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NUREG-0556

final

environmental statement

related to operation of

WHITE MESA URANIUM PROJECT

ENERGY FUELS NUCLEAR, INC.

MAY 1979

Docket No. 40-8681

U. S. Nuclear Regulatory Commission • Office of Nuclear Material Safety and Safeguards

NUREG-0556

FINAL ENVIRONMENTAL STATEMENT

related to the
Energy Fuels Nuclear, Inc.,

WHITE MESA URANIUM PROJECT

(San Juan County, Utah)

Docket No. 40-8681

May 1979

prepared by the
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUMMARY AND CONCLUSIONS

This Final Environmental Statement was prepared by the staff of the U.S. Nuclear Regulatory Commission and issued by the Commission's Office of Nuclear Material Safety and Safeguards.

1. This action is administrative.

2. The proposed action is the issuance of a Source Material License to Energy Fuels Nuclear, Inc., for the construction and operation of the proposed White Mesa Uranium Project with a product (U_3O_8) production limited to 7.3×10^5 kg (1.6×10^6 lb) per year.

3. The following is a summary of environmental impacts and adverse effects.

   a. Impacts to the area from the operation of the White Mesa Uranium Project will include the following:

      - Alterations of up to 195 ha (484 acres) that will be occupied by the mill, mill facilities, tailings area, and roads. Approximately 135 ha (333 acres) will be permanently committed to tailings disposal.
      - An increase in the existing background radiation levels of the mill area as a result of continuous but small releases of uranium, radium, radon, and other radioactive materials during operation.
      - Socioeconomic effects on the towns of Blanding and Monticello, Utah, where the majority of mill workers will be housed during mill construction and operation.
      - Production of waste material (tailings) from the mill, which will be produced at a rate of about 1.8×10^6 kg (2000 tons) per day for 15 years and will be deposited onsite in subsurface pits.

   b. Surface water will not be affected by normal milling operations. Mill process water will be taken from the Navajo aquifer, and process water will be discharged to the tailings impoundment at about 1.18 m^3 (310 gal) per minute. Approximately 5.9×10^5 m^3 (480 acre-ft) of water per year will be utilized by the mill, and this is not expected to have an effect on the Navajo aquifer.

   c. There will be no discharge of liquid or solid effluents from the mill and tailings site. The discharge of pollutants to the air will be small and the effects negligible. The estimated total annual whole-body and organ dose commitments to the population within 80 km (50 miles) of the proposed mill site are presented below. Natural background doses are also presented for comparison. These dose estimates were based on the projected population in the year 2000. The dose commitments from normal operations of the proposed White Mesa mill will represent only very small increases from those due to current background radiation sources. Radiation dose commitments to individuals living in nearby residences will not be permitted to exceed the 25-millirems-per-year EPA limit (40 CFR Part 190).

Annual population dose commitments to the population within an 80-km (50-mile) radius of the plant site in the year 2000

	Dose (man-rems/yr)	
Receptor organ	Plant effluents	Natural background
Total body	3.4	7,500
Lung	7.1	7,500
Bone	6.4	7,500
Bronchial epithelium	13.2	23,000

d. Construction and operation of the White Mesa mill will require the commitment of small amounts of chemicals and fossil fuels, relative to their abundance.

e. Construction and operation of the White Mesa mill will provide employment and induced economic benefits for the region, but may also result in some socioeconomic stress.

f. The area devoted to the milling operations will be reclaimed after operations cease, but the approximately 135 ha (333 acres) tailings area may be unavailable for further productive use. However, when reclamation is completed and testing shows that radiation levels have been reduced to acceptable levels, it may be possible to return the tailings area to its former use as grazing land.

g. Historical and archeological surveys have identified archeological and historic sites within the proposed project area. Pursuant to 36 CFR Part 63.3, the NRC requested a determination from the Secretary of the Interior that the area on which the archeological sites are located is eligible for inclusion in the National Register of Historic Places (National Register) as an Archeological District. The resulting determination was that the White Mesa Archeological District is eligible for inclusion in the National Register. Although a similar request was made for determinations of eligibility for the historic sites, these determinations await supplementary documentation. It is anticipated that the NRC will enter into a Memorandum of Agreement under 36 CFR Part 800, "Procedures for the Protection of Historic and Cultural Properties," to ensure adequate mitigation of impacts to cultural resources.

4. Principal alternatives considered are as follows:

   a. alternative sites for the mill,
   b. alternative mill processes,
   c. alternative of using an existing mill,
   d. alternative methods for tailings management,
   e. alternative energy sources, and
   f. alternative of no licensing action on the mill.

5. The following Federal, State, and local agencies were asked to comment on the Draft Environmental Statement:

   Department of Commerce
   Department of the Interior
   Department of Health, Education, and Welfare
   Federal Energy Regulatory Commission
   Department of Energy
   Department of Transportation
   Environmental Protection Agency
   Department of Agriculture
   Advisory Council on Historic Preservation
   Department of Housing and Urban Development
   Utah Board of Health
   Utah State Planning Coordinator
   Utah Division of Oil, Gas, and Mining

6. This Final Environmental Statement was made available to the public and to the specified agencies in May 1979.

7. On the basis of the analysis and evaluation set forth in this Environmental Statement, it is proposed that any license issued for the White Mesa mill should be subject to the following conditions for the protection of the environment.

   a. The applicant shall construct the tailings disposal facility to incorporate the features described in Alternative 1 of Sect. 10.3 and in Sect. 3.2.4.7 and to meet the safety criteria specified in NRC Regulatory Guide 3.11.

   b. The applicant shall implement an interim stabilization program that minimizes to the maximum extent reasonably achievable dispersal of blowing tailings. This program shall include the use of written operating procedures that specify the use of specific control methods for all conditions. The effectiveness of the control methods used shall be evaluated weekly by means of a documented tailings area inspection.

c. The applicant shall implement the environmental monitoring program summarized in Table 6.2 of this document. The applicant shall establish a control program that shall include written procedures and instructions to control all environmental monitoring prescribed herein and shall provide for periodic management audits to determine the adequacy of implementation of these environmental controls. The applicant shall maintain sufficient records to furnish evidence of compliance with these environmental controls. In addition, the applicant shall conduct and document an annual survey of land use (grazing, residences, etc.) in the area surrounding the proposed project.

d. Before engaging in any activity not assessed by the NRC, the applicant shall prepare and record an environmental evaluation of such activity. When the evaluation indicates that such activity may result in a significant adverse environmental impact that was not assessed, or that is greater than that assessed in this Environmental Statement, the applicant shall provide a written evaluation of such activities and obtain prior approval of the NRC for the activity.

e. If unexpected harmful effects or evidence of irreversible damage not otherwise identified in this Environmental Statement are detected during construction and operation, the applicant shall provide to the NRC an acceptable analysis of the problem and a plan of action to eliminate or reduce the harmful effects or damage.

f. The applicant shall conduct a meteorological monitoring program as specified in Section 6.1 of this document. The data obtained from this program shall be tabulated and made available for NRC inspection.

g. The applicant shall provide for stabilization and reclamation of the mill site and tailings disposal areas and mill decommissioning as described in Alternative 1 of Section 10.3 and in Section 3.3 of this document.

h. The applicant shall provide surety arrangements to ensure completion of the mill site and tailings area stabilization, reclamation, and decommissioning plans.

i. The applicant shall consult and coordinate with the Utah Division of Wildlife Resources regarding the extent of fencing and other ways to mitigate any adverse impacts that may occur to deer.

j. The applicant shall routinely monitor the tailings discharge system at 4-hr intervals and document the results. The applicant shall monitor the use of the impoundment by wildlife in conjunction with the program to monitor the tailings discharge system.

8. On the basis of the analysis and evaluation set forth in this Environmental Statement, it is proposed that any license issued for the White Mesa mill should be subject to conditions for the protection of historic, archeological, architectural, and cultural resources. The conditions should be similar to those outlined in the proposed Memorandum of Agreement in Appendix E.

9. The position of the NRC is that, after weighing the environmental, economic, technical, and other benefits of the operation of the White Mesa Uranium Project against environmental and other costs and after considering available alternatives, the action called for under the National Environmental Policy Act of 1969 and 10 CFR Part 51 is the issuance of a Source Material License subject to conditions 7a through 7j and in 8, above.

   As announced in a *Federal Register* notice dated 3 June 1976 (41 FR 22430), the NRC is preparing a generic environmental statement on uranium milling. Although it is the NRC's position that the tailings impoundment method discussed in this Statement represents the most environmentally sound and reasonable alternative now available at this site, any NRC licensing action will be subject to express conditions that approved waste-generating processes and uranium mill tailings management practices may be subject to revision in accordance with the conclusions of the final generic environmental impact statement and any related rule making.

CONTENTS

1. INTRODUCTION

1.1 THE APPLICANT'S PROPOSAL

Pursuant to Title 10, *Code of Federal Regulations* (CFR), Part 40.31 and to 10 CFR Part 51, Energy Fuels Nuclear, Inc. (the applicant), on February 6, 1978, applied to the Nuclear Regulatory Commission (NRC) for an NRC Source Material License to construct and operate a uranium processing mill. This mill, hereafter referred to as the White Mesa Uranium Project, will process ores from independent and company-owned mines. There will be no uranium mining at the project site.

The project will consist of construction and operation of a mill with a nominal processing capacity of 1800 metric tons (MT; 2000 tons) per day with provision for recovery of vanadium as well as uranium.

The applicant presently controls by ownership, lease, or contract, ore reserves of approximately 8600 MT (9500 tons) of U_3O_8 with an average ore grade of 0.125%. The proposed operating schedule is 24 hr/day, 340 days per year. At this schedule, there are about 11 years of ore supply. The applicant has designed for a 15-year project lifetime with the expectation that other ore sources will be discovered later. Based on these figures and a 94% recovery, the mill will produce approximately 730 MT (800 tons) of U_3O_8 per year.

Waste materials (tailings) from the mill will be produced at about 1800 MT (2000 tons) of solids per day and stored onsite. Sequential preparation, filling, and reclamation of tailings impoundment cells are planned (Sect. 3.2.4.7). This will decrease the amount of tailings exposed (and radon exhaled) during operation of the mill.

In accordance with NRC Guides 3.5 and 3.8, the applicant has submitted a Source Material License Application (Form AEC-2),[1] an Environmental Report (ER),[2] and supplements to the ER in response to questions by the NRC staff.

1.2 BACKGROUND INFORMATION

The proposed Energy Fuels Nuclear, Inc., mill will be located in San Juan County, Utah, about 8 km (5 miles) south of Blanding, Utah (Fig. 1.1). Ore for the mill feed will be provided through two existing ore buying stations, one near Hanksville in Wayne County, Utah, and the other adjacent to the planned mill on the same site (Fig. 2.1). These buying stations, owned by Energy Fuels, purchase ore from independent mines and will also receive ore from company-owned mines.

The surface area of the project site is owned by Energy Fuels Nuclear, Inc., or controlled by mill site claims. The mill will occupy about 20 ha (50 acres) of the site, including 6 ha (16 acres) presently occupied by the existing ore buying station. At the end of the proposed 15-year project lifetime, the tailings disposal cells will occupy approximately another 135 ha (333 acres).

The purpose of this Environmental Statement is to discuss in detail the environmental effects of project construction as well as monitoring and mitigating measures proposed to minimize the effects of the project on the immediate area and surrounding environs.

1.3 FEDERAL AND STATE AUTHORITIES AND RESPONSIBILITIES

Under 10 CFR, Part 40, an NRC license is required in order to "receive title to, receive, possess, use, transfer, deliver ... import ... or export ... source material ..." (i.e.,

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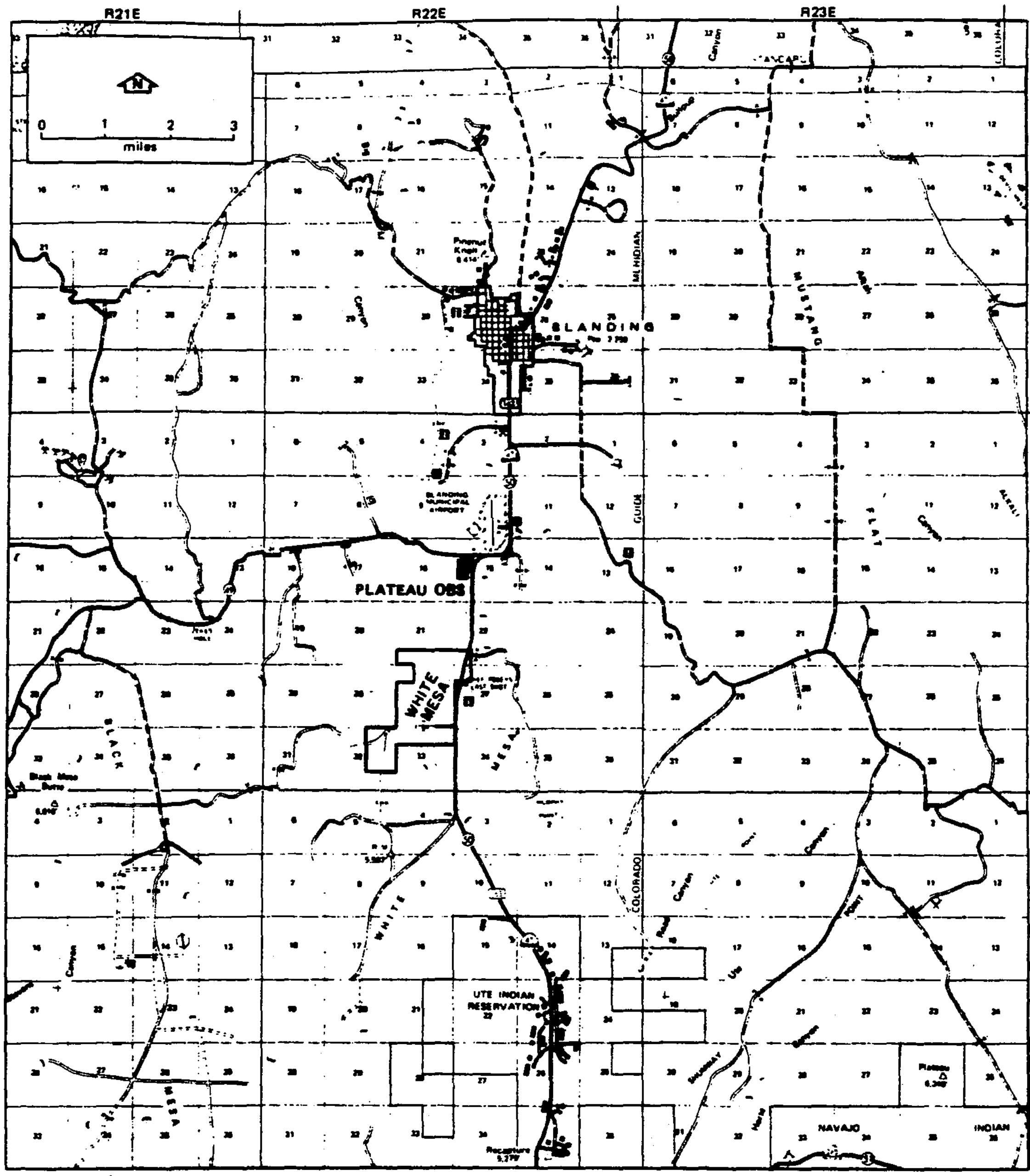

Fig. 1.1. Location of the site of the White Mesa Uranium Project [OBS = ore buying station]. <u>Source</u>: Plateau Resources, Ltd., *Application for a Source Material License for the Blanding Ore Buying Station,* Grand Junction, Colo., Apr. 3, 1978, Fig. 2.1-2.

uranium and/or thorium in any form or ores containing 0.05% or more of uranium, thorium, or combinations thereof). 10 CFR Part 51 provides for the preparation of a detailed Environmental Statement pursuant to the National Environmental Policy Act of 1969 (NEPA) prior to the issuance of an NRC license to authorize uranium milling.

The NEPA became effective on January 1, 1970. Pursuant to Section 102(2)(C), in every major Federal action significantly affecting the quality of the human environment, Federal agencies must include a detailed statement by the responsible official on

1. the environmental impact of the proposed action,
2. any adverse environmental effects that cannot be avoided should the proposal be implemented,
3. alternatives to the proposed action,
4. the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and
5. any irreversible and irretrievable commitments of resources that would be involved in the proposed action should it be implemented.

This detailed Environmental Statement has been prepared in response to the above requirements.

The State of Utah implements other rules and regulations affecting the project through necessary permits and approvals provided by State agencies. The Utah Division of Oil, Gas, and Mining is the responsible agency for all mine and mill sites within the State under the "Utah Mined Land Reclamation Act of 1975." Title II of the "Uranium Mill Tailings Radiation Control Act of 1978" gives the NRC direct licensing authority over uranium mill tailings. Bonding arrangements will be required to assure funding for reclamation of the tailings impoundment and mill site grounds and for decommissioning of the facility.

1.4 STATUS OF REVIEWS AND ACTIONS BY FEDERAL AND STATE AGENCIES

The only regulatory action required from the NRC is the issuance of a Source Material License. In addition, before construction and operation of the White Mesa Uranium Project can be completely implemented, the State of Utah requires that permits or licenses be obtained prior to the initiation of various stages of construction and operation of the mill. The current status of these regulatory approvals and permits is given in Table 1.1.

1.5 NRC MILL LICENSING ACTIONS

In June 1976 [*Fed. Regist.* 41(108): 22430-22431 (June 3, 1976)], the NRC specified that applicants requesting a Source Material License prior to the NRC's issuance of its generic environmental impact statement on uranium milling (scheduled for release in 1979) should address five criteria that will be weighed by the Commission in licensing and relicensing actions. These criteria are considered below as they apply to the White Mesa Uranium Project.

1. *It is likely that each individual licensing action of this type would have a utility that is independent of the utility of other licensing actions of this type.*

   This statement is manifestly true for uranium mills in general and for the White Mesa mill in particular. This mill is located near multiple mining operations producing low-grade ore (≈0.13%). The costs of hauling this ore over longer distances make this project virtually independent of other milling operations. This milling project can be considered on its own merits, licensing actions with respect to other mills are independent of this mill, and a separate cost-benefit analysis can be performed.

