holes showed that the few closed hairline fractures present in the Burro Canyon and Dakota Formations do not substantially affect the hydraulic conductivity of the formations.

TABLE 1.5.3.2-1
Summary of Borehole Tests, 1994 Drilling Program
White Mesa Project, San Juan County, Utah

Well No.	Interval	Type of Test	Formation	Hydraulic Conductivity gpd/ft^2	Hydraulic Conductivity cm/sec
WMMW-20	110.5-114.5	Constant Head	Brushy Basin	0.005	2.30E-07
	87.0-90.0	Slug	Burro Canyon	0.015	5.29E-06
WMMW-21	109.5-117.0	Constant Head	Brushy Basin	0.17	8.15E-06
WMMW-22	130.0-140.0	Constant Head	Brushy Basin	-No Take-	
	76-120	Slug	Burro Canyon	0.06	3.14E-06
GH-94-1	34.0-40.0	Constant Head	Dakota	0.16	7.10E-06
	40.0-50.0	Constant Head	Dakota	1.18	5.60E-05
	70.0-80.0	Constant Head	Burro Canyon	0.01	9.88E-07
	92.0-100	Constant Head	Burro Canyon	13.1	6.20E-04
	103.0-110.0	Constant Head	Burro Canyon	15.84	7.70E-04
	130.0-140.0	Constant Head	Brushy Basin	3.6	1.70E-04
	163.0-165.0	Constant Head	Brushy Basin	-No Take-	
GH-94-2A	34.0-40.0	Constant Head	Dakota	0.66	3.10E-05
	32.5-40.0	Constant Head	Dakota	18.72	8.90E-04
	50.0-56.0	Constant Head	Dakota	2.30	1.10E-04
	60.0-70.0	Constant Head	Burro Canyon	1.04	4.90E-05
	70.0-80.0	Constant Head	Burro Canyon	4.18	2.00E-04
	80.0-90.0	Constant Head	Burro Canyon	3.02	1.50E-04
	138.0-144.0	Constant Head	Brushy Basin	-No Take-	
GH-94-3	155.0-161.0	Constant Head	Brushy Basin	0.07	3.26E-06
	138.0-144.0	Constant Head	Brushy Basin	0.06	2.70E-06

TABLE 1.5.3.2-2
Results of Laboratory Tests

Well No.	Interval Tested (ft)	Formation Tested	Vertical Permeabilities cm/sec
WMMW-20	92.0-92.5	Brushy Basin	7.96E-11
	95.4-96.0	Brushy Basin	2.96E-09
	104.0-104.4	Brushy Basin	2.43E-09
	105.0-105.5	Brushy Basin	7.28E-11
	109.5-110.0	Brushy Basin	1.02E-09
WMMW-21	94.8-95.3	Brushy Basin	5.78E-06
	106.5-107.0	Brushy Basin	6.38E-10
	114.5-115.0	Brushy Basin	1.46E-07
WMMW-22	122.2-122.7	Brushy Basin	1.08E-06
	126.3-127.2	Brushy Basin	6.94E-10
	133.3-133.7	Brushy Basin	2.11E-09
	137.3-137.8	Brushy Basin	5.95E-04
GH-1	163.0-163.5	Brushy Basin	1.68E-08
	165.0-165.5	Brushy Basin	6.76E-07
GH-2A	161.0-161.5	Brushy Basin	6.73E-09
GH-3	157.0-157.5	Brushy Basin	9.42E-10
GH-4	158.0-158.5	Brushy Basin	2.17E-09

Well No.	Interval Tested (ft)	Formation Tested	Horizonal Permeabilities cm/sec
WMMW-20	95.4-96.0	Brushy Basin	1.09E-07
	105.0-105.5	Brushy Basin	6.14E-10
WMMW-21	94.8-95.3	Brushy Basin	8.31E-10
WMMW-22	137.3-137.8	Brushy Basin	3.67E-08

1.5.4 Climatological Setting

The climate of southeastern Utah is classified as dry to arid continental. The region is generally typified by warm summer and cold winter temperatures, with precipitation averaging less than 11.8 inches annually and evapotranspiration in the range of 61.5 inches annually (Dames and Moore, 1978).

Precipitation in southeastern Utah is characterized by wide variations in seasonal and annual rainfall and by long periods of no rainfall. Short duration summer storms furnish rain in small areas of a few square miles and this is frequently the total rainfall for an entire month within a given area. The average annual precipitation in the region ranges from less than 8 inches at Bluff to more than 16 inches on the eastern flank of the Abajo Mountains, as recorded at Monticello. The mountain peaks in the Henry, La Sal and Abajo Mountains may receive more than 30 inches of precipitation, but these areas are very small in comparison to the vast area of much lower precipitation in the region.

1.5.5 Perched Groundwater Characteristics

The perched water in the Burro Canyon formation originates in the areas north of the site as shown by the direction of groundwater flow from north to south (see Figure 1.5.5-1). The thickness of saturation is greatest in the northern and central sections of the site and reduces toward the south. The configuration of the perched water table and map of saturated thicknesses are provided on Figures 1.5.5-1 and 1.5.5-2, respectively. The topography of the Brushy Basin Member which defines the bottom of the perched water is shown on Figure 1.5.5-3 (Hydrogeologic Evaluation Figure 2.6).

The groundwater from the Burro Canyon formation discharges into the adjacent canyons (Westwater Creek and Corral Canyon) as evidenced by springs and productive vegetation patterns. Some part of the groundwater flow may enter the Brushy Basin Member via relief fractures which occur in close proximity to the canyons. The location of the canyons which bound the White Mesa on the west, east and south are shown on Figure 1.5.3-1.

The geometric mean of the hydraulic conductivity of the saturated part of Burro Canyon formation is 1.0E-05 cm/sec. The water yield per well is very low, as documented by nine pumping tests, and is typically below 0.5 gpm. In contrast to the very low pumping rates observed in eight wells, Well WMMW-11 produced a higher yield on the order of 2 gpm. This higher yield may be attributable to the presence of localized high-permeability material, such as a lense of coarser material acting as a drainage gallery. Localized fracturing could also cause a similar effect, but few fractures have been documented during drilling of this or other wells (Umetco, 1992; Dames & Moore, 1978).