Table 1.1. Status of regulatory approvals and permits required prior to operation of the White Mesa Uranium Project

Permit or license	Granting authority[a]	Date of application	Date granted
Water appropriation permits	USEO		
47943–(09-689)		3-7-77	10-17-77
47331–(09-672)		12-10-76	4-27-77
Water Quality Construction Permit	UBWQ, UWPCC	11-22-78, 11-7-78	3-12-79
Public drinking water system	UBWQ, UWPCC	2-23-77	4-20-77
Air Quality Construction Permit	UBAQ, UACC	11-22-78	In review
Mill tailings disposal	UBSWM	11-22-78	None required
Recording of mill site claims	BLM	Continuing	
Source Material License	USNRC	2-6-78	3-12-79
Sanitation facilities	UBS		None required
Prevention of significant deterioration	USEPA	11-15-78	In review

[a]Explanation of acronyms and initialisms: Utah State Engineers Office, USEO; Utah Bureau of Water Quality, UBWQ; Utah Water Pollution Control Committee, UWPCC; Utah Bureau of Air Quality, UBAQ; Utah Air Conservation Committee, UACC; Utah Bureau of Solid Waste Management, UBSWM; U.S. Bureau of Land Management, BLM; U.S. Nuclear Regulatory Commission, USNRC; Utah Bureau of Sanitation, UBS; and U.S. Environmental Protection Agency, USEPA.

2. *It is not likely that the taking of any particular licensing action of this type during the time frame under consideration would constitute a commitment of resources that would tend to significantly foreclose the alternatives available with respect to any other individual licensing action of this type.*

   The proposed action involves the construction and operation of a mill to produce yellow cake from local uranium ore bodies. As pointed out in the response to the first criterion, uranium mills are normally located close to economically exploitable ore bodies. The ore would not likely be exploited to provide feed for a more distant mill. As to the commitment of resources, none of the materials involved in the construction and operation of the mill are unique or in short supply; hence, licensing this mill would not effect any licensing action with respect to other mills. Air, land, and water resources would be used locally but not to an extent to preclude the erection and operation of another mill.

3. *It is likely that any environmental impacts associated with any individual licensing action of this type would be such that they could adequately be addressed within the context of the individual license application without overlooking any cumulative environmental impact.*

   This Environmental Statement contains an assessment of the environmental impacts associated with the proposed licensing action and their severity, and includes proposed monitoring programs and actions to mitigate the impacts. Cumulative impacts have been addressed within the context of the individual license. The relative isolation of the proposed site virtually ensures that all appropriate environmental impacts can be adequately addressed in this site-specific Environmental Statement. Adverse effects characteristic of all uranium mills will be evaluated in a forthcoming generic environmental statement.

The major objective of the generic statement is the generation of proposals to mitigate such effects.

4. *It is likely that any technical issues that may arise in the course of a review of an individual license application can be resolved within that context.*

   The applicant has considered alternative mill processes, tailings, disposal methods, and other technical issues in its license application and Environmental Report. The staff has reviewed the applicant's evaluations and, in addition, has evaluated other technical issues. All of these evaluations and, presumably, any further technical issues that may arise during review are resolvable within the content of the individual licensing action, inasmuch as this mill is independent of other mills. In addition, the license will be conditioned as required by the *Federal Register* notice of June 3, 1976, to permit revision of waste generation, waste management, and other practices.

5. *A deferral on licensing actions of this type would result in substantial harm to the public interest as indicated above because of uranium fuel requirements of operating reactors and reactors now under construction.*

   As previously stated by the NRC[4] "the full capacity of the existing mills will be required to support presently operating nuclear power reactors and those expected to to begin operation in 1977." The White Mesa mill is one of a small number of new mills that have been proposed in the last several years and a deferral of its operation could decrease the supply of uranium and extend the time required for the delivery of fuel to reactors now operating or under construction. This could adversely affect the ability of reactors to deliver needed electrical power. Such a short-fall of electrical energy is generally construed to be harmful to the public interest. (See also Sects. 10.5 and 10.6 and Appendix B.)

REFERENCES FOR SECTION 1

1. Energy Fuels Nuclear, Inc., "Application for Source Material License (NRC-2)", February 6, 1978, revised September 26, 1978.

2. Energy Fuels Nuclear, Inc., "Environmental Report, White Mesa Uranium Project, San Juan County, Utah", January 30, 1978, revised May 15, 1978.

3. Energy Fuels Nuclear, Inc., letter to NRC, November 8, 1978.

4. "Uranium Milling, Intent to Prepare a Generic Environmental Impact Statement," Federal Register (41 FR 22430), June 3, 1976.

2. THE EXISTING ENVIRONMENT

2.1 CLIMATE

2.1.1 General influences

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

2.1.2 Precipitation

Precipitation in the vicinity of the White Mesa Uranium Project is light (Table 2.2). Normal annual precipitation is about 30 cm (12 in.). Most precipitation in the area is rainfall, with about 25% 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.

2.1.3 Winds

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. Summaries of wind direction and wind speed distributions are given in Tables D.1 and D.2 of Appendix D.

2.1.4 Storms

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-hr precipitation reported to have fallen during a 30-year period at Blanding was 5.02 cm (1.98 in.). 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 (see Sect. 5.1.3.1 for estimate of probability). Strong winds can occur in the area along with thunderstorm activity in the spring and summer. The White Mesa site is susceptible to occasional duststorms, 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. Duststorms usually occur following frontal passages during the warmer months and are occasionally associated with thunderstorm activities.

Table 2.1. Temperature means and extremes at Blanding, Utah[a]

Month	Means: Daily maximum °C	Daily maximum °F	Daily minimum °C	Daily minimum °F	Monthly °C	Monthly °F	Extremes: Record highest °C	Record highest °F	Year	Record lowest °C	Record lowest °F	Year
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: Plateau Resources, Limited, *Application for Source Material License*, Table 2.2-1, p. 2-6, Apr. 3, 1978.

Table 2.2. Precipitation means and extremes at Blanding, Utah[a]

Month	Total: Mean monthly cm	Mean monthly in.	Maximum monthly cm	Maximum monthly in.	Greatest daily cm	Greatest daily in.	Year
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: Plateau Resources, Limited, *Application for Source Material License*, Table 2.2-2, p. 2-8, Apr. 3, 1978.

2.2 AIR QUALITY

The proposed mill site lies within the jurisdiction of the Four Corners Interstate Air Quality Control Region No. 14, which encompasses parts of Colorado, Arizona, New Mexico, and Utah. The air quality of the region is evaluated according to a classification system that was established in 1971 for all Air Quality Control Regions (AQCR) in the United States (ER, Sect. 2.7.4.2). The classification system rates the five major air pollutants (particulate matter, sulfur dioxide, nitrogen oxides, carbon monoxide, and photochemical oxidants) as having a priority of I, II, or III. A priority I rating means that a portion of the region is significantly violating Federal standards for a particular pollutant and special emission controls are needed. If the emissions are predominately from a single-point source, then it is further classified as IA. A priority rating of II indicates a better quality of air in the region; a priority III rating classifies the highest quality. The concentrations that define the classification are outlined in Table 2.3.

Table 2.3. Federal regional priority classifications based on ambient air quality

Pollutant	Average time	Air quality for each priority group[a]		
		I	II	III
Sulfur oxides	Annual	>100 μg/m³	60–100 μg/m³	<60 μg/m³
	24 hr	>455 μg/m³	260–455 μg/m³	<260 μg/m³
	3 hr		1300 μg/m³	<1300 μg/m³
Particulate matter	Annual	>95 μg/m³	60–95 μg/m³	<60 μg/m³
	24 hr	>325 μg/m³	150–325 μg/m³	<150 μg/m³
Carbon monoxide	8 hr	>14 mg/m³		<14 mg/m³
	1 hr	>55 mg/m³		<55 mg/m³
Nitrogen dioxide	Annual	>110 μg/m³		<110 μg/m³
Photochemical oxidants	1 hr	>195 μg/m³		<195 μg/m³

[a] In the absence of measured data to the contrary, any region containing an area whose 1970 "urban place" population exceeds 200,000 will be classified priority I. All others will be classified priority III. Hydrocarbon classifications will be same as for photochemical oxidants.

Source: ER, Table 2.7-20.

The priority classifications for the Four Corners Interstate AQCR, which includes the proposed mill site, are presented below:

	Sulfur dioxides	Particulate matter	Nitrogen oxides	Carbon monoxide	Photochemical oxidants (Hc)
Priority classification	IA	IA	III	III	III

The priority IA ratings for particulate matter and sulfur dioxide for the AQCR are due to emissions from fossil-fueled power plants located within the region (ER, Sect. 2.7.4.2). However, none of the power plants lie within 50 km (31 miles) of the mill site, which suggests that the air quality in the vicinity of the site may be better than the priority IA classification indicates.

The Utah Division of Health monitors total suspended particulates and sulfur dioxide at a station located 105 km (66 miles) west-southwest of the site at Bull Frog Marina. Except for the short-term (24-hr) particulate measurement, all reported values (ER, Table 2.7-21) were well below the Federal and State of Utah air quality standards. The 24-hr particulate violations are believed to have been caused by dust blown by high winds.

Based on data collected from four sampling locations on the project site for one year, dustfall averaged 33 g/m^2 per month; the highest monthly average was 102 g/m^2 occurring in August.[1] Total suspended particulate monitoring from October 1977 through February 1978 revealed a geometric mean of 18 $\mu g/m^3$.[1] Dustfall for this same time period averaged 23 g/m^2 per month. If a linear relationship between total suspended particulate matter and dustfall is assumed, the annual geometric mean for total suspended particulates is expected to be 26 $\mu g/m^3$. This value is well below the Federal and State air quality standard of 60 $\mu g/m^3$. The maximum 24-hr concentration was 79 $\mu g/m^3$, or approximately one-half of the Federal and State standard of 150 $\mu g/m^3$. Sulfation-rate monitoring for one year at four locations on the site indicate that sulfur dioxide concentrations at the site vicinity are less than 0.005 ppm.[1] The Federal and State standard for the annual average of sulfur dioxide is 0.03 ppm.

2.3 TOPOGRAPHY

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 deepstream 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.

2.4 DEMOGRAPHY AND SOCIOECONOMIC PROFILE

The site of the proposed White Mesa Uranium Mill is in San Juan County in southeastern Utah (Fig. 2.1), approximately 8 km (5 miles) south of the city of Blanding. Energy Fuels Nuclear, Inc., currently operates an ore buying station on this property. Energy Fuels also operates an ore buying station near Hanksville, Utah. It is intended that ore will be transported from the Hanksville facility to the proposed mill on Utah Route 95, passing through portions of Wayne, Garfield, and San Juan counties (ER, pp. 2-4 to 2-7). It should be noted that Plateau Resources Limited currently operates a uranium ore buying station in Blanding at a site located approximately 3 km (1.9 miles) north of the Energy Fuels' White Mesa site.

Because of its close proximity to the proposed mill site, the city of Blanding is likely to receive the largest share of this project's socioeconomic impacts. The communities of Monticello and Bluff also are likely to share the effects of mill-induced population increases and ensuing social impacts. These three communities and Hanksville have been studied for socioeconomic impacts. The counties of San Juan, Wayne, and Garfield have been examined where effects are likely to be generalized over a larger area.

2.4.1 Demography of the area

2.4.1.1 Current population and distribution

Compared to most eastern states, Utah is rather sparsely populated with a 1977 population of 1,271,300 — a 20% increase since 1970. This population represents an overall density of 39.9 persons per square kilometer (15.4 per square mile), but nearly 70% of Utah's population lives in the counties of Salt Lake, Utah, and Weber where Salt Lake City, Provo, and Ogden, respectively, are located.

San Juan County, where the proposed White Mesa mill would be constructed, has a population of 13,000 (an increase of 35.3% from 1970). Wayne County, the site of the Hanksville ore buying station, has a population of 1800 (a 21.4% increase since 1970). Garfield County has a total population of 3600 (an increase of 14% from 1970). The data in Table 2.4 illustrate that while these three counties have experienced growth in recent years, their overall density has remained low.

The closest city to the proposed mill site is Blanding (Table 2.5), which had a 1977 population of 3075, up 37% from 1970. Monticello, the county seat, has 2208 residents, 54% more than in 1970. Between them, these two communities account for nearly 40% of San Juan County's population (ER, p. 2-18). Another 46% of the total is made up of Navajo Indians living on or near

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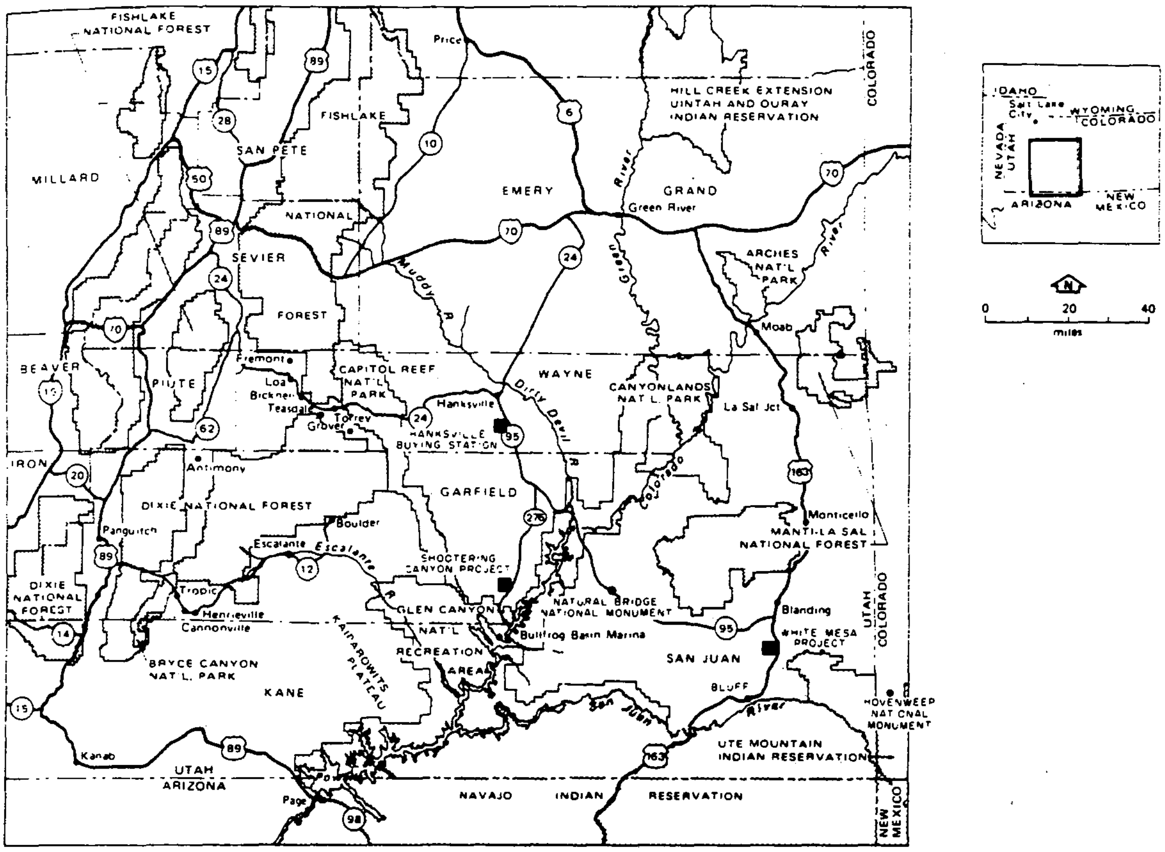

Fig. 2.1. Regional map of the White Mesa Uranium Project site. Source: Plateau Resources, Ltd., *Application for a Source Material License for the Blanding Ore Buying Station,* Grand Junction, Colo., Apr. 3, 1978.

Table 2.4. Area and population for Utah and Wayne, Garfield, and San Juan counties, 1970 and 1977

State or county	Land area		Total population			Population per square kilometer			
						1970		1977[a]	
	km^2	sq miles	1970	1977[a]	Change (%)	km^2	sq. mile	km^2	sq. mile
Utah, total	213,180	82,340	1,059,273	1,271,300	20.0	5.0	12.9	5.9	15.4
Wayne	6,444	2,489	1,483	1,800	21.4	0.2	0.6	0.3	0.7
Garfield	13,507	5,217	3,157	3,600	14.0	0.2	0.6	0.3	0.7
San Juan	20,412	7,884	9,606	13,000	35.3	0.5	1.2	0.5	1.6

[a]Preliminary data.

Source: U.S. Bureau of Census, 1970; Utah Population Work Committee, 1977.

Table 2.5. Population centers near the White Mesa Uranium Project

	Approximate distance from the project sites			
	Blanding site		Hanksville site	
	km	miles	km	miles
Colorado				
Grand Junction[a]	290	180	260	160
Cortez[a]	140	85	346	215
Durango[a]	210	130	420	260
Utah				
Blanding	8	5	209	130
Monticello	48	30	225	140
Bluff	32	20	225	140
Hanksville	225	140	16	10
Moab[a]	130	80	193	120
New Mexico				
Farmington[a]	260	160	750	290

[a]Population greater than 4500 according to 1975 Census records.

Source: Adapted from ER, Table 2.2-1.

the Navajo Reservation in southern San Juan County (ER, p. 2-15). The town of Bluff has a population of 280, more than double its population in 1970 (ER, p. 2-18).

Within a 290-km (180-mile) radius of the proposed mill there are several larger cities that are important regional centers (See Table 2.5 for distance relationships to the project sites). Moab, Utah, the closest and also the smallest, has a population of approximately 4500 according to 1976 census records (ER, Table 2.2-1). Cortez, Colorado, has a population slightly under 6800 and Durango, Colorado, has nearly 12,000 residents. Both Grand Junction, Colorado, and Farmington, New Mexico, have populations approaching 28,000.

Approximately 16 km (10 miles) from the Hanksville ore buying station is the town of Hanksville, which had a 1975 population of 160.

The area within an 8-km (5-mile) radius of the proposed mill is sparsely populated and primarily agricultural. It is estimated that about 70 to 80 people currently reside here. The closest currently inhabitated dwelling unit is approximately 5 km (3 miles) north of the site (Applicant's responses to ER questions, Enclosure 2, p. 2), but most area residents live to the south in the Ute Mountain community of White Mesa. The Blanding airport also lies within this 8-km (5-mile) zone, and approximately 30 to 40 people use that facility daily.