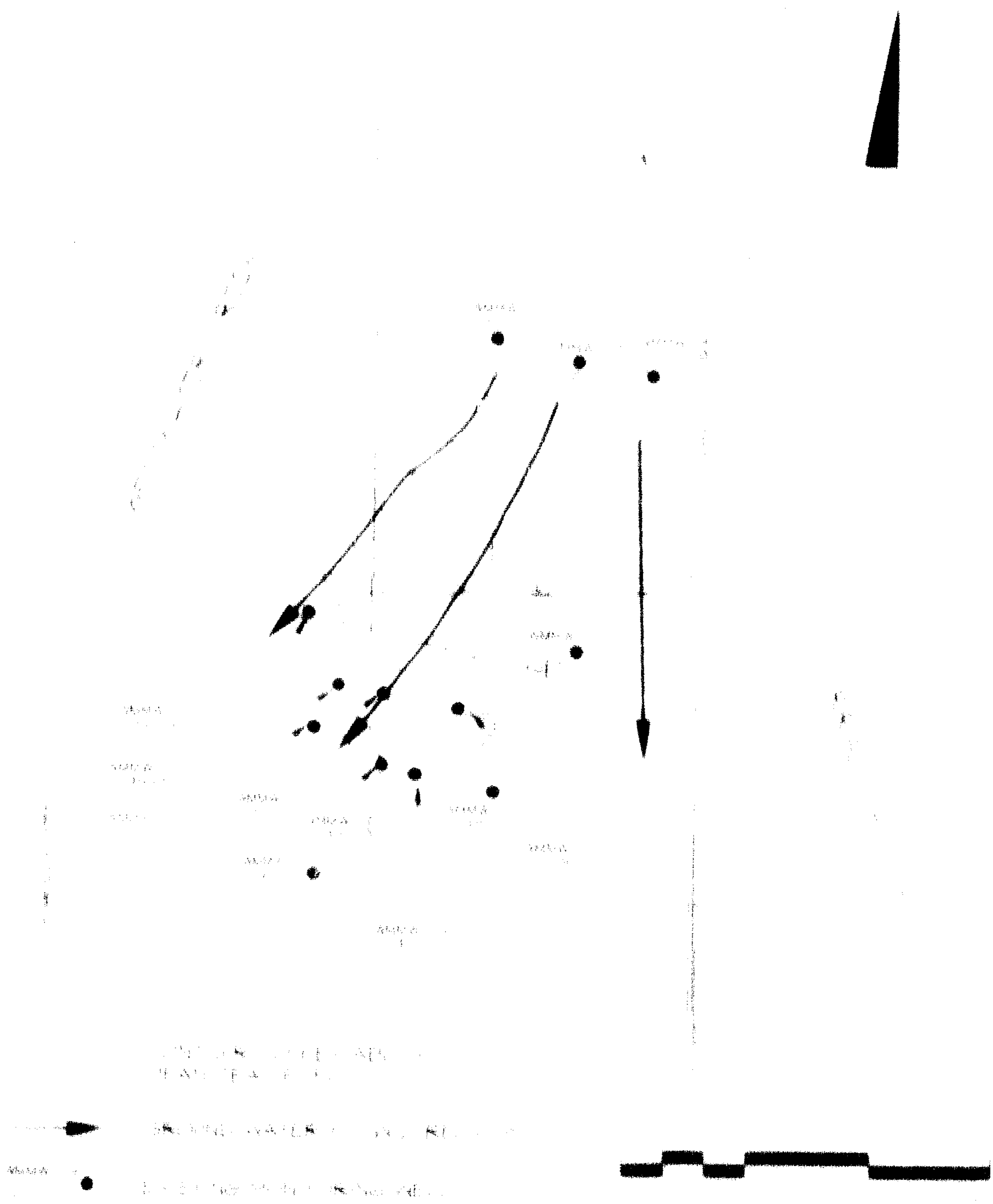


FIGURE 55 Perched Ground Water Levels

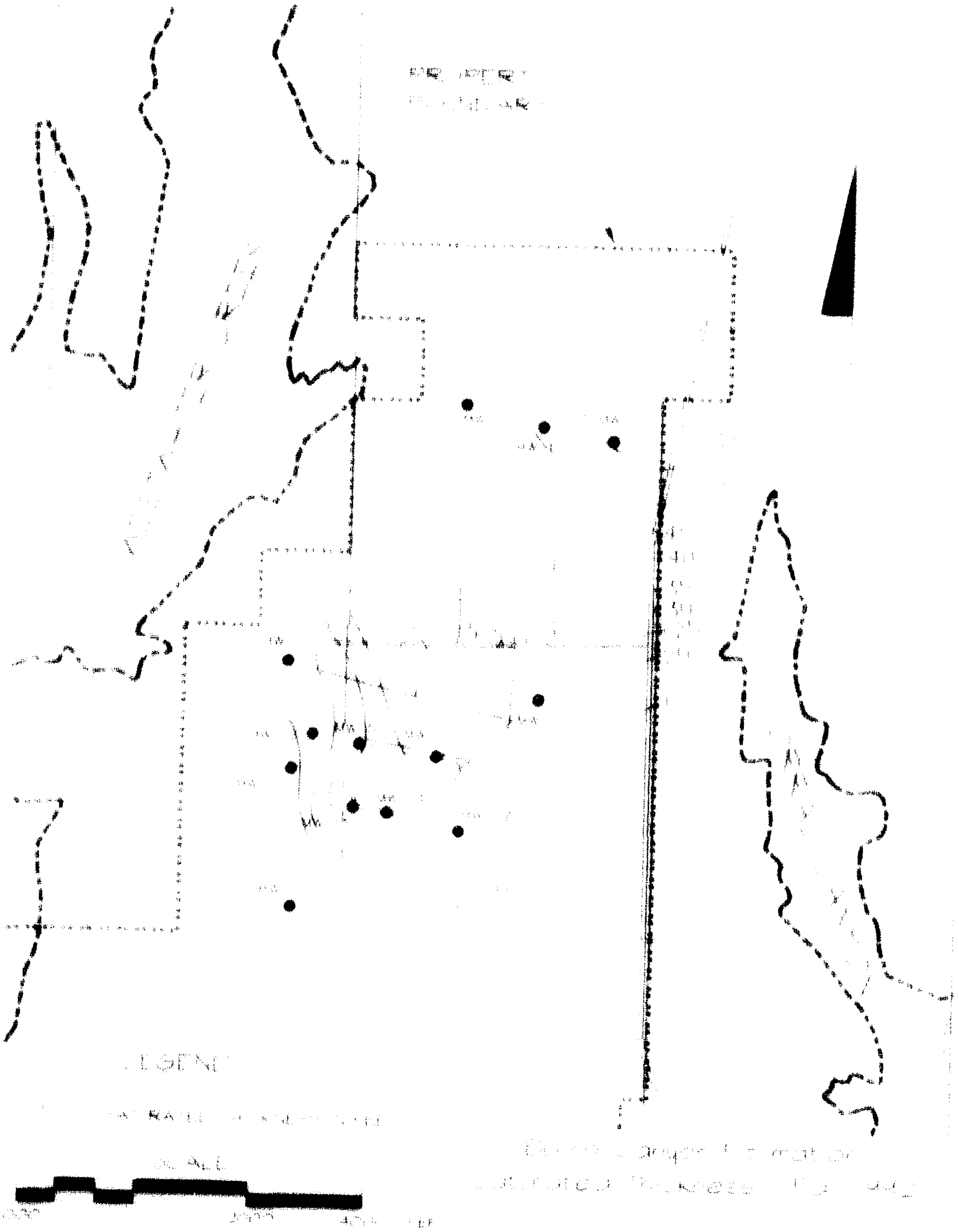


FIGURE 5.5.2 Saturated Thickness of Perched Water

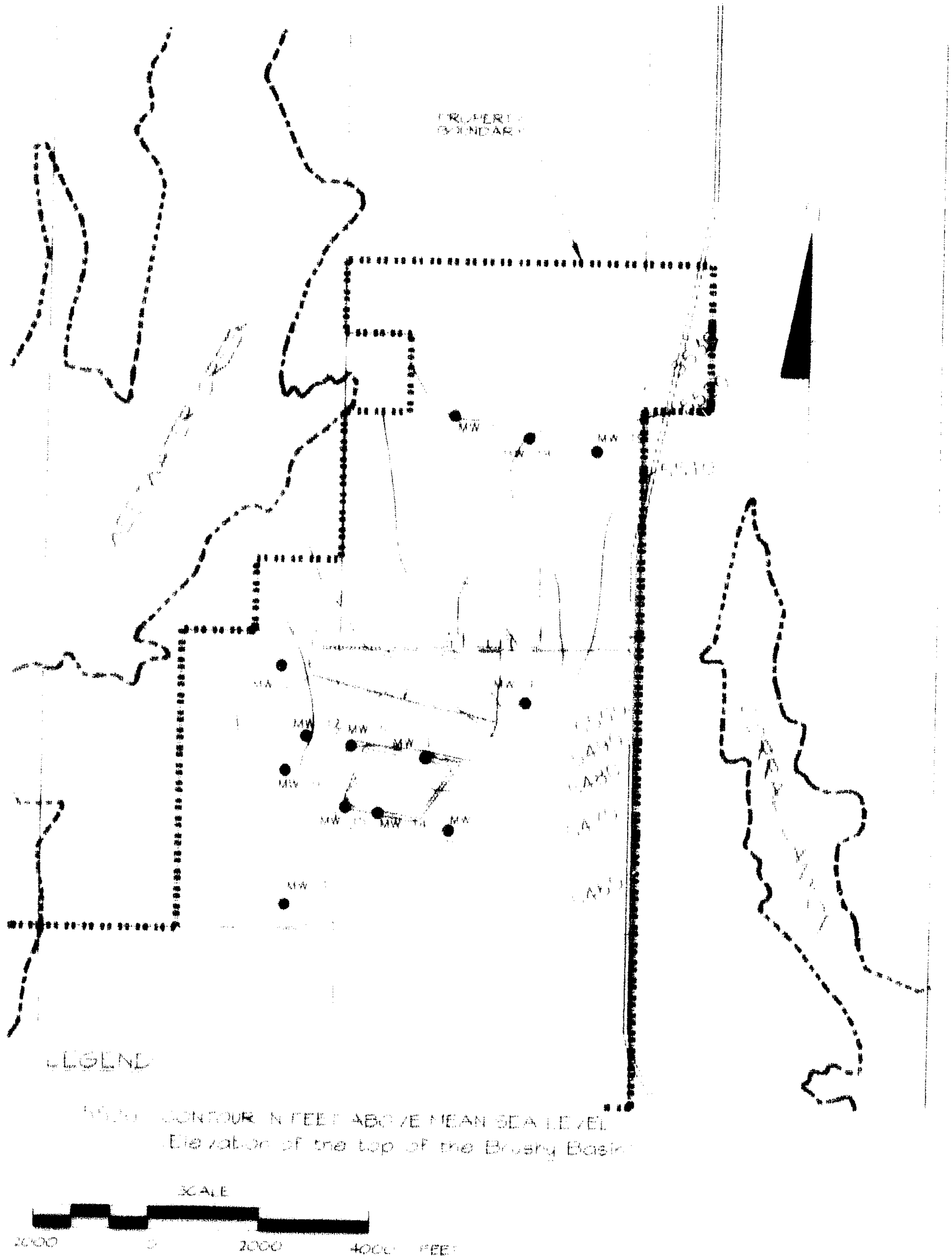


FIGURE 5.5-3. Topography of the Brushy Basin Formation

Table 1.5.5-1
Monitoring Well and Ground Water Elevation Data
White Mesa Uranium Mill

Well Name	Date Installed	Total Depth	Perforations	Water Level			Measuring Point	
				Date	Depth (ft.)	Elevation (ft.-MSL)	Above LDS (ft.)	Elevation (ft.-MSL)
WMMW-1	Sep-79	117'	92'-112'	11/19/92	75.45	5572.77	2.0	5648.22
WMMW-2	Sep-79	128.8'	85'-125'	11/19/92	110.06	5503.43	1.8	5613.49
WMMW-3	Sep-79	98'	67'-87'	11/19/92	83.74	5471.58	2.0	5555.32
WMMW-4	Sep-79	123.6'	92'-12'	11/19/92	92.42	5530.15	1.6	5622.57
WMMW-5	May-80	136'	95.5'-133.5'	11/19/92	108.32		0.6	5609.33
WMMW-6	May-80		This well was destroyed during construction of Cell 3.					