2.4.1.2 Projected population and distribution

Between now and the year 2000, Utah's population is expected to rise steadily according to projections prepared by the Utah Agricultural Experiment Station (Table 2.6). Both high and low projections assume a gradual decline in mortality and constant fertility. The difference between them is that the high figures also assume a positive net migration while the low figures are based on no net migration at all. Projections for San Juan County indicate a much greater growth rate than for the State as a whole (Table 2.6).

According to the city manager of Blanding, a population increase of almost 1500 is expected within the next three years, bringing the number of city residents to 4540 by 1981 (City Manager of Blanding, Utah, personal communication, July 10, 1978). This estimate represents an increase of 47.6% over the 1977 population and is based on the assumption that the proposed White Mesa uranium mill will be built. Monticello's city manager is also predicting growth, but at a lesser rate than for Blanding. Between now and 1983, an increase of approximately 600 (or 27%) is expected (City Manager of Monticello, Utah, personal communication, July 30, 1978).

Table 2.6. Population projections,[a] San Juan, Wayne, and Garfield counties, compared to the State

	1975[b]	1980	1990	2000	Percent increase (1975–2000)
Utah					
High	1,216,843	1,420,553	1,803,985	2,163,927	78
Low	1,206,584	1,302,815	1,484,231	1,655,528	37
San Juan County					
High	12,816	17,373	26,002	33,300	160
Low	12,716	13,954	16,917	19,753	55
Wayne County					
High	1,960	2,660	3,770	4,530	131.1
Low	1,950	2,060	2,310	2,510	28.7
Garfield County					
High	3,480	3,940	4,670	5,960	71.3
Low	3,470	3,760	4,460	5,120	47.6

[a]High projections assume a gradual decline in mortality, constant fertility, and positive net migration. Low projections assume a gradual decline in mortality, constant fertility, and no net migration.

[b]U.S. Census estimation for 1975 indicates that actual population for the State and all three counties was below the "low" projection presented in this table.

Source: ER, Table 2.2-22.

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The Blanding airport, about 5.6 km (3.5 miles) north of the prospective mill site, has plans to expand its existing runway and storage areas by summer of 1979. An increase in flights to and from the facility may accompany these improvements (Manager of Blanding City Airport, personal communication, Aug. 2, 1978). The Ute Mountain Indian community of White Mesa is currently considering requesting the use of the idle Blanding Launch Site, part of the White Sands Missile Range, from the U.S. Army. This property, which is approximately 6 km (4 miles) south of the mill site, would be used for a community center and would not have permanent residents.

2.4.1.3 Transient population

Although the permanent population in southeastern Utah is relatively low, this area receives a substantial number of tourists each year (Table 2.7). Capital Reef National Park alone had nearly 0.5 million visitors in 1976. The exact numbers fluctuate from year to year, but the overall trend appears to be toward increasing visitation. Manti-La Sal Forest, which is six miles north of Blanding, is the nearest recreation area.

2.4.2 Socioeconomic profiles

2.4.2.1 Social profile

Housing

Blanding. From 1972 to 1975, approximately 12 new units were added each year, but in 1976 that figure rose to 37.[2,3] In 1977, 43 new dwelling units were added, and this accelerated rate of construction appears to be continuing (City Manager of Blanding, Utah, personal communication, July 10, 1978). Mobile homes in this area are often found on individual lots in single-family neighborhoods as well as in mobile home parks.

At present, the supply of new housing is keeping up with the number of residences, and the vacancy rate is very low. Approximately 200 lots are available for single-family houses in Blanding to accommodate future growth. There are also around 25 current vacancies in a local mobile home park (ER, p. 4-18). The supply of rental units in Blanding, as in many small cities, is low (ER, p. 2-50).

Table 2.7. Visitor statistics, recreation areas in southeastern Utah[a]

Area	Visitors (thousands)					
	1972	1973	1974	1975	1976	1977 (January–September)
Glen Canyon National Recreation Area	60.8					
Canyonlands National Park	60.8	62.6	59.0	71.8	80.0	67.3
Manti-La Sal National Forest (visitor days)[b]	105.3	100.9	88.7	76.4		NA[c]
Capital Reef National Park	272.0	311.2	234.0	292.1	469.6	364.2 (through August)
Hovenweep National Monument[d]	12.1	12.0	11.0	13.2	19.4	16.2
Natural Bridges National Monument	58.5	42.7	40.3	48.4	71.9	67.1

[a] Data refer to actual visitations for each area except Manti-La Sal National Forest. Here, data indicate recreation visitor days. A visitor day is the equivalent of one person entering an area for 12 hr.

[b] Data refer to the Monticello Ranger District only.

[c] Indicates data not available.

[d] Data refer to the Square Tower Ruin Unit, near Blanding.

Source: ER, Table 2.2-5.

Monticello. During the five years of 1972 through 1976, the supply of housing in Monticello was increasing at approximately six units per year.[4,5] In 1977 this figure jumped to around 60 units per year, and between 60 and 80 new units are expected to be constructed in 1978; however, the demand for housing has not yet exceeded the supply (City Manager of Monticello, Utah, private communication, July 20, 1978). An expected annexation will double the size of the city and provide room for at least 150 more single-family homes. Approximately 35 vacancies now exist in local mobile home parks (ER, p. 4-18). As in Blanding, rental housing is scarce. A 23-unit apartment is currently being constructed to accommodate some of the demand for this kind of housing (City Manager of Monticello, Utah, private communication, July 20, 1978).

Bluff. Over the last five years, the supply of new housing in Bluff has increased at a rate of five or six new housing units annually and the demand has not exceeded the supply. The existence of approximately 70 vacant lots with water connections and available spaces in two mobile parks within the city limits indicate that Bluff is capable of accommodating future growth (ER, p. 2-56).

Hanksville. Hanksville currently has no excess housing supply, and the majority of families live in mobile homes. Hanksville is presently installing a new water system to service the existing community and to provide service for 24 new building sites for permanent housing.

Public services

Blanding. Water is obtained from surface runoff and underground wells, and an 0.11-m^3/sec (1800-gpm) sewage treatment plant is operated by the city. Water consumption in 1976 averaged 0.023 m^3/sec (547,000 gpd). The current system is adequate to handle moderate population increases, and improvements are being planned to handle the influx of new residents expected by 1981 (City Manager of Blanding, Utah, personal communication, July 10, 1978). Sewage treatment is provided through a lagoon system, and improvements are planned for the near future. Electricity is provided through a city-owned distribution system; the city also provides solid waste collection and disposal. Propane gas is available through two private distributors, but there is no natural gas service (ER, p. 2-46). Local streets are maintained jointly by the city and county (Treasurer of San Juan County, Utah, personal communication, July 25, 1978).

Blanding has a full-time police force of three officers and an auxiliary force of eight, and a volunteer fire department provides fire protection. Health care is available through the 36-bed San Juan County Hospital in Monticello, a 31-bed nursing home in Blanding, and two local doctors, one public health nurse, and one dentist. There is a mental health clinic in town with one full-time therapist (ER, p. 2-47).

Two elementary schools and one high school serve Blanding. The combined capacity of the elementary schools is 750 students; 630 are currently enrolled. With 874 students, however, the high school has 174 students more than the planned capacity. The opening of two new high schools, scheduled for the near future (one in 1978 and one in 1979/1980), should ease the current overcrowding (ER, p. 2-48).

Blanding's recreational resources consist of one swimming pool, one lighted ball field, one nine-hole golf course, three parks, and a school softball field and gymnasium that are also available for public use.[6] Local residents also have access to several National parks, forests, monuments, and recreation areas (Table 2.7). The San Juan County Library is located just north of Blanding (Treasurer of San Juan County, Utah, personal communication, July 25, 1978). In addition, the applicant has recently provided support for certain recreational endeavors in the local area through the sponsorship of athletic teams and related activities. To accommodate anticipated future growth, the city has set apart an area for an additional ball field and park.[6]

Monticello. Water is supplied by surface runoff and groundwater, and, as in Blanding, there is a city-operated water treatment plant. Improvements to the water supply system are being undertaken to raise its overall capacity (City Manager of Monticello, Utah, personal communication, July 20, 1978). Primary and secondary sewage treatment is provided by a local digestor plant, and future improvements are planned (ER, p. 2-51). The City of Monticello distributes electricity supplied by Utah Power and Light to city residents. The transmission system is now at capacity, but Monticello's city manager has said that the city is currently considering ways to expand its service area. Natural gas is available through the Utah Gas Service (ER, p. 2-53). Monticello currently operates a waste disposal service, and street maintenance is a joint responsibility of city and county.

Police and fire protection is provided by the three full-time police employees and one part-time police employee. They are aided by the County Sheriff's Department and a volunteer fire department with three trucks (ER, pp. 2-53 and 2-54). The 36-bed San Juan County Hospital and a small mental health clinic with one therapist and one outreach worker are in Monticello. There is also a public health nurse in town.

There are an elementary school and a high school in town, both of which are currently operating at about two-thirds of their peak capacity. The elementary school, which can handle 550 students, now has 365 enrolled. The high school, designed for 500, serves 370 students (ER, p. 2-54).

Three public parks, one swimming pool, one golf course, a local ski resort, and the National areas listed in Table 2.7 provide recreational opportunities for area residents. One of the city parks is currently being expanded, and it is the judgment of the city manager that these facilities are adequate to handle future mill-induced population increases.[6]

Bluff. The water system for Bluff consists of three artesian wells and a 760-m^3 (2×10^5-gal) storage tank capable of servicing a population almost double the present one. Sewage treatment is currently provided through individual septic tanks although construction of a community treatment facility has been proposed (ER, p. 2-56).

Two sheriff's deputies are responsible for local police protection, and fire protection is the responsibility of an eight-person volunteer fire department. Bluff residents have access to county health services in neighboring cities, and outreach workers for the Four Corners Mental Health Agency are available.

One elementary school, with a capacity of 200, provides education for the 104 students. A proposal for expansion of recreational facilities was recently defeated by community voters, leaving one park, one ball field, and the recreational areas shown in Table 2.7.[6]

Hanksville. A single privately owned well supplies water to Hanksville residents and is operating at peak capacity although installation of a new water storage and distribution system is under way. No community sewage is provided. A county dump is available for city waste disposal (ER, p. 2-72). The Gar-Kane Power Company supplies electricity in this area (ER, p. 2-74).

Law enforcement is provided by one part-time sheriff and road maintenance is also provided by the county. Ambulance and emergency medical services are available in town; however, the nearest medical clinic is in Green River, 97 km (60 miles) to the north. The nearest hospital is over 160 km (100 miles) away in Moab (ER, p. 2-72).

Hanksville's 50 elementary students attend a local school with an enrollment capacity of 60. Middle and high schoolers are bused to Bicknell, 105 km (65 miles) away. The middle school has a current enrollment of 105 and a capacity of 120; the high school has 155 students and the ability to take 200 (ER, p. 2-74).

Culture

Navajo and Ute Indian populations concentrated in southern San Juan County have their own cultural heritage. As shown in Table 2.8, almost half of the county's residents are nonwhite (46.4%), and most of these are Navajos. Religion is another significant influence in southeastern Utah. The predominant Church of Jesus Christ of Latter Day Saints stresses within its beliefs the values of family life, education, and marriage and provides a focus for community life. Table 2.8 also compares the age and educational attainment of the three counties and the State as a whole.

Table 2.8. Selected demographic characteristics, San Juan County, compared to Utah (1970)

	San Juan County	Wayne County	Garfield County	Utah
Total population	9,606	1,638	3,157	1,059,273
Race				
White	5,153			1,033,880
Other (%)	46.4			2.4
Education				
Median school years completed (population 25 years and over)	10.7	12.1	12.2	12.5
Percent of population with less than 5 years	27.0	1.2	0.3	2.0
Percent of population with 4 years of college or more	8.8	8.9	8.7	14.0
Age				
Median age	18.0	27.3	26.4	23.0
Percent under 5 years	13.9	7.4	8.2	10.6
Percent 5–17	36.0	35.4	32.6	29.6
Percent 18–64	45.6	49.3	49.4	52.5
Percent 65+	4.5	7.9	9.8	7.3

Source: ER, Tables 2.2-4 and 2.2-21.

2.4.2.2 Economic profile

Between 1970 and April 1978, the number of nonagricultural payroll jobs in San Juan County increased by over 1000 – from 1786 to 2452. The relative importance of the various economic sectors also shifted in that period. Services stayed nearly the same; the relative importance of trade, transportation, construction, and manufacturing declined slightly; and the significance of finance, insurance, and real estate rose a little. The importance of mining and government changed dramatically, however. Employment in government services declined from 31.6 to 24.5%, while mining climbed from 21.3 to 31.7% of the total.[7]

Because total employment increased so greatly, the absolute number of jobs rose in all categories. The largest increase by far, however, was in mining, which grew from 381 jobs in 1970 to 935 in April 1978. In the one-year period ending April 1978, the largest numerical increases were experienced in construction, mining, trade, and services (Table 2.9).

Table 2.9. Nonagricultural payroll jobs in San Juan, Wayne, and Garfield counties from April 1977 to April 1978

	April 1977	Percent of total	April 1978	Percent of total	Percent change
San Juan County					
Manufacturing	185	6.6	197	6.7	6.5
Mining	890	31.5	935	31.7	5.1
Construction	142	5.0	155	5.2	9.2
Transportation, commerce, utilities	157	5.6	168	5.7	7.0
Trade	400	14.2	424	14.4	6.0
Finance, insurance, real estate	25	0.9	27	0.9	8.0
Services	303	10.7	322	10.9	6.3
Government	718	25.5	724	24.5	0.8
Total	2820	100.0	2452	100.0	4.7
Wayne County					
Manufacturing	28	6.5	24	6.5	3.6
Mining	48	11.1	50	11.2	4.2
Construction	63	14.6	64	15.4	9.5
Transportation, commerce, utilities	2	0.5	2	0.4	–
Trade	44	11.4	52	11.6	6.1
Finance, insurance, real estate	7	1.6	7	1.6	–
Services	23	5.3	24	5.4	4.3
Government	211	49.0	214	47.9	1.4
Total	431	100.0	447	100.0	3.7
Garfield County					
Manufacturing	237	19.1	252	19.4	6.3
Mining	46	3.7	48	3.7	4.3
Construction	57	4.6	62	4.8	8.8
Transportation, commerce, utilities	66	5.3	71	5.4	7.6
Trade	184	14.9	195	15.0	6.0
Finance, insurance, real estate	14	1.1	15	1.2	7.1
Services	288	23.3	306	23.6	6.2
Government	347	28.0	350	26.9	0.9
Total	1234	100.0	1244	100.0	4.8

Source: Utah Department of Employment Security, Research and Analysis Section, adapted from *Quarterly Employment Newsletter of Southeastern District of Utah*, January–April 1978.

The mineral industry is extremely important to San Juan County, and uranium production is a substantial component of this sector. In fact, San Juan County is the largest producer of uranium in Utah, and this activity has increased dramatically since 1975 (Utah Geological and Mineral Survey, private communication, July 17, 1978). Natural gas and crude oil are the other important materials being produced here (ER, p. 2-32).

Tourism is also an important part of San Juan County's economy, a part that has been increasing steadily in recent years. Between 1975 and 1977, tourist room rentals increased by 32.5%.

Total nonagricultural payroll employment in Wayne County was 447 in April 1978 (Table 2.9). The government employed almost 50% of those workers, and construction, trade, and mining activities accounted for nearly 40%.

In Garfield County, nonagricultural employment for April 1978 totaled 1244 (Table 2.9). The government accounted for slightly over 25% of this employment, services for slightly under 25%, manufacturing for almost 20%, and trade for another 15%.

Between 1973 and 1977, per capita income for the State of Utah rose by 44%, from $4100 to $5900. Increases in per capita income for San Juan County did not keep pace with raises elsewhere. Income in 1973 was $2400, 58.5% of the State average, and 1977 income was $3400 or 57.6% of the State figure (Table 2.10).

Between 1970 and 1977, unemployment fell for the State as a whole and for Wayne, Garfield, and San Juan counties. The State figure went from 6.1 to 5.3%; Wayne County, from 8.5 to 7.2%; Garfield, from 19.2 to 7.9%; and San Juan, from 10.7 to 8.1% (Table 2.11).

The characteristics of job applicants in San Juan County, where the White Mesa mill is to be located, are listed in Table 2.12. Most jobs in mining are classified in the "miscellaneous" section.

The number of retail and wholesale establishments and their sales are shown in Table 2.13 for San Juan County and the cities of Blanding and Monticello. Since 1967, county wholesale and retail sales have both nearly tripled.[8] Retail sales are almost evenly divided between Blanding and Monticello, together accounting for 94.3% of the county's total retail activity.

In 1977, San Juan County levied an ad valorem tax of 16 mills on the assessed value of all property in the county for the general fund. An additional 40 mills was collected for the county school district and a final 2 mills for the countywide water conservation district. The communities of Monticello, Blanding, and Bluff also levied an extra 15, 21, and 10 mills, respectively, on the assessed value of all property within their corporate limits. Finally, the Monticello and Blanding Cemetery Districts each collected 2 mills on all property within those district boundaries. Mines and mills are subject to the above taxes as is all other real property. The total amount collected from all these funds combined was $5,126,748 (Treasurer of San Juan County, Utah, personal communication, July 25, 1978), two-thirds of which went to the County School District. In addition to the property tax, San Juan County also received $87,496 in sales taxes.

San Juan County handles its financial affairs through a number of separate funds, the largest of which is the general fund (Appendix C). Within this fund, the property tax comprises the largest single source of revenue, accounting for slightly over 33% of the 1977 total. Shared revenues from the State of Utah contributed another 20.1%, and Federal shared revenues and in-lieu-of-tax payments added another 15.3%.

The largest expenditure for San Juan County in 1977 was for road maintenance ($1,176,000) amounting to slightly over one-half of total county funds. Other large outlays were 11.2% for health services and 6.4% for the Sheriff's Department.

In the fiscal year ending in June 1977, the largest source of revenue for the city of Blanding's general fund (Appendix C) was the sale of a general obligation electric-, water-, and sewer-improvement bond issue, yielding $225,000. This was followed by slightly over $55,000 from sales and use taxes and a little more than $44,000 from property taxes. Federal revenue sharing and waste collection and disposal fees were the other major sources of funds, each contributing about $18,000 to the total. Utility operations were financed through a separate fund.