WMMW-7	May-80		This well was destroyed during construction of Cell 3.					
WMMW-8	May-80		This well was destroyed during construction of Cell 3.					
WMMW-11	Oct-82	135'	90.7'-130.4'	11/19/92	102.53	5508.55	2.4	5611.08
WMMW-12	Oct-82	130.3'	84'-124'	11/19/92	109.68	5499.77	0.9	5609.45
WMMW-13	Oct-82	118.5'	This well was destroyed during construction of Cell 4A.					
WMMW-14	Sep-89	129.1'	90'-120'	11/19/92	105.34	5491.05	0.0	5596.39
WMMW-15	Sep-89	138'	99'-129'	11/19/92	108.28	5490.34	0.8	5598.62
WMMW-16	Dec-92	91.5'	78.5'-88.5'	7/12/92	Dry		1.5	
WMMW-17	Dec-92	110'	90'-100'	11/30/92	87.56		1.5	
WMMW-18	Dec-92	148.5'	103.5'-133.5'	11/30/92	92.11		1.5	
WMMW-19	Dec-92	149'	101'-131'	10/12/92	85.00		1.5	
#9-1	May-80	33.5'	10'-30'	3/4/91	Dry		1.8	5622.83
#9-2	May-80	62.7'	39.7"-59.7"	3/4/91	Dry		2	5622.58
#10-2	May-80	33.5'	11.3'-31.3'	3/4/91	Dry		2	5633.58
#10-2	May-80	62.2'	39.2'-59.2'	3/4/91	Dry		2.1	5633.39

Notes:
1. Well locations provided on Figure 1.5.3-1.
2. LDS = leak detection system.
3. ft.-MSL = feet - mean sea level.

Adapted from: Table 2.3, Hydrogeologic Evaluation

1.5.5.1 Perched Water Quality

Groundwater monitoring of the Burro Canyon formation saturated zone has been conducted at the White Mesa facility since 1979. Table 1.5.5-1 (Hydrogeologic Evaluation Table 2.3) provides a list of wells that have been constructed for monitoring purposes at the facility. Figure 1.5.3.1-1 indicates the locations of these wells. The water quality data obtained from these wells are provided both in tabular and graphical form in Appendix B of the Hydrogeologic Evaluation, with more recent data in the Semi-annual Effluent Report for July through December 1995 and the Semi-annual Effluent Report for January through June 1995 (Energy Fuels Nuclear, Inc).