Blanding's major expenditures in the same year were for public utility capital improvements and police expenses, each of which cost less than $50,000. Street maintenance cost about half this amount, and waste collection and airport funds made up the last of the major expenditures.

Table 2.10. Per capita incomes for Utah and Wayne, Garfield, and San Juan counties, 1973–1977

State or county	1973	1974	1975	1976[a]	1977[b]
Utah	$4,100	$4,500	$4,800	$5,300	$5,900
Wayne	3,100	3,400	3,800	4,100	6,100
Garfield	3,400	3,300	3,500	4,200	5,000
San Juan	2,400	2,700	2,900	2,900	3,400

[a] Revised.
[b] Preliminary estimate.
Source: Utah Department of Employment Security, Research and Analysis Section, adapted from *Quarterly Employment Newsletter of Southeastern District of Utah,* January–March 1978.

Table 2.11. Total civilian labor and unemployment for Utah and Wayne, Garfield, and San Juan counties, 1970 and 1977

State or county	Labor force		Unemployment		Unemployment rate	
	1970	1977[a]	1970	1977[a]	1970	1977[a]
Utah	414,248	551,900	25,214	29,500	6.1	5.3
Wayne	664	880	57	63	8.5	7.2
Garfield	1,483	1,773	285	140	19.2	7.9
San Juan	3,015	4,198	322	341	10.7	8.1

[a] Preliminary.
Source: Utah Department of Employment Security, Research and Analysis Section, adapted from *Quarterly Employment Newsletter of Southeastern District of Utah,* January–March 1978.

Table 2.12. Occupational characteristics of job applicants in the Blanding area, January–March 1978

Includes persons actively seeking employment, some of whom were employed at the time

Professional, technical, managerial	44
Clerical, sales	59
Service	76
Farm, fisheries, forestry	39
Processing	5
Machine trades	27
Bench work	56
Structural	156
Miscellaneous	51
Total	513

Source: Utah Department of Employment Security, Research and Analysis Section, adapted from *Quarterly Employment Newsletter of Southeastern District of Utah,* January–March 1978.

Table 2.13. Retail and wholesale activity in San Juan County, Blanding, and Monticello (1976)

	San Juan County	Blanding	Monticello
Number of retail establishments	101	35	40
Retail sales	$15,300,000	$7,150,000	$7,280,000
Number of wholesale establishments	9	3	3
Wholesale sales	$ 5,600,000	NA[a]	NA

[a]NA: Information is not available.

Source: Utah Industrial Development Information System, *Economic Facts for San Juan County, Blanding, and Monticello*, 1977.

As in Blanding, Monticello has a separate fund for operating public utilities. Over $350,000 was spent during fiscal year 1977-1978. Slightly over half of the city's nearly $150,000 in general fund revenues for the fiscal year ending June 1978 came from sales and use taxes, while property taxes contributed another 25%. Unlike the county, both Monticello and Blanding receive more of their general funds from sales taxes than from property taxes. The largest expenditure in 1978 was the $54,800 spent on administration. This figure was followed by the $49,400 spent for police protection.

2.4.2.3 Transportation

A system of two-lane paved highways and unimproved roads accounts for virtually all transport of people and products in and out of San Juan County. Although Blanding, Bluff, Monticello, and Canyonlands National Park have small municipal airports, there is no rail, bus, or commercial air service (ER, p. 2-30).

U.S. Route 163 receives a greater amount of traffic than any other road in the county. This highway runs between I-70 on the north [approximately 161 km (100 miles) from the proposed mill] and U.S. Route 160 in Arizona to the south; the highway passes through Monticello, Blanding, and Bluff. The heaviest traffic in the county is on this artery just north of Monticello, where the average daily vehicles were about 2685 in 1975. More recent figures indicate a 43% increase in traffic in this area between 1975 and 1977 (ER, p. 2-30).

Traffic volumes on Utah Route 95 from the Blanding area to Hanksville are much lighter but have been increasing in recent years (Table 2.14). From 1975 to 1977, an increase of 33% was observed on Highway 95 south of Hanksville (ER, p. 2-30). U.S. Route 666 from Monticello to Cortez, Colorado, also carries a significant amount of traffic.[9] All of the roads in this area carry a substantial amount of out-of-state traffic (Table 2.14).

2.5 LAND USE

2.5.1 Land resources

Southeastern Utah is known as the Canyonlands area; an arid climate and rugged terrain have limited permanent settlement of this region. Large rock formations and deep, narrow canyons are characteristic of the area, and these, combined with the Indian ruins found here, are attracting increasing numbers of tourists (ER, p. 2-23). Much of this area is isolated, however, and the population density is low (Sect. 2.4.1.1).

The site of the proposed White Mesa Uranium Mill consists of 600 ha (1480 acres), approximately 8 km (5 miles) south of the city of Blanding off U.S. Route 163. About one-third of the total site is scheduled to be actually used for mill operations and tailings disposal. The immediate area is bordered by both privately owned and Federal land.

Table 2.14. Traffic volumes in 1975 for San Juan County and Blanding-Hanksville route

Highway	Segment	Average daily traffic counts[a]	Approximate percentage of out-of-state passenger traffic
Utah Route 95	Blanding to Natural Bridges Natl. Monument	310	20
	Natural Bridges to Hite	95	10
	Hite to Hanksville	95–290	10–20
U.S. Route 163	Monticello to La Sal Junction	1490–2685	20–35
	Monticello to Blanding	860–1985	10–25
	Blanding to Utah Route 262 turnoff	740–925	20–30
	Utah Route 262 to Bluff	530	40
	Bluff to Mexican Hat	560	40
Utah Route 263	Route 95 to Halls Crossing at Glen Canyon	25–35	20
Utah Route 261	Route 95 to Mexican Hat	130	50

[a]Two figures in this column represent values given for different points along the route. One figure indicates that a traffic count was taken at only one location.
Source: ER, Table 2.2-9.

Much of the land in San Juan County is Federally owned (see Table 2.15). Approximately two-thirds of this land is administered by the U.S. Bureau of Land Management for multiple uses such as grazing, mineral extraction, timber production, and wildlife management. Another one-fifth of the Federal land is managed by the National Park Service and slightly less than one-sixth is under the control of the U.S. Forest Service (ER, p. 2-25). One-fourth of the total area is Indian land. Nearly all of this territory is part of the Navajo Indian Reservation, but a small portion belongs to the Ute Mountain tribe (ER, pp. 2-23 to 2-26). The State owns 6.5% of San Juan County, leaving only 8.3% in private hands (Table 2.15).

Table 2.15. Land ownership, Wayne, Garfield, and San Juan counties, 1967

	Wayne County			Garfield County			San Juan County		
	ha	acres	Percentage	ha	acres	Percentage	ha	acres	Percentage
Federal	542,055	1,338,875	84.2	1,195,842	2,953,729	89.0	1,208,247	2,985,630	59.8
State	59,373	146,651	9.2	90,167	222,712	6.7	131,707	325,317	6.5
Indian	0	0	0	0	0	0	505,086	1,247,563	25.0
Private	40,472	99,965	6.3	53,578	132,337	4.0	168,664	416,600	8.3
Urban and transportation	2,193	5,416	0.3	3,507	8,662	0.3	6,177	15,253	0.3
Small water[a]	54	133	*b*	389	960	*b*	404	997	*b*
Total area	644,146	1,591,040	100.0	1,343,481	3,318,400	100.0	2,019,940	4,991,360	100.0

[a]Includes water areas of 0.8 to 16 ha (2 to 40 acres) and streams less than 0.20 km (0.125 mile) in length
[b]Less than 0.1%.
Source: ER, Table 2.2-23.

In Wayne County, much of the land is Federally owned (Table 2.15). As in San Juan County, administration is split between the U.S. Bureau of Land Management, the U.S. Forest Service, and the National Park Service. The State controls 9.2% of the land in Wayne County, and 6.3% is in private hands. There is no Indian land.

Garfield County exhibits almost the same ownership pattern as neighboring Wayne County. Federal land control is exercised by the U.S. Bureau of Land Management, the U.S. Forest Service, and the National Park Service (ER, p. 2-63). State land accounts for 6.7% of the total, and private land comprises another 4%. There is no Indian land (Table 2.15).

Because of the arid nature of this area, the primary agricultural use of the non-Federal property in all three counties is rangeland (Table 2.16). The land within 8 km (5 miles) of the proposed mill is primarily used for grazing. In addition to the uranium ore buying station currently operated at the site by Energy Fuels Nuclear, Inc., nonagricultural land uses in this area include the Blanding airport, a small commercial establishment, a part of the Ute Mountain Indian community of White Mesa, several structures connected with the U.S. Army's Blanding Launch Site, and another ore-buying station, operated by Plateau Resources, Inc. (ER, p. 2-29).

Table 2.16. Land use in Wayne, Garfield, and San Juan counties excluding Federal land, 1967[a]

	Wayne County			Garfield County			San Juan County		
	ha	acres	Percentage	ha	acres	Percentage	ha	acres	Percentage
Cropland	8,829	21,815	8.6	13,651	33,732	9.2	59,093	146,016	7.3
Irrigated	8,829	21,815	8.6	12,897	31,869	8.7	2,878	7,111	0.4
Nonirrigated	0	0	0	754	1,863	0.5	56,215	138,905	6.9
Pasture	0	0	0	1,481	3,660	1.0	24,497	60,531	3.0
Rangeland	69,465	171,645	68.0	91,923	227,139	62.3	511,139	1,263,007	63.0
Forest	4,235	10,464	4.2	24,331	60,120	16.5	187,100	462,318	23.0
Other[b]	17,277	42,691	16.9	12,302	30,398	8.3	23,314	57,608	2.9
Urban and transportation	2,192	5,416	2.1	3,506	8,662	2.4	6,173	15,253	0.8
Small water[c]	54	133		389	960	0.3	403	997	
Total non-Federal	10,205	252,165	100.0	147,582	364,671	100.0	811,719	2,005,730	100.0
Federal	541,843	1,338,875		1,195,374	2,953,729		1,208,284	2,985,630	
Total county acreage	643,894	1,591,040		1,342,956	3,318,400		2,020,003	4,991,360	

[a] Water areas of more than 16 km (40 acres) and rivers wider than 0.20 km (0.125 mile) are excluded.

[b] "Other" includes strip mine areas, salt flats, mud flats, marshes, rock outcrops, feed lots, farm roads, ditch banks, and miscellaneous agricultural land.

[c] Includes water areas of 0.8 to 16 ha (2 to 40 acres) and streams less than 0.20 km (0.125 mile) in length.

Source: ER, Tables 2.2-8 and 2.2-24.

2.5.1.1 Mill ownership

The surface area of the entire 600-ha (1480-acre) project site is currently owned by Energy Fuels Nuclear, Inc. (ER, p. 2-4).

2.5.1.2 Farmlands

Because the rugged terrain and arid climate of the White Mesa region have restricted development of cultivated croplands, grazing is the predominant agricultural land use (Table 2.16). Dry farming produces primarily wheat and beans. No unique or prime farmlands exist on the mill site or in the surrounding area.[6]

The Federal government owns and administers, through the U.S. Bureau of Land Management, approximately 60% of the total land area of San Juan County (ER, Sect. 2.2.1.3). This land, classified as multiple use, is leased for grazing, oil and gas exploration, and mining claims, and is managed for wildlife and recreation. The majority (63%) of the private land in San Juan County is rangeland (Table 2.16).

The site for the proposed uranium mill (Fig. 2.2) was previously used for grazing. Also, potential grazing land lies on all sides of the applicant's property (Fig. 2.2). Based upon primary production for rangeland in fair condition, and assuming 50% of the primary production will be grazed, grazing capacity of rangeland in the vicinity of the site is conservatively estimated at about 0.69 to 1.24 animal units months (AUMs) per hectare (0.28 to 0.5 AUMs per acre);[10] that is, about 0.8 to 1.4 ha (2 to 3.6 acres) of rangeland are required to support one cow or five sheep for one month per year. The nearest cultivated cropland (alfalfa) occurs 2.4 km (1.5 miles) north of the site boundary, and the nearest garden plot lies approximately 1.6 km (1 mile) north.[10]

2.5.1.3 Urban areas

The communities of Blanding, Monticello, and Bluff, all within 48 km (30 miles) of the proposed White Mesa mill site, and the town of Hanksville, 16 km (10 miles) from the Hanksville ore buying station, have been discussed in detail in Sects. 2.4.1.1, 2.4.1.2, and 2.4.2.1. The two largest of these, Blanding and Monticello, have a number of regulations governing land use, including zoning, subdivision regulations, and building codes (City Manager of Blanding, Utah, and City Manager of Monticello, Utah, personal communications, July 10, 1978, and July 20, 1978, respectively).

2.5.2 Historical, scenic, and archeological resources

2.5.2.1 Historical sites

Although there are no cultural sites on or adjacent to the proposed mill site which are presently included in the National Register of Historic Places (National Register), the White Mesa Archeological District has been determined eligible for inclusion in the National Register. Landmarks of southeastern Urah currently included in the National Register are summarized in Table 2.17. Closest to the proposed mill site is the Edge of Cedars Indian Ruin, located in Blanding (approximately six miles north of the proposed mill site).

A historical survey was conducted on the proposed mill site, and six historical sites were identified. Five of the six historical sites are currently under review to determine eligibility for the National Register.

2.5.2.2 Scenic areas

Southeastern Utah is known for its unusual scenic qualities, in particular the abundance of massive stone arches and other outstanding rock formations. The general area features a uniquely rugged terrain with wide vistas, badlands, and steep canyons.

Canyonlands National Park is an area of unusual, interesting geological formations, and the Glen Canyon National Recreation Area on Lake Powell is a man-made lake on the Colorado River. Capitol Reef National Park contains numerous colorful stone formations. At Natural Bridges Monument, rock arches span deep canyons, forming the largest natural bridges in the world. These and other natural and scenic landmarks draw visitors to southeastern Utah every year. In addition, the area contains an abundance of Indian ruins and petroglyphs. Newspaper Rock State Park, Edge of the Cedars State Park, and Hovenweep National Monument are noted areas of scenic and archeological interest (Fig. 2.1). Closest to the proposed mill site is Edge of The Cedars State Park (historicia monument), located in Blanding (approximately three miles north of the proposed mill site).

2.5.2.3 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 Sections 21, 22, 27, 28, 32, and 33 of T37S, R22E, and encompassed 809 ha (2000 acres), of which 81 ha (200 acres) are administered by the U.S. Bureau of Land Management and 130 ha (320 acres) 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 about 0 A.D. to 1300 A.D. All but 22 of the sites were within the

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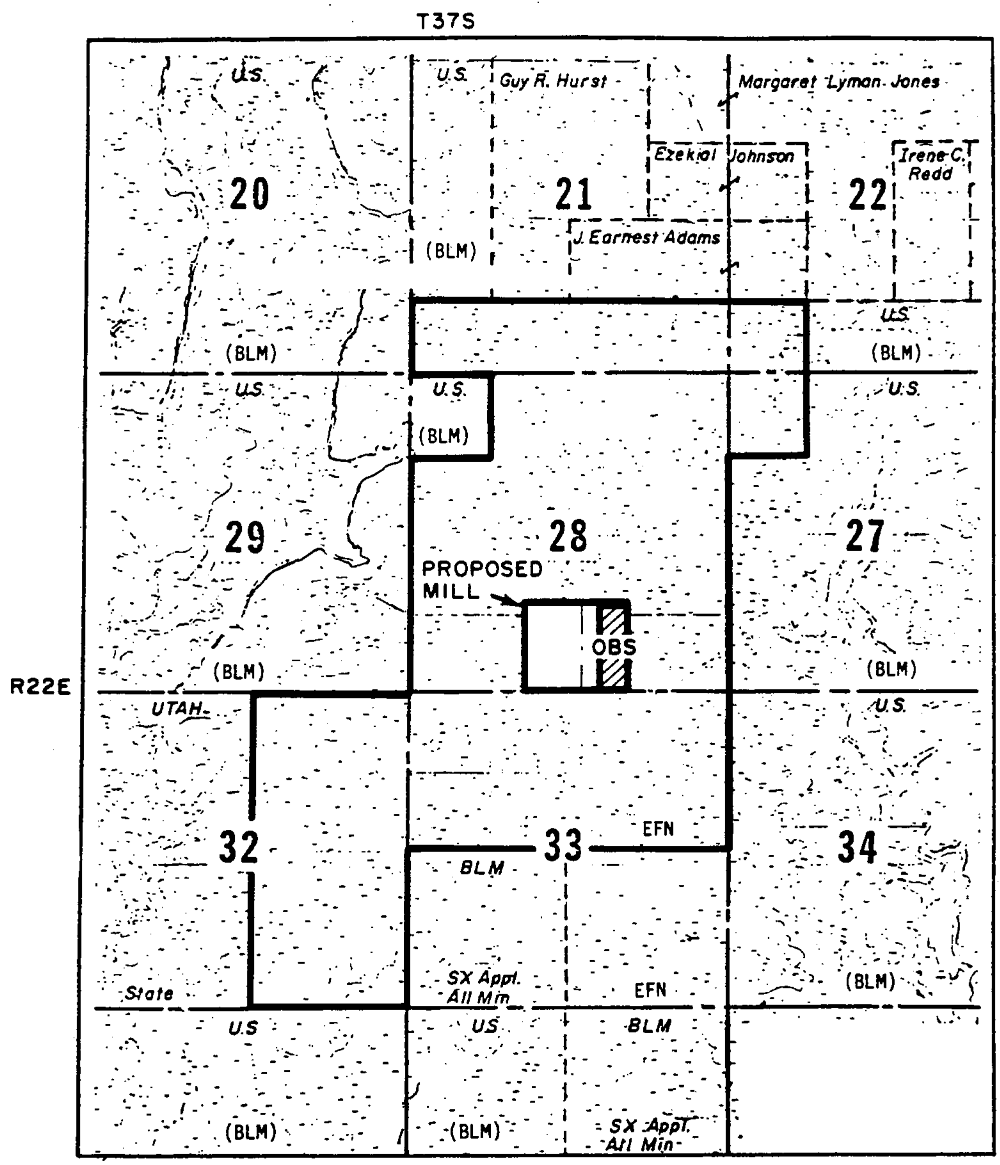

Fig. 2.2. Land Ownership in the vicinity of the project site (OBS = ore-buying station). Source: ER, Plate 2.1-3 and Sect. 2.1.

Note: Energy Fuels Nuclear currently owns T37S R22E Section 33, SE¼, but this quarter section is not part of the proposed project.

project boundaries. 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.

Table 2.17. Historic sites in southeastern Utah included in the "National Register of Historic Places"

Location	Site
San Juan County	
Blanding	Edge of Cedars Indian Ruin
35 miles southeast of Blanding	Hovenweep National Monument
Southeast of Mexican Hat	Poncho House
25 miles southeast of Monticello	Alkali Ridge
30 miles west of Monticello	Salt Creek Archaeological District
Glen Canyon National Recreation Area	Defiance House[a]
14 miles north of Monticello	Indian Creek State Park[a]
Wayne County	
Capital Reef National Park on Utah Route 24	Fruita School House
3 miles southeast of Bicknell	Hans Peter Nielson Gristmill
60 miles south of Green River, in Canyonlands National Park	Harvest Scene Pictograph
Green River vicinity	Horseshoe (Barrier) Canyon Pictograph Panel
Capital Reef National Park	Gifford Barn[a]
Capital Reef National Park	Lime Kiln[a]
Capital Reef National Park	Oyler Tunnel[a]
Garfield County	
46 miles south of Hanksville	Starr Ranch
South of Hanksville	Susan's Shelter
Near Panquitch	Bryce Canyon Airport Hangar

[a]Pending nominations to the "National Register of Historic Places."

Sources: U.S. Department of the Interior, "National Register of Historic Places," *Fed. Regist.* 41(28), Feb. 10, 1976, and subsequent issues through 43(225), Nov. 21, 1978.

Archaeological test excavations were conducted by the Antiquities Section, Division of State History, in the spring of 1978,[11] on 20 sites located in the area to be occupied by tailings cells 2,3 and 4. Of these sites, twelve were deemed by the State Archaeologist 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 archaeological sites were located during this survey, some of which are believed to be of equal or greater significance than the more significant sites from the earlier study. Determination of the actual significance of all untested sites will require additional field investigation.

Table 2.18. Distribution of recorded sites according to temporal position

Temporal position	Approximate dates[a] (A.D.)	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 ER, Table 2.3-2, and from supplementary reports on project archeology.

Note: These sites are shown in Fig. 3.4.

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. Requirements for further action to be taken are discussed in Sect. 4.2.2 and in Appendix E.

2.6 WATER

2.6.1 Surface water

2.6.1.1 Surface-water description

The proposed 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 (Sect. 2.7.1 and Fig. 2.8). There is a small drainage area of approximately 25 ha (62 acres) above the proposed 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 average annual rainfall [30 cm (11.8 in.)] cause these streams to be intermittently active, responding to spring snowmelt and local rainstorms (particularly thunderstorms). Surface runoff from approximately 155 ha (384 acres) of the project site drains westward and is collected by Westwater Creek, and runoff from another 155 ha (384 acres) drains east into Corral Creek. The remaining 289 ha (713 acres) of the southern and southwestern portions of the site drain indirectly into Cottonwood Wash (ER, 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 Fig. 2.3 and their drainages tabulated in Table 2.19. Total runoff from the site (total yield per watershed area) is estimated to be less than 1.3 cm (0.5 in.) annually (ER, p. 2-143).

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

Fig. 2.3. Drainage map of the vicinity of the White Mesa Uranium Project.
Source: ER, Plate 2.6-5.

Table 2.19. 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 of Bluff, Utah	⩽60,000	⩽23,000

Source: ER, Table 2.6-3.

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 29.7 cm (11.8 in.) per year at Blanding (ER, p. 2-168), local soil characteristics (Sect. 2.8), and the porous nature of local stream channels. Two small ephemeral catch basins are present on the site to the northwest and northeast of the present buying station (Sect. 2.9.2).

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 13 km^2 (5 sq miles). Westwater Creek is also an intermittent tributary of Cottonwood Wash. The Westwater Creek drainage basin covers nearly 70 km^2 (27 sq miles) at its confluence with Cottonwood Wash 2.5 km (1.5 miles) 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 29 km (18 miles) south of the project site. The San Juan River, a major tributary for the upper Colorado River, has a drainage of 60,000 km^2 (23,000 sq miles) measured at the USGS gage to the west of Bluff, Utah (ER, p. 2-130).

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 (Sect. 2.8). For example, on August 1, 1968, a flow of 581 m^3/sec (20,500 cfs) was recorded in Cottonwood Wash near Blanding. The average flow for that day, however, was only 123 m^3/sec (4340 cfs). By August 4, the flow had returned to 0.5 m^3/sec (16 cfs) (ER, p. 2-135). Monthly streamflow summaries are presented in Fig. 2.4 for Cottonwood Wash and Recapture Creek. Flow data are not available for the two smaller watercourses 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. According to the applicant, flow typically ceases in Corral and Westwater creeks within 6 to 48 hr after precipitation or snowmelt ends.

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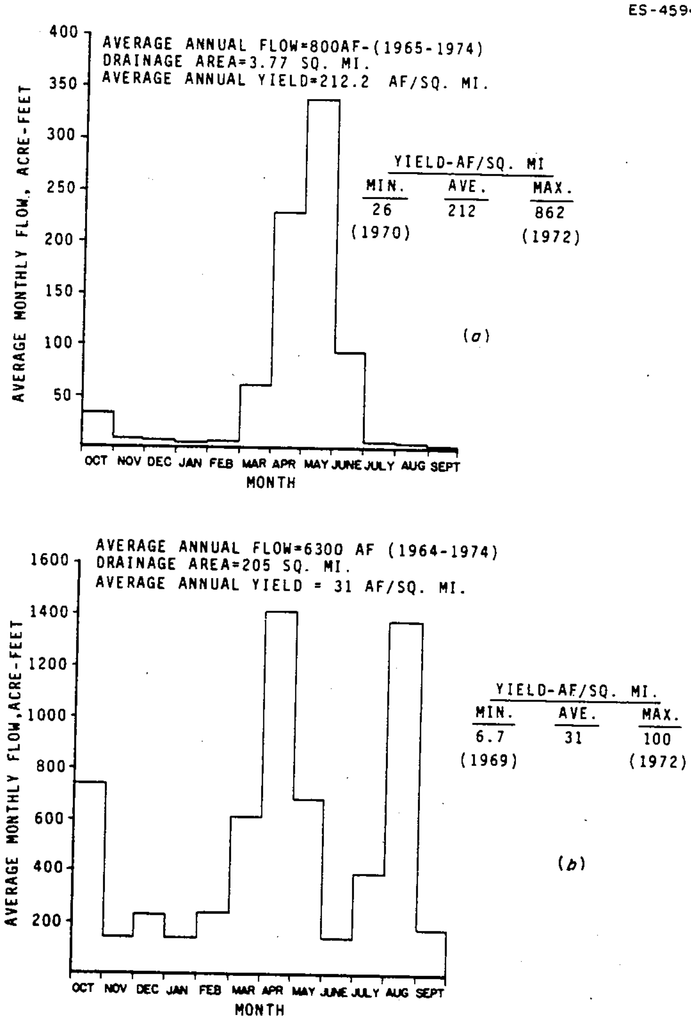

Fig. 2.4. Streamflow summary in the Blanding, Utah, vicinity. *(a)* Upper portion of the watershed near the headwaters of Recapture Creek near Blanding at 7200 ft MSL; USGS gage 09378630. *(b)* Cottonwood Wash about 11 km (7 miles) southwest of Blanding at 5138 ft MSL; USGS gage 09378700. Source: Adapted from the ER, Plate 2.6-6.

2.6.1.2 Surface-water quality

The applicant began sampling surface-water quality in the project vicinity 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 onsite 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 proposed mill site has been filled with well water by the applicant to serve as a nonpotable water source during planned construction of office and laboratory buildings in conjunction with the proposed mill (approximately six months). This water has not been sampled by the applicant but presumably reflects the poor quality associated with local groundwater (Sect. 2.6.2). Sampling of ephemeral surface waters in the vicinity has necessitated correlation with major precipitation events as these watercourses are normally dry at other times.

The chemical and physical water quality parameters measured by the applicant are listed in Table 2.20. The locations of the surface-water sample sites are presented in Table 2.21 and Fig. 2.5, and the water quality values obtained for these sample sites are given in Table 2.22. Water quality samples were collected during the spring at several intermittently active streams (Fig. 2.5) 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 proposed 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 proposed 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 flow rates for Westwater Creek averaged <0.08 m/sec (<0.3 fps) at the time of sampling.

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 [24 m/sec (80 fps) streamflow].

The concentrations of TDS increased downstream in Corral Creek, averaging 3180 mg/liter at S3R and 6660 mg/liter (one sample) at S4R. Total hardness averaged in excess of 2000 mg/liter, and pH values were slightly alkaline. Estimated flows in Corral Creek were typically less than 0.03 m/sec (0.1 fps) during sampling.

The spring sample collected at 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 1500 mg/liter (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). This level is 40 times the EPA recommended limit for the protection of freshwater aquatic life (0.05 μg/liter).[12] Total iron measured in the pond (S5R, 11/10/77) was 9.4 mg/liter, over nine times the EPA recommended limit of 1 mg/liter for the protection of aquatic life. These values appear to reflect groundwater quality in the vicinity (Sect. 2.6.2) and are probably due to evaporative concentration and not due to human perturbation of the environment.

2.6.1.3 Surface-water utilization

Regional surface water is primarily used for agricultural irrigation and stock-watering purposes. Water usage from the San Juan River in Utah alone amounts to approximately 12.2×10^3 m^3 (9900 acre-ft) per year. Table 2.23 lists the existing surface-water appropriations within the project vicinity. Water uses in San Juan County are presented in Table 2.24.

Table 2.20. Physical and chemical water quality parameters

Specific conductance (field), micromhos/cm	Manganese
Total suspended solids	Aluminum
Temperature (field)	Arsenic
pH (lab, field)	Barium
Redox potential	Boron
Total dissolved solids	Cadmium
Dissolved oxygen (field)	Chromium
Oil and grease	Copper
Total hardness as $CaCO_3$	Lead
Total alkalinity as $CaCO_3$	Mercury
Carbonate as CO_3	Molybdenum
Chloride	Nickel
Cyanide	Selenium
Fluoride	Strontium
Nitrate as N	Vanadium
Sulfate as SO_4	Zinc
Calcium	Silver
Iron, total and dissolved	Po-210
Magnesium	Pb-210
Ammonia as N	Th-230
Phosphorus, total as P	Uranium (natural)
Potassium	Ra-226
Silica	Gross α
Sodium	Gross β
Chemical oxygen demand (COD)	

Source: ER, Table 6.1-1.

Table 2.21. Surface water sampling stations

Station no.	Location
S1R	Westwater Creek at downstream (south) side of Highway 95 bridge
S2R	Corral Creek at downstream (south) side of small bridge
S3R	Corral Creek at spillway of small earthen dam
S4R	Corral Creek at junction with Recapture Creek 0.40 km (0.25 mile) from end of jeep road
S5R	Surface pond south of mill site, 0.20 km (0.125 mile) west of Highway 47
S6R	Small wash south of mill site, 1.6 km (1.0 mile) west of Highway 47
S7R	East side of Cottonwood Creek, at jeep trail intersection south-southwest of mill site
S8R	East side of Cottonwood Creek, at jeep trail intersection west-southwest of mill site
S9	East side of Westwater Creek, at jeep trail intersection

Source: ER, p. 6-1.

Table 2.22. Water quality of surface waters in project vicinity, Blanding, Utah

Zero values (0.0) are below detection limits.

Parameter	Sampling for dates as given						
	7/25/77	11/10/77	3/23/78	3/23/78[a]	7/25/77	11/10/77	3/23/78
	Westwater Creek, S1R[c]				Corral Creek, S2R[c]		
Field specific conductivity, μmhos/cm	*b*	490	620		*b*	*b*	
Field pH		7.6	8.3				
Dissolved oxygen							
Temperature, °C		3	14				
Estimated flow, m/hr (fps)		21.9 (0.02)	39.9 (0.03)				
Determination, mg/liter							
pH	*b*	8.2	8.35		*b*	*b*	
TDS (at 180°C)		496	559				
Redox potential		220	186				
Alkalinity (as $CaCO_3$)		206	229				
Hardness, total (as $CaCO_3$)		262	289				
Carbonate (as CO_3)		0.0	2.3				
Aluminum, dissolved		0.2	0.10				
Ammonia (as N)		<0.1	0.18				
Arsenic, total			0.007				
Barium, total		<0.2	0.22				
Boron, total		0.1	<0.1				
Cadmium, total		<0.002	<0.005				
Calcium, dissolved		76	140				
Chloride		17	38				
Sodium, dissolved		31	60				
Silver, dissolved			<0.005				
Sulfate, dissolved (as SO_4)		103	163				
Vanadium, dissolved		<0.01	<0.005				
Manganese, dissolved		0.030	0.04				
Chromium, total		<0.01	0.01				
Copper, total		<0.005	0.01				
Fluoride, dissolved		0.3	0.4				
Iron, total		0.28	1.5				
Iron, dissolved		0.17	0.21				
Lead, total		<0.05	<0.05				
Magnesium, dissolved		17.0	26				
Mercury, total		<0.0005	<0.00003				
Molybdenum, dissolved			0.002				
Nitrate (as N)		<0.05	<0.05				
Phosphorus, total (as P)		0.05	0.06				
Potassium, dissolved		2.8	2.0				
Selenium, dissolved			0.003				
Silica dissolved (as SiO_2)		7	9				
Strontium, dissolved		0.44	0.76				
Uranium, total (as U)		0.006	0.004				
Uranium, dissolved (as U)		0.002	0.003				
Zinc, dissolved		0.09	0.04				
Total organic carbon		6	7				
Chemical oxygen demand		23	48				
Oil and grease		1	1				
Total suspended solids		12	47				
Determination, pCi/liter							
Gross alpha ± precision	*b*	0.1 ± 1.1	4.5 ± 2.0	*b*	*b*	*b*	
Gross beta ± precision		0 ± 9	8 ± 11				
Ra-226 ± precision		0.2 ± 0.3	0.2 ± 0.3				
Th-230 ± precision		0.0 ± 0.4	0.1 ± 0.4				
Pb-210 ± precision		0.7 ± 2.3	1.1 ± 3.8				
Po-210 ± precision		0.1 ± 0.5	0.0 ± 0.7				

Table 2.22. (Continued)

Parameter	Sampling for dates as given						
	7/25/77	11/10/77	3/23/78	3/23/78[a]	7/25/77	11/10/77	3/23/78
	Corral Creek, S3R[c]				Junction of Corral and Recapture creeks, S4R[c]		
Field specific conductivity, µmhos/cm	2000	2400	3500	3500	d	d	6000
Field pH	6.8		7.9	7.8			7.9
Dissolved oxygen							
Temperature °C	27.7	8	13	13			14
Estimated flow, m/hr (fps)	98.7 (0.09)	21.9 (0.02)	65.8 (0.06)	65.8 (0.06)			10.9 (0.01)
		Determination, mg/liter					
pH	6.7	8.0	8.23	8.15	d	d	8.11
TDS (at 180°C)	1350	3160	4095	4130			6660
Redox potential	260	240	190	193			195
Alkalinity (as $CaCO_3$)	70	172	236	236			274
Hardness, total (as $CaCO_3$)	853	1910	2200	2200			2100
Carbonate (as CO_3)	0.0	0.0	0.0	0.0			0.0
Aluminum, dissolved	0.04	<0.1	<0.1	<0.1			<0.1
Ammonia (as N)	0.15	<0.1	<0.1	0.13			<0.1
Arsenic, total	<0.01		0.011	0.013			0.010
Barium, total	0.36	0.4	0.18	0.22			0.29
Boron, total	0.1	0.2	0.2	0.2			0.2
Cadmium, total	0.004	0.006	0.01	0.01			0.02
Calcium, dissolved	150	78	546	571			649
Chloride	54	152	214	189			556
Sodium, dissolved	115	160	312	315			1205
Silver, dissolved	0.004		0.02	0.01			0.02
Sulfate, dissolved (as SO_4)	803	2000	2596	2854			3760
Vanadium, dissolved	0.004	<0.01	0.005	<0.005			<0.005
Manganese, dissolved	0.20	0.030	0.05	0.04			0.32
Chromium, total	0.02	0.01	0.02	0.04			0.04
Copper, total	0.01	0.010	0.02	0.03			
Fluoride, dissolved	0.32	0.6	0.8	0.8			
Iron, total	0.08	0.09	0.09	0.12			0.30
Iron, dissolved	0.12	0.07	0.09	0.04			0.10
Lead, total	0.04	0.15	0.10	0.08			0.14
Magnesium, dissolved	120	20	359	376			353
Mercury, total	0.002	<0.0005	0.00003	0.00009			0.00002
Molybdenum, dissolved	<0.01		0.004	0.003			0.004
Nitrate (as N)	0.21	0.11	0.81	0.81			<0.05
Phosphorus, total (as P)	0.21	0.06	<0.02	<0.02			0.06
Potassium, dissolved	13	4.8	6.9	6.8			6.8
Selenium, dissolved	0.16		0.032	0.027			0.005
Silica, dissolved (as SiO_2)	10	2	3	3			11
Strontium, dissolved	1.9	2.2	5.0	5.1			12
Uranium, total (as U)	0.005	0.028	0.046	0.038			0.085
Uranium, dissolved (as U)	0.002	0.028	0.046	0.036			0.082
Zinc, dissolved	0.06	0.02	0.02	0.01			0.02
Total organic carbon		11	17	18			22
Chemical oxygen demand		79	234	155			61
Oil and grease		1	2	<1			1
Total suspended solids		9	6	9			24
		Determination, pCi/liter					
Gross alpha ± precision	15 ± 2	19 ± 6	13.4 ± 6.6	0 ± 11	d	d	7.0 ± 2.9
Gross beta ± precision	180 ± 20	0 ± 29	95 ± 50	37 ± 4			25 ± 18
Ra-226 ± precision	0.0 ± 0.3	0.3 ± 0.3	0.4 ± 0.4	0.09 ± 0.03			0.2 ± 0.3
Th-230 ± precision	3.1 ± 0.5	0.1 ± 0.5	1.3 ± 0.6	0 ± 0.1			1.5 ± 0.7
Pb-210 ± precision	1.4 ± 2.1	2.4 ± 2.6	1.4 ± 3.6	0 ± 1			1.4 ± 3.7
Po-210 ± precision	0.0 ± 0.3	0.6 ± 0.7	0.5 ± 0.9				1.4 ± 1.1