Examination of the spatial distribution and temporal trends (or lack thereof) in concentrations of analyzed constituents provides three significant conclusions:

1. The quality of perched water throughout the site shows no discernible pattern in variation,

2. The water is generally of poor quality [moderately high values of chloride, sulfate, and totally dissolved solids (TDS)], and

3. Analytical results show that operations at the White Mesa Uranium Mill have not impacted the quality of the perched water of the Burro Canyon formation.

To arrive a these conclusions, comparisons of the water chemistries from the various wells were analyzed in the Hydrogeologic Evaluation by graphical techniques. The purpose of the comparisons was to determine if trends in chloride, which would be associated with water from the tailings ponds,

were increasing in the perched water of the Burro Canyon formation. The trilinear plot and the Stiff diagram were used to conduct a preliminary evaluation of differences or similarities in water quality data between wells. The following is a summary of the conclusions drawn in the Hydrogeologic Evaluation.

Temporal and Spatial Variations

The trilinear plots and Stiff diagrams presented in the Hydrogeologic Evaluation (Figures 2.7-2.10) show that the water from all wells is of the sulfate (anion) type. The cation definition of the water type is variable. Of the 13 wells analyzed for water chemistry, four fall in the calcium-sulfate type category, four fall in the (sodium plus potassium)-sulfate type, two samples classify as the magnesium-sulfate type. Five samples have no dominant cation type. However, these five samples tend to classify more closely to the (sodium plus potassium)-sulfate and calcium-sulfate types.

The spatial variability of water quality data within the Burro Canyon formation is illustrated on Hydrogeologic Evaluation Figures 2.7 through 2.13, and the data Tabled in Appendix B of the Hydrogeologic Evaluation. Upgradient Monitoring Wells WMMW-1, WMMW-18, and WMMW-19 varied in sulfate concentrations from 676 to 1736 milligrams per liter (mg/l). Likewise, chloride concentrations in these wells varied from 12 to 92 mg/l. Across the site, sulfate and chloride concentrations vary with no discernible pattern to the variations. Details regarding chemistry of the Burro Canyon formation water can be found in Appendix B of the Hydrogeologic Evaluation.

Variability of water within the Burro Canyon formation is the result of slow moving to nearly stagnant groundwater flow beneath the site. These conditions are likely leading to dissolution of minerals from the Brushy Basin Member and the formation of sulfate-dominated waters.

Statistical Analysis

Because of the variable groundwater chemistry in the Burro Canyon formation baseline data, comparison of individual well groundwater chemistries to a single background groundwater well is not an appropriate method of monitoring potential disposal cell leakage or groundwater impacts. Water quality baseline and comparisons to that baseline established on a well-by-well basis has been proposed in the POC, as this method will best provide a meaningful representation of changes in groundwater chemistry.

Based on a review of water quality data gathered from 1979 through 1992, which are presented in the Hydrogeologic Evaluation, and considering the apparent variability of chemical composition of perched water and the absence of any impact from operations, EFN proposes to apply, an intra-well approach for assessing water quality trends. This approach, described in Appendix C, the Points of Compliance (POC) report (Titan, 1994), involves determination of background concentrations for a number of selected wells.

1.6 GEOLOGY

The following text is copied, with minor revisions, from the Environmental Report (Dames and Moore, 1978b) (ER). The text has been duplicated herein for ease of reference and to provide background information concerning the site geology. ER Subsections used in the following text are shown in parentheses immediately following the subsection titles.

The site is near the western margin of the Blanding Basin in southeastern Utah and within the Monticello uranium-mining district. Thousands of feet of multi-colored marine and non-marine

sedimentary rocks have been uplifted and warped, and subsequent erosion has carved a spectacular landscape for which the region is famous. Another unique feature of the region is the wide-spread presence of unusually large accumulations of uranium-bearing minerals.

1.6.1 Regional Geology

The following descriptions of regional physiography; rock units; and structure and tectonics are reproduced from the ER for ease of reference and as a review of regional geology.