Table 2.22. (Continued)

Parameter	Sampling for dates as given						
	7/25/77	11/10/77	3/23/78	3/23/78[a]	7/25/77	11/10/77	3/23/78
	Surface pond, S5R[c]			Unnamed Wash, S6R[c]		Cottonwood Creek, S7[c]	
Field specific conductivity, µmhos/cm	e	100	250	d	d		320
Field pH		6.8	8.4				8.2
Dissolved oxygen							
Temperature, °C		7	20				12
Estimated flow, m/hr (fps)							1097 (10)
		Determination, mg/liter					
pH	e	6.9	7.94	d	d		8.36
TDS (at 180°C)		264	291				295
Redox potential		280	130				172
Alkalinity (as $CaCO_3$)		218	138				149
Hardness, total (as $CaCO_3$)		67	129				154
Carbonate (as CO_3)		0.0	0.0				2.3
Aluminum, dissolved		2.0	1.0				2.4
Ammonia (as N)		<0.1	0.19				0.15
Arsenic, total			0.008				0.027
Barium, total		<0.2	0.33				0.66
Boron, total		0.2	0.1				<0.1
Cadmium, total		<0.002	<0.005				0.006
Calcium, dissolved		22	72				134
Chloride		8	10				7
Sodium, dissolved		0.6	5.4				20
Silver, dissolved			<0.005				<0.005
Sulfate, dissolved (as SO_4)		64	20.3				52.6
Vanadium, dissolved		<0.01	0.012				0.012
Manganese, dissolved		0.095	0.15				0.69
Chronium, total		0.04	0.04				0.03
Copper, total		0.005	0.02				0.04
Fluoride, dissolved		<0.1	0.1				0.2
Iron, total		9.4	11				3.9
Iron, dissolved		1.2	1.0				1.7
Lead, total		<0.05	<0.05				0.08
Magnesium, dissolved		3.2	8.8				25
Mercury, total		<0.0005	0.00005				0.00007
Molybdenum, dissolved			0.002				0.004
Nitrate (as N)		4.26	0.05				0.14
Phosphorus, total (as P)		0.04	0.37				0.85
Potassium, dissolved		14	13				2.3
Selenium, dissolved			<0.005				<0.005
Silica, dissolved (as SiO_2)		2	7				10
Strontium, dissolved		0.10	0.34				0.49
Uranium, total		0.004	0.002				0.011
Uranium, dissolved (as U)		0.003	<0.002				0.007
Zinc, dissolved		0.02	0.10				0.050
Total organic carbon		15	20				10
Chemical oxygen demand		71	58				60
Oil and grease		2	1				1
Total suspended solids		268	210				1600
		Determination, pCi/liter					
Gross alpha ± precision	e	1.1 ± 1.1	1.2 ± 1.1	d	d		3.2 ± 1.8
Gross beta ± precision		15 ± 10	27 ± 8				32 ± 11
Ra-226 ± precision		0.2 ± 0.3	0.1 ± 0.9				0.6 ± 1.5
Th-230 ± precision		0.0 ± 0.4	0.9 ± 0.6				0.2 ± 0.4
Pb-210 ± precision		2.6 ± 2.2	0.0 ± 3.8				4.3 ± 3.7
Po-210 ± precision		0.2 ± 0.5	0.0 ± 0.6				0.0 ± 0.7

Table 2.22. (Continued)

Parameter	Sampling for dates as given						
	7/25/77	11/10/77	3/23/78	3/23/78[a]	7/25/77	11/10/77	3/23/78
	Cottonwood Creek, S8R[c]				Westwater Creek, S9[c]		
Field specific conductivity, μmhos/cm	550	445	240	240	*d*	*d*	320
Field pH	6.6	6.9	8.1	7.9			8.0
Dissolved oxygen							
Temperature, °C	35	6.0	7	7			9
Estimated flow, m/hr (fps)	0.4	0.7	80	80			0.28
Determination, mg/liter							
pH	7.5	8.2	8.21	8.09	*d*	*d*	8.20
TDS (at 180°C)	944	504	275	253			969
Redox potential	220	260	210	224			190
Alkalinity (as $CaCO_3$)	134	195	155	155			147
Hardness, total (as $CaCO_3$)	195	193	148	154			117
Carbonate (as CO_3)	0.0	0.0	0.0	0.0			0.0
Aluminum, dissolved	3.0	0.7	2.4	0.16			4.0
Ammonia (as N)	0.12	<0.1	0.13	0.16			0.75
Arsenic, total	0.02		0.041	0.032			0.037
Barium, total	1.2	0.2	0.85	1.1			0.81
Boron, total	0.1	0.2	0.1	<0.1			0.1
Cadmium, total	0.004	<0.002	<0.005	0.01			0.006
Calcium, dissolved	79	54	178	72			172
Chloride	13	24	7	6			18
Sodium, dissolved	36	66	23	21			125
Silver, dissolved	0.002		<0.005	<0.005			0.006
Sulfate, dissolved (as SO_4)	564	132	39.7	39.7			85
Vanadium, dissolved	0.003	<0.01	<0.005	<0.005			0.008
Manganese, dissolved	0.84	0.065	0.78	0.02			0.60
Chronium, total	0.14	<0.01	0.04	0.05			0.60
Copper, total	0.09	0.005	0.05	0.05			0.05
Fluoride, dissolved	0.36	0.2	0.2	0.2			0.2
Iron, total	150	5.9	50	53			44
Iron, dissolved	1.4	0.62	1.9	0.11			2.5
Lead, total	0.14	0.05	0.10	0.10			0.10
Magnesium, dissolved	24	17	28	17			13
Mercury, total	0.002	<0.0005	0.00006	0.0012			0.00012
Molybdenum, dissolved	<0.01	0.10	0.002	0.002			0.006
Nitrate (as N)	1.77	0.14	0.13	0.12			0.05
Phosphorus, total (as P)	0.05	3.2	0.96	0.84			0.88
Potassium, dissolved	6.9	3.2	2.5	1.2			3.2
Selenium, dissolved	0.08		<0.005	<0.005			<0.005
Silica, dissolved (as SiO_2)	10	8	11	18			11
Strontium, dissolved	0.64	0.60	0.56	0.34			0.65
Uranium, total	0.027	0.004	0.014	0.014			0.004
Uranium, dissolved (as U)	0.015	0.004	0.008	0.006			0.002
Zinc, dissolved	0.06	0.05	0.06	0.008			0.12
Total organic carbon		7	12	11			16
Chemical oxygen demand		61	163	111			66
Oil and grease		2	2	2			1
Total suspended solids		146	2025	1850			1940
Determination, pCi/liter							
Gross alpha ± precision	16 ± 3	2.9 ± 1.5	7.3 ± 2.4	23 ± 3	*d*	*d*	
Gross beta ± precision	72 ± 17	0 ± 10	28 ± 11	110 ± 6			
Ra-226 ± precision	0.6 ± 1.3	1.1 ± 0.5	1.9 ± 1.7	2.0 ± 0.1			
Th-230 ± precision	0.9 ± 0.6	0.0 ± 0.4	0.0 ± 0.3	0.2 ± 0.1			
Pb-210 ± precision	0.8 ± 1.9	0.0 ± 2.2	2.5 ± 4.3	0 ± 1			
Po-210 ± precision	0.0 ± 0.3	0.6 ± 0.7	0.0 ± 0.6				

[a]Replicate sample analyzed for quality assurance on radioactivity.
[b]Not enough water in stream to sample adequately.
[c]See Table 2.21 for locations of sampling stations.
[d]No water in stream to sample.
[e]Not sampled.
Source: Adapted from ER, Table 2.6-7.

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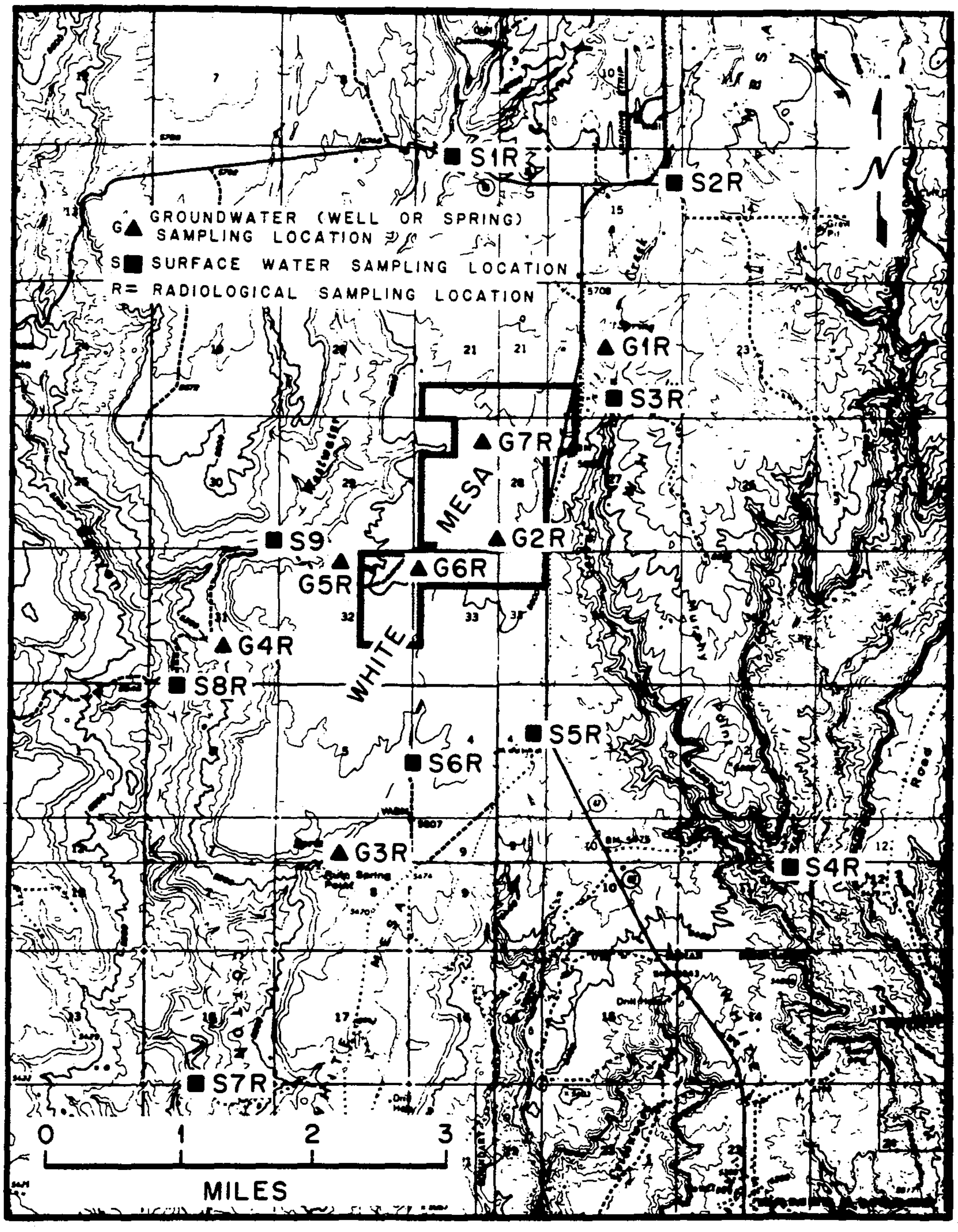


Fig. 2.5. Preoperational water quality sampling stations in the White Mesa project vicinity. Source: ER, Plate 2.6-10.

Table 2.23. Current surface water users in project vicinity

Name	Address	Application date	Application number	Quantity cfs	Quantity m^3/sec
		Corral Creek			
Fred Halliday	Blanding, Utah	August 12, 1971	40839	0.5	0.014
		Cottonwood Creek or Wash			
William Keller	Moab, Utah	November 12, 1907	1647	1.0	0.028
Hyrum Perkins	Bluff, Utah	June 22, 1910	3322	5.49	0.156
U.S. Indian Service	Ignacia, Colorado	March 12, 1924	9486	1.18	0.033
U.S. Indian Service	Ignacia, Colorado	March 24, 1924	9491	0.738	0.021
U.S. Indian Service	Ignacia, Colorado	March 24, 1924	9492	0.298	0.008
Kloyd Perkins	Blanding, Utah	April 13, 1928	10320	1.455	0.041
W. R. Young	Blanding, Utah	October 22, 1928	104935	0.0015	0.00004
W. R. Young	Blanding, Utah	October 23, 1928	10496	0.0022	0.0006
W. R. Young	Blanding, Utah	October 22, 1928	10497	0.002	0.00005
San Juan County water Conservation district	Monticello, Utah	October 10, 1962	34666	12,000 (acre-ft)	1500 (ha-m)
Earl Perkins	Blanding, Utah	April 16, 1965	36924	5.0	0.142
		Westwater Creek			
Seth Shumway	Blanding, Utah	January 7, 1929	10576	0.005	0.002
H. E. Shumway	Blanding, Utah	Segregation date: February 28, 1970	37101a	0.7623	0.022
Preston Nielson	Blanding, Utah	Segregation date: October 22, 1970	37601a	0.2377	0.007
Parley Redd	Blanding, Utah	Claim date: October 16, 1970	Claim 2373	0.015	0.0004
Kenneth McDonald	Blanding, Utah	Change of Appropriation: June 12, 1974	42302	1.0	0.028

Source: ER, Table 2.6-4.

Table 2.24. Water use of San Juan County, 1965

Use	Consumption m^3 X 10^3	Consumption Acre-ft
Irrigated crops (5000 acres)	6,785	5,500
Reservoir evaporation	123	100
Incidental use[a]	1,603	1,300
Municipal and industrial[b]	2,220	1,800
Minerals[b]	1,357	1,100
Augmented fish and wildlife[b]	123	100
Total	12,211	9,900

[a] Incidental use of irrigation water by phreatophytes and other miscellaneous vegetation.

[b] Includes evaporation losses applicable to these sources of depletion.

Source: ER, Table 2.6-5.

2.6.2 Groundwater

A generalized section of the stratigraphic and water-bearing units in southeastern Utah is shown in Fig. 2.6. Recharge of these aquifers occurs from seasonally variable rainfall infiltrating along the flanks of the Abajo, Henry, and La Sal mountains and along the flanks of folds. Recharge water also originates from precipitation on the flat-lying beds where it percolates into the groundwater region along joints.

In the White Mesa area, 39 groundwater appropriations (applications for water wells) are on file with the Utah State Engineers Office for wells lying within an 8-km (5-mile) radius of the project site. All but one of these wells produce from the Dakota and Morrison formations. Thirty-five of these are for wells which are actually constructed (ER, Table 2.6-1). Most of these wells produce less than 55 m^3/day (10 gpm) and are used for domestic, irrigation, and stock-watering purposes. The remaining well, which was drilled to a depth of 548 m (1800 ft) by Energy Fuels Nuclear, withdraws water from the Navajo Sandstone. The majority (31) are hydrologically upgradient or cross gradient with respect to the project site. The remaining four wells (three onsite and one offsite, south) are on land owned by the applicant. Two of the onsite wells are located in the area of the proposed tailings impoundment and will be completely plugged with bentonite and/or another suitable clay.[5,6] The well which is offsite and south will be capped or used for monitoring purposes.

As is the case throughout most of the Four Corners region, the Blanding area depends largely on groundwater for its water supply. A porous soil, underlain by the Dakota Sandstone on top of a regional aquiclude (the Brushy Basin Member of the Morrison Formation), provides the Blanding area with a near-surface source of groundwater. This situation is somewhat uncommon in the highly dissected south-central portion of the Colorado Plateau.

The Dakota sandstone on White Mesa has been completely isolated by erosion; consequently, all recharge to this formation comes from precipitation and irrigation on the mesa. No irrigation occurs close to the mill site, and normal precipitation is only 30 cm (12 in.) per year, most of which reenters the atmosphere as evapotranspiration (i.e., it does not penetrate the soils over the Dakota). The Dakota is the underlying bedrock under the proposed tailings impoundment and has a permeability coefficient from 1.5 to 3 m (5 to 10 ft) per year (ER, Sect. 4.2.4.1 and Appendix H). Jointing occurs in the formation but is probably not fully penetrating. An aquiclude, the Brushy Basin member of the Morrison Formation, underlies the Dakota sandstone, which accounts for the groundwater retained in the lower portion of the Dakota.

In the immediate vicinity, only the Dakota Sandstone and the Salt Wash Member (including the Westwater Member) are significant aquifers. The Entrada and Navajo formations contain larger quantities of water, but their depth prohibits common exploitation, in use for domestic water supplies.

Comb Ridge and the Abajo Mountains are significant areas of recharge of the Salt Wash and deeper aquifers. General gradients of groundwater movement in these aquifers follow the regional structure, and the water discharges ultimately in the vicinity of the San Juan River.

Because the Brushy Basin Member acts as an aquiclude to the Salt Wash Member in the uplands, the primary recharge areas for this aquifer are Brushy Basin Wash to the northwest of Blanding, Cottonwood Creek to the west and southwest of the town, and the upper reaches of Montezuma Creek, especially along Dodge and Long canyons.

Several permeability tests were conducted at the mill and tailings retention sites. The results of these tests show a hydraulic conductivity of 1.5 to 3 m (5 to 10 ft) per year (see Fig. 2.7). The shallow groundwater movement at the mill site is estimated to be about 0.3 to 0.6 cm (0.01 to 0.02 ft) per year toward the south-southwest and the shallow groundwater movement at the tailings site is about 0.08 to 0.3 cm (0.0025 to 0.01 ft) per year in the same direction. The values were derived using the following formula based on Darcy's Law:

$$V = Ki/\Theta ,$$

where

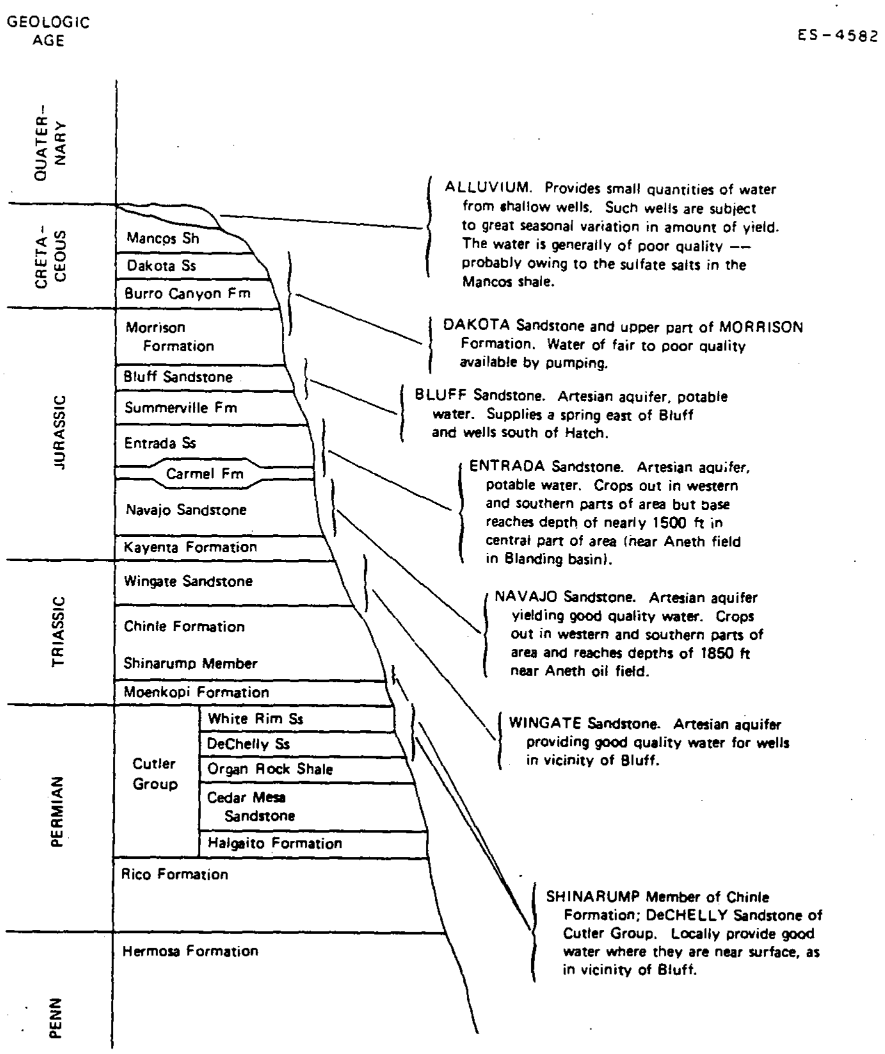


Fig. 2.6. Generalized stratigraphic section showing freshwater-bearing units in southeastern Utah. Source: ER, Plate 2.6-1.

V = the rate of movement of groundwater through the formation,

K = the hydraulic conductivity of formation 1.5 to 3 m/year (5 to 10 ft/year),

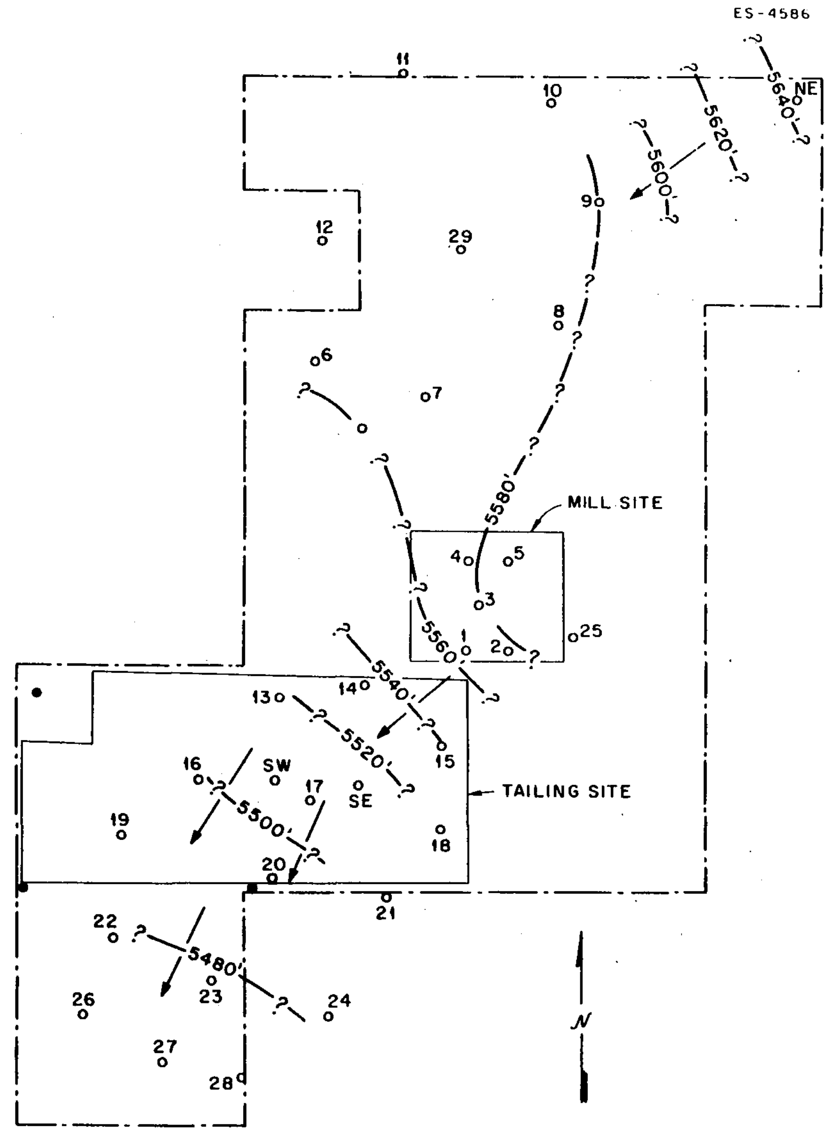
i = gradient (calculated as 0.03 at mill site and 0.01 at tailings site),

Θ = porosity of formation (assumed as 20%).

Table 2.25 is a tabulation of groundwater quality of the Navajo Sandstone aquifer. The TDS range from 244 to 1110 mg/liter in three samples taken over a period from January 27, 1977, to May 4, 1977. High iron (0.57 mg/liter) concentrations are found in the Navajo Sandstone. The U.S. Environmental Protection Agency recommends 0.3 mg of dissolved iron per liter for drinking water.[13] Feltis[14] noted that the total dissolved solids in the alluvium and at shallow depths in the Dakota Sandstone, the Burro Canyon Formation, and the Morrison Formation range from 300 to 2000 mg/liter.

The applicant has sampled groundwater from local springs and wells at locations shown in Fig. 2.5. Total dissolved solids ranged from about 700 to 3300 mg/liter. Standards for public drinking water were frequently exceeded for sulfate, selenium, iron, and arsenic. The waters are suitable for stock and wildlife use.

DRILL HOLE NO.	DATE	LAND SURFACE ELEVATION	DEPTH TO WATER	ELEVATION OF WATER
3	09/19/77	5634.4	56.5'	5577.9
	09/22/77		56.0'	5578.4
	09/27/77		56.5'	5577.9
	11/04/77		56.8'	5577.6
9	09/30/77	5679.3	100.0'	5579.3
	11/04/77		99.8'	5579.5
12	09/30/77	5648.1	75.0'	5573.1
	11/04/77		81.3'	5566.8
19	09/27/77	5600.3	110.0'	5490.3
	11/04/77		110.0'	5490.3
28	09/22/77	5547.6	75.0'	5472.6
	09/27/77		76.0'	5471.6
	11/04/77		75.7'	5471.9
N. E.	11/04/77	5472	34.7'	5637.3
N	09/16/77	5653	93.0'	5560.0
	09/22/77		93.5'	5559.5
	09/27/77		94.0'	5559.0
	09/08/77		94.0'	5559.0
S. E.	09/08/77	5595	96.0'	5499.0
	09/16/77		84.0'	5511.0
	09/22/77		84.5'	5510.5
	09/27/77		84.5'	5510.5
S. W.	09/08/77	5595	91.0'	5504.0
	09/16/77		90.0'	5505.0
	09/22/77		90.5'	5504.5
	09/27/77		90.0'	5505.0
	11/04/77		90.7'	5504.3



KEY

—5520'— ELEVATION OF WATER TABLE (FEET ABOVE MSL)

← DIRECTION OF SHALLOW GROUND WATER MOVEMENT

○28 BOREHOLE LOCATION AND NUMBER ENCOUNTERING WATER

Fig. 2.7. Groundwater-level map of the White Mesa site.
Source: ER, Plate 2.6-2.

Table 2.25. Water quality of groundwater in the project vicinity[a]
Zero values (0.0) are below detection limits

Parameter	Blanding mill site well in Navajo Sandstone, G2R				
	1/27/77[b]	5/4/77[c]	7/25/77	12/05/77	3/23/78
Field specific conductivity, μmhos/cm			400		310
Field pH			6.9		7.6
Dissolved oxygen					--
Temperature °C			22.2		11
Estimated flow, m^3day (gpm)			109 (20)		--
	Determination, mg/liter				
pH	8.0	7.9	7.7	7.9	8.16
TDS (at 180°C)	244	245	1110	446	216
Redox potential			220	220	211
Alkalinity (as $CaCO_3$)	189	180	224	185	187
Hardness, total (as $CaCO_3$)	196		208	195	177
Carbonate (as CO_3)	0.0		0.0	0.0	0.0
Aluminum, dissolved			<0.01	<0.1	<0.1
Ammonia (as N)	0.0		<0.1	<0.1	0.16
Arsenic, total	0.014		<0.01	<0.01	0.007
Barium, total	<0.0		0.13	<0.1	0.15
Boron, total	0.040		<0.1	0.11	<0.1
Cadmium, total	0.0		0.004	<0.02	<0.005
Calcium, dissolved	51	49	51	57	112
Chloride	0.0	50	<1	2	4
Sodium, dissolved	8.0		5.3	23	13
Silver, dissolved	0.0		<0.002	0.010	0.006
Sulfate, dissolved (as SO_4)	24	17	17	83	26.7
Vanadium, dissolved			<0.002	0.16	0.005
Manganese, dissolved	0.020		0.03	0.03	0.03
Chromium, total	0.0		0.02	<0.05	0.02
Copper, total	0.0		0.005	<0.010	0.005
Fluoride, dissolved	0.17	0.1	0.22	0.2	0.2
Iron, total	0.54		0.61	0.35	2.1
Iron, dissolved			0.57	0.30	2.3
Lead, total	0.0		0.02	<0.05	<0.05
Magnesium, dissolved	17	19	18	15	21
Mercury, total	0.0	0.0	0.002	<0.00002	0.00002
Molybdenum, dissolved			<0.01	0.010	0.004
Nitrate (as N)	0.05	0.12	<0.05	<0.05	<0.05
Phosphorus, total (as P)	0.03		<0.01	<0.02	0.03
Potassium, dissolved	3.0		3.2	2.8	2.4
Selenium, dissolved	0.0		0.05	0.014	<0.005
Silica, dissolved (as SiO_2)	12	5.8	12	6	8
Strontium, dissolved			0.67	0.5	0.60
Uranium, total (as U)			<0.002	0.16	<0.002
Uranium, dissolved (as U)			<0.002	0.031	<0.002
Zinc, dissolved	0.0		0.39	0.007	0.12
Total organic carbon				1.1	16
Chemical oxygen demand				<1	66
Oil and grease				1.0	1
Total suspended solids				6	1940
	Determination (pCi/liter)				
Gross alpha ± precision		7	10.2 ± 2.6	1.6 ± 1.3	1.9 ± 1.4
Gross beta ± precision		<20	73 ± 19	8 ± 8	9 ± 8
Ra-226 ± precision			0.1 ± 0.3	0.6 ± 0.4	0.3 ± 0.3
Th-230 ± precision			0.7 ± 2.7	0.3 ± 0.6	0.1 ± 0.4
Pb-210 ± precision			1.0 ± 2.0	0.7 ± 2.1	0.0 ± 4.0
Po-210 ± precision			0.0 ± 0.3	0.0 ± 0.8	0.0 ± 0.6

[a]The spring in Corral Creek, Station No. G1R, was tested on July 25, 1977, and again on November 10, 1977. Because of the low flow, the spring could not be located.

[b]Utah State Division of Health Analysis, Lab No. 77061.

[c]Partial analysis by Hazen Research, Inc., Sample No. HRI-11503.

Source: Adapted from ER, Table 2.6-6, and "Supplemental Report, Baseline Water Quality Environmental Report, White Mesa Uranium Project," June 29, 1978.

2.7 GEOLOGY, MINERAL RESOURCES, AND SEISMICITY

2.7.1 Geology

2.7.1.1 Regional geology

The proposed project site is near the western margin of the Blanding Basin in southeastern Utah. Thousands of feet of marine and nonmarine sedimentary rocks have been uplifted, moderately deformed, and subsequently eroded. North of the site is the Paradox fold and fault belt; to the west, the Monument uplift; to the south is the San Juan River and the Tyende Saddle; and to the east is the Four Corners platform (the Canyonlands section merges with the Southern Rocky Mountain province; see Fig. 2.8). The area is characterized by deeply eroded canyons, mesas, and buttes formed from sedimentary rocks of pre-Tertiary age. Regionally, elevations range from about 900 m (3000 ft) to more than 3350 m (11,000 ft). With the exception of the deeper canyons and isolated mountain peaks, the average elevation is approximately 1500 m (5000 ft).

Exposed sedimentary rocks in southeastern Utah have an aggregate thickness of about 1800 to 2100 m (6000 to 7000 ft) and range in age from Pennsylvanian to Late Cretaceous.

Shoemaker noted three origins of the structural features seen in the project area: (1) structures related to large-scale regional epeirogenic deformation (Monument Uplift and Blanding Basin), (2) structures formed due to diapiric deformation of thick evaporities, and (3) structures formed due to magmatic intrusions (Abajo Mountains).[15,16]

2.7.1.2 Blanding site geology

The proposed site is located near the center of White Mesa. The nearly flat surface of the mesa has a thin veneer of loess and is underlain by resistant sandstone caprock. Surface elevations across the site range from 1690 to 1720 m (5550 to 5650 ft). The maximum relief between White Mesa and the adjacent Cottonwood Canyon is about 230 m (750 ft).

White Mesa is drained to the west by Cottonwood Wash and Westwater Creek and to the east by Recapture Creek. There streams are intermittent and flow into the San Juan River. In the project area, exposed rocks are of Jurassic, Cretaceous, and Pleistocene-Recent age (see Fig. 2.9). The Jurassic to Upper Cretaceous rocks are represented, in ascending order, by the San Rafael Group, the Morrison Formation, the Burro Canyon Formation, the Dakota Sandstone, and the Mancos Shale. The rocks are primarily cross-bedded sandstones, conglomeratic sandstones, claystones, mudstones with some sandy shales, and limestones. Cenozoic rocks include eolian loess, stream-born alluvium, colluvium, and talus.

The structure of White Mesa is simple. The Dakota Sandstone and Burro Canyon Formation are essentially flat with gentle undulations and are commonly jointed. Two joint directions are found usually perpendicular to each other.

2.7.2 Mineral resources

2.7.2.1 Uranium deposits

Two types of uranium mineralization exist in the region: (1) tabular deposits nearly parallel to the bedding of fine-grained to conglomeritic sandstone lenses and (2) fracture-controlled deposits. None of the fracture-controlled deposits have yielded large production.[17] The tabular deposits occur in the Chinle, Morrison, and Cutler formations. Vanadium is a common byproduct of most uranium produced from the Morrison Formation. Principal uranium minerals are uraninite and coffinite.

2.7.2.2 Other mineral resources

Seven wildcat oil wells were drilled about 6 km (4 miles) west of the proposed site. All were dry and were abandoned.

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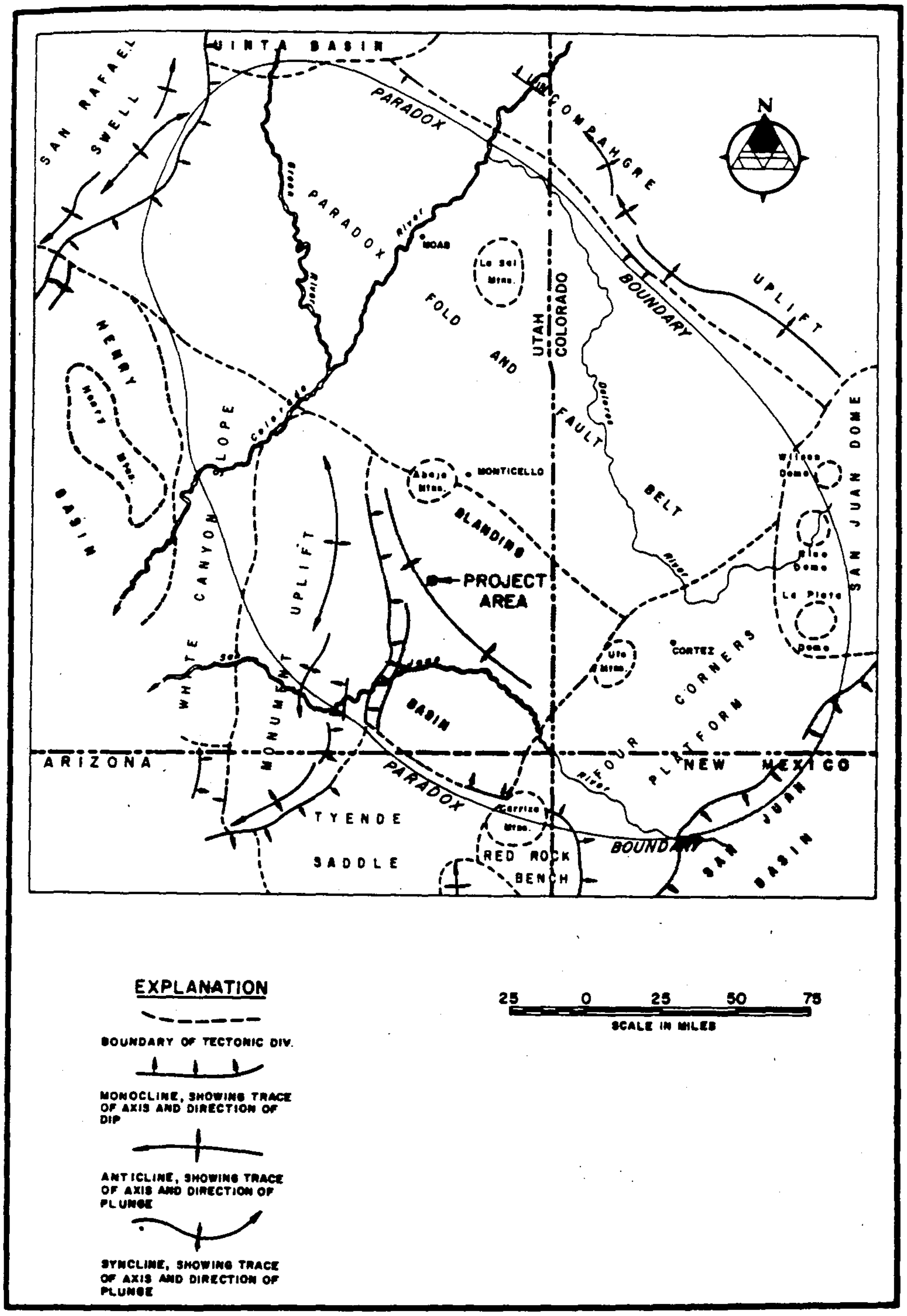

Fig. 2.8. Tectonic index map. Source: ER, Plate 2.4-1.