1.6.1.1 Physiography (ER Section 2.4.1.1)

The project site is within the Canyon Lands section of the Colorado Plateau physiographic province. To the north, this section is distinctly bounded by the Book Cliffs and Grand Mesa of the Uinta Basin; western margins are defined by the tectonically controlled High Plateaus section, and the southern boundary is arbitrarily defined along the San Juan River. The eastern boundary is less distinct where the elevated surface of the Canyon Lands section merges with the Southern Rocky Mountain province.

Canyon Lands has undergone epeirogenic uplift and subsequent major erosion has produced the region's characteristic angular topography reflected by high plateaus, mesas, buttes, structural benches, and deep canyons incised into flat-laying sedimentary rocks of pre-Tertiary age. Elevations range from approximately 3,000 feet (914 meters) in the bottom of the deeper canyons along the southwestern margins of the section to more than 11,000 feet (3,353 meters) in the topographically anomalous laccolithic Henry, Abajo and La Sal Mountains to the northeast. Except for the deeper

canyons and isolated mountain peaks, an average elevation in excess of 500 feet (1,524 meters) persists over most of the Canyon Lands section.

On a more localized regional basis, the project site is located near the western edge of the Blanding Basin, sometimes referred to as the Great Sage Plain (Eardly, 1958), lying east of the north-south trending Monument Uplift, south of the Abajo Mountains and adjacent to the northwesterly-trending Paradox Fold and Fault Belt (Figure 1.6-1). Topographically, the Abajo Mountains are the most prominent feature in the region, rising more than 4,000 feet (1,219 meters) above the broad, gently rolling surface of the Great Sage Plain.

The Great Sage Plain is a structural slope, capped by the resistant Burro Canyon formation and the Dakota Sandstone, almost horizontal in an east-west direction but descends to the south with a regional slope of about 2,000 feet (610 meters) over a distance of nearly 50 miles (80 kilometers). Though not as deeply or intricately dissected as other parts of the Canyon Lands, the plain is cut by numerous narrow and vertical-walled south-trending valleys 100 to more than 500 feet (30 to 152+ meters) deep. Water from the intermittent streams that drain the plain flow southward to the San Juan River, eventually joining the Colorado River and exiting the Canyon Lands section through the Grand Canyon.

1.6.1.2 Rock Units (ER Section 2.4.1.1)

The sedimentary rocks exposed in southeastern Utah have an aggregate thickness of about 6,000 to 7,000 feet (1,829 to 2,134 meters) and range in age from Pennsylvanian to Late Cretaceous. Older unexposed rocks are known mainly from oil well drilling in the Blanding Basin and Monument Uplift. These wells have encountered correlative Cambrian to Permian rock units of markedly

differing thicknesses but averaging over 5,000 feet (1,524 meters) in total thickness (Witkind, 1964). Most of the wells drilled in the region have bottomed in the Pennsylvanian Paradox Member of the Hermosa formation. A generalized stratigraphic section of rock units ranging in age from Cambrian through Jurassic and Triassic (?), as determined from oil-well logs, is shown in Table 1.6-1. Descriptions of the younger rocks, Jurassic through Cretaceous, are based on field mapping by various investigators and are shown in Table 1.6-2.

Paleozoic rocks of Cambrian, Devonian and Mississippian ages are not exposed in the southeastern Utah region. Most of the geologic knowledge regarding these rocks was learned from the deeper oil wells drilled in the region, and from exposures in the Grand Canyon to the southwest and in the Uinta and Wasatch Mountains to the north. A few patches of Devonian rocks are exposed in the San Juan Mountains in southwestern Colorado. These Paleozoic rocks are the result of periodic transgressions and regressions of epicontinental seas and their lithologies reflect a variety of depositional environments.

In general, the coarse-grained feldspathic rocks overlying the Precambrian basement rocks grade upward into shales, limestones and dolomites that dominate the upper part of the Cambrian. Devonian and Mississippian dolomites, limestones and interbedded shales unconformably overlay the Cambrian strata. The complete absence of Ordovician and Silurian rocks in the Grand Canyon, Uinta Mountains, southwest Utah region and adjacent portions of Colorado, New Mexico and Arizona indicate that the region was probably epeirogenically positive during these times.

The oldest stratigraphic unit that crops out in the region is the Hermos formation of Middle and Late Pennsylvanian age. Only the uppermost strata of this formation are exposed, the best exposure being in the canyon of the San Juan River at the "Goosenecks" where the river traverses the crest of the