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ERA	SYSTEM	SERIES (Age)		STRATIGRAPHIC UNIT	THICKNESS* (ft)	LITHOLOGY
CENOZOIC	QUATERNARY	Holocene to Pleistocene		Alluvium	2-25+	Silt, sand and gravel in arroyos and stream valleys.
				Colluvium and Talus	0-15+	Slope wash, talus and rock rubble ranging from cobbles and boulders to massive blocks fallen from cliffs and outcrops of resistant rock.
				Loess	0-22+	Reddish-brown to light-brown, unconsolidated, well-sorted silt to medium-grained sand; partially cemented with caliche in some area; reworked partly by water.
				Unconformity		
MESOZOIC	CRETACEOUS	Upper Cretaceous		Mancos Shale	0-11(?)	Gray to dark-gray, fissile, thin-bedded marine shale with fossiliferous sandy limestone in lower strata.
				Dakota Sandstone	30 - 75	Light yellowish-brown to light gray-brown, thick bedded to cross-bedded sandstone, conglomeratic sandstone; interbedded thin lenticular gray carbonaceous claystone and impure coal; local course basal conglomerate.
				Unconformity		
		Lower Cretaceous		Burro Canyon Formation	50 - 150	Light-gray and light-brown, massive and cross-bedded conglomeratic sandstone and interbedded green and gray-green mudstone; locally contains thin discontinuous beds of silicified sandstone and limestone near top.
				Unconformity(?)		
	JURASSIC	Upper Jurassic	Morrison Formation	Brushy Basin Member	200-450	Variegated gray, pale-green, reddish-brown, and purple bentonitic mudstone and siltstone containing thin discontinuous sandstone and conglomerate lenses.
				Westwater Canyon Member	0-250	Interbedded yellowish- and greenish-gray to pinkish-gray, fine- to course-grained arkosic sandstone and greenish-gray to reddish-brown sandy shale and mudstone.
				Recapture Member	0-200	Interbedded reddish-gray to light brown fine- to medium-grained sandstone and reddish-gray silty and sandy claystone.
				Salt Wash Member	0-350	Interbedded yellowish-brown to pale reddish-brown fine-grained to conglomeritic sandstones and greenish- and reddish-gray mudstone.
				Unconformity		
			San Rafael Group	Bluff Sandstone	0-150+	White to grayish-brown, massive, cross-bedded, fine- to medium-grained eolian sandstone.
				Summerville Formation	25-125	Thin-bedded, ripple-marked reddish-brown muddy sandstone and sandy shale.
				Entrada Sandstone	150-180	Reddish-brown to grayish-white, massive, cross-bedded, fine- to medium-grained sandstone.
		Middle Jurassic		Carmel Formation	20-100+	Irregulary bedded reddish-brown muddy sandstone and sandy mudstone with local thin beds of brown to gray limestone and reddish- to greenish-gray shale.
				Unconformity		

*To convert feet to meters, multiply feet by 0.3048.

Fig. 2.9. Generalized stratigraphic section of exposed rocks in the project vicinity. Source: ER, Table 2.4-2.

Thin, discontinuous beds of impure lignite and coal up to 0.6 m (2 ft) thick occur throughout the Dakota Sandstone. Although several of these coal beds have been mined on a limited scale in the Blanding area, most of the coals are too impure for commercial use.[18]

Copper deposits are associated with the fracture-controlled uranium-vanadium deposits in the Abajo Mountains and with some sedimentary deposits. The copper content may be as high as 3%. Sand and gravel deposits are mined on the east and south slopes of the Abajo Mountains for pavement construction material.

Although water is produced from wells drilled to the Burro Canyon Formation and the Dakota Sandstone, this water is commonly mineralized and in some localities unfit for human consumption.[19] Deep wells drilled to the Entrada and Navajo sandstones yield potable water.[17,19] Several springs in the project vicinity discharge groundwater from the Burro Canyon Formation.

2.7.3 Seismicity

Within a 320-km (200-mile) radius of the site, 450 seismic events occurred between 1853 and 1978. Of these, at least 45 had an intensity of VI or greater on the Modified Mercalli Scale.

Within a 160-km (100-mile) radius of the project area, 15 earthquakes have been recorded. Of these, only one had an intensity of V, and the rest were IV or less. The nearest event occurred in Glen Canyon National Recreation Area, about 70 km (43.5 miles) northwest of the proposed site. The next closest event occurred about 94 km (58.5 miles) to the northeast. The event of intensity V occurred on August 29, 1941, just east of Durango, Colorado.[20] It is doubtful that any of these events would have been felt in the vicinity of Blanding.

Based on the region's seismic history, the probability of a major damaging earthquake occurring at or near the proposed site is remote. Algermissen and Perkins[21] indicate that there is a 90% probability that horizontal acceleration of 40% gravity (0.4 g) would not be exceeded within 50 years.

2.8 SOILS

The majority (99%) of the soil on the project site consists of the Blanding soil series (ER, Sect. 2.10.1.1). The remaining 1% of the site is in the Mellenthin soil series. Because the Mellenthin soil occurs only on the eastern-central edge of the site (ER, Plate 2.10-1), it should not be affected by construction and operation of the mill.

The mill and associated tailings disposal ponds will be located on Blanding silt loam, a deep soil formed from wind-blown deposits of fine sands and silts. Although soil textures are predominantly silt loam, silty-clay-loam textures are found at some point in most profiles (ER, Table 2.10-2). This soil generally has a 10- to 13-cm (4- to 5-in.) reddish-brown, silt-loam A horizon and a reddish-brown, silt-loam to silty-clay-loam B horizon. The B horizon extends downward about 30 to 40 cm (12 to 16 in.) where the soil then becomes calcareous silt-loam or silty-clay-loam, signifying the C horizon. The C horizon and the underlying parent material are also reddish-brown in color.

The A and B horizon both have an average pH of about 8.0, whereas the average pH at the C horizon is about 8.5. Subsoil sodium levels range up to 12% in some areas, which is close to the upper limit of acceptability for use in reclamation work (ER, Sect. 2.10.1.1). Other elements, such as boron and selenium, are well below potentially hazardous levels. Potassium and phosphorus values are high in this soil (ER, Table 2.10-2) and are generally adequate for plant growth. Nitrogen, however, is low (ER, Sect. 2.10.1.1) and may have to be provided for reclamation.

With the well-drained soils, relatively flat topography (Sect. 2.3), and low precipitation (Sect. 3.2.1), the site generally has a low potential for water erosion. However, the flows resulting from thunderstorm activity are nearly instantaneous and, if uncontrolled, could result in substantial erosion. When these soils are barren, they are considered to have a high potential for wind erosion. Although the soil is suitable for crops, the low percentage of available moisture (6 to 9%) is a limiting factor for plant growth; therefore, light irrigation may be required to establish native vegetation during reclamation.

2.9 BIOTA

2.9.1 Terrestrial

2.9.1.1 Flora

The natural vegetation presently occurring within a 40-km (25-mile) radius of the site is very similar to that of the potential,[22] being characterized by pinyon-juniper woodland intergrading with big sagebrush (*Artemesia tridentata*) communities. The pinyon-juniper community is dominated by Utah juniper (*Juniperus osteosperma*) with occurrences of pinyon pine (*Pinus edulis*) as a codominant or subdominant tree species. The understory of this community, which is usually quite open, is composed of grasses, forbs, and shrubs that are also found in the big sagebrush communities. Common associates include galleta grass (*Hilaria jamesii*), green ephedra (*Ephedra viridis*), and broom snakeweed (*Gutierrezia sarothrae*). The big sagebrush communities occur in deep, well-drained soils on flat terrain, whereas the pinyon-juniper woodland is usually found on shallow rocky soil of exposed canyon ridges and slopes.

Seven community types are present on the project site (Table 2.26 and Fig. 2.10). Except for the small portions of pinyon-juniper woodland and the big sagebrush community types, the majority of the plant communities within the site boundary have been disturbed by past grazing and/or treatments designed to improve the site for rangeland. These past treatments include chaining, plowing, and reseeding with crested wheatgrass (*Agropyron desertorum*). Controlled big sagebrush communities are those lands containing big sagebrush that have been chained to stimulate grass production. In addition, these areas have been seeded with crested wheatgrass. Both grassland communities I and II are the result of chaining and/or plowing and seeding with crested wheatgrass. The reseeded grassland II community is in an earlier stage of recovery from disturbance than the reseeded grassland I community. The relative frequency, relative cover, relative density, and importance values of species sampled in each community are presented in the ER, Table 2.8-2. The percentage of vegetative cover in 1977 was lowest on the reseeded grassland II community (10.7%) and highest on the big sagebrush community (33%) (Table 2.27).

Table 2.26 Community types and expanse within the project site boundary

Community type	Expanse	
	ha	acres
Pinyon–juniper woodland	5	13
Big sagebrush	113	278
Reseeded grassland I	177	438
Reseeded grassland II	121	299
Tamarisk-salix	3	7
Controlled big sagebrush	230	569
Disturbed	17	41

Table 2.27. Ground cover for each community within the project site boundary

Community type	Percentage of each type of cover		
	Vegetative cover	Litter	Bare ground
Pinyon–juniper woodland[a]	25.9	15.6	55.6
Big sagebrush	33.3	16.9	49.9
Reseeded grassland I	15.2	24.2	61.0
Reseeded grassland II	10.7	9.5	79.7
Tamarisk-salix	12.0	20.1	67.9
Controlled big sagebrush	17.3	15.3	67.4
Disturbed	13.2	7.0	80.0

[a] Rock covered 4.4% of the ground.

Based upon dry weight composition, most communities on the site were in poor range condition in 1977 (ER, Tables 2.8-3 and 2.8-4). Pinyon-juniper, big sagebrush, and controlled big sagebrush communities were in fair condition. However, precipitation for 1977 at the project site was classed as drought conditions (ER, Sect. 2.8.2.1). Until July, no production was evident on the site.

No designated or proposed endangered plant species[23] occur on or near the project site (ER, Sect. 2.8.2.1). Of the 65 proposed endangered species in Utah, six have documented distributions in San Juan County.[24] A careful review of the habitat requirements and known distributions of these species indicates that, because of the disturbed environment, these species would probably not occur on the project site.

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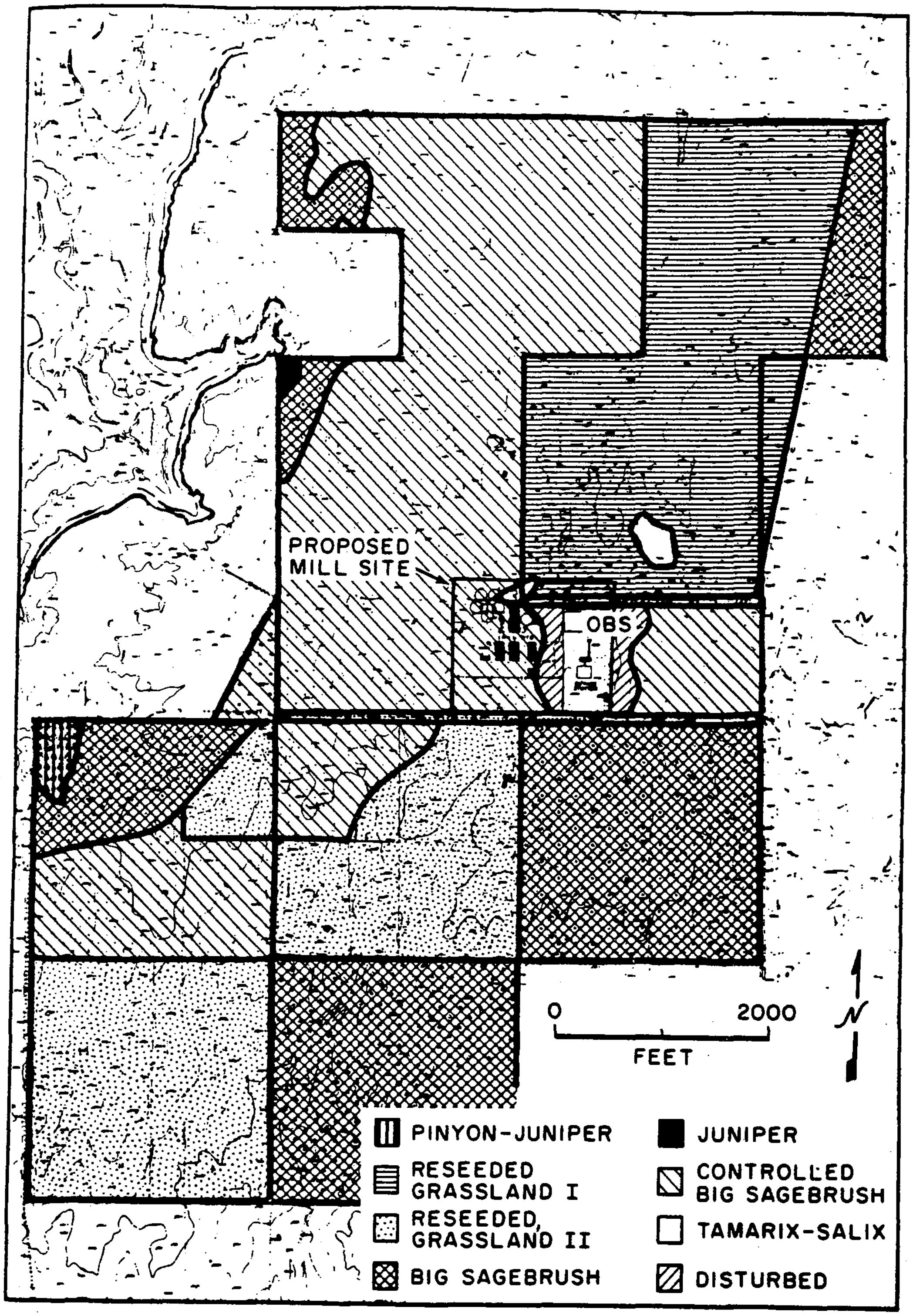

Fig. 2.10. Community types on the White Mesa project site. Source: Energy Fuels Nuclear, Inc., "Responses to Comments Telecopied from NRC to Energy Fuels Nuclear, Sept. 25, 1978," Oct. 4, 1978, Plate 2.8-2.

2.9.1.2 Fauna

The applicant has collected wildlife data through four seasons at several locations on the site (Fig. 6.1). The presence of a species was based on direct observations, trappings, and signs such as the occurrence of scat, tracks, or burrows. A total of 174 vertebrate species potentially occur within the vicinity of the proposed mill (ER, Appendix D), 78 of which were confirmed (ER, Sect. 2.8.2.2).

Although seven species of amphibians are thought to occur in the area, the scarcity of surface water limits the use of the site by amphibians. The tiger salamander (*Ambystoma tigrinum*) was the only species observed. It appeared in the pinyon-juniper woodland west of the project site (ER, Sect. 2.8.2.2).

Eleven species of lizards and five snakes potentially occur in the area. Three species of lizards were observed: the sagebrush lizard (*Sceloparas graciosus*), western whiptail (*Cnemidophorus tigris*), and the short-horned lizard (*Phrynosoma douglassi*) (ER, Sect. 2.8.2.2). The sagebrush and western whiptail lizard were found in sagebrush habitat, and the short-horned lizard was observed in the grassland. No snakes were observed during the field work.

Fifty-six species of birds were observed in the vicinity of the project site (Table 2.28). The abundance of each species was estimated by using modified Emlen transects and roadside bird counts in various habitats and seasons. Only four species were observed during the February sampling. The most abundant species was the horned lark (*Eremophila aepestis*) followed by the common raven (*Corvus corax*), which were both concentrated in the grassland. Avian counts increased drastically in May. Based on extrapolation of the Emlen transect data, the avian density on grassland of the project site during spring was about 305 per square kilometer (123 per 100 acres). Of these individuals, 94% were horned larks and western meadowlarks (*Sturnella neglecta*). This density and species composition are typical of rangeland habitats.[25] In late June the species diversity declined somewhat in grassland but peaked in all other habitats. By October the overall diversity decreased but again remained the highest in grassland.

Raptors are prominent in the western United States. Five species were observed in the vicinity of the site (Table 2.28). Although no nests of these species were located, all (except the golden eagle, *Aquila chrysaetos*) have suitable nesting habitat in the vicinity of the site. The nest of a prairie falcon (*Falco mexicanus*) was found about 1.2 km (3/4 mile) east of the site. Although no sightings were made of this species, members tend to return to the same nests for several years if undisturbed (ER, Sect. 2.8.2.2).

Of several mammals that occupy the site, mule deer (*Odocoileus hemionus*) is the largest species. The deer inhabit the project vicinity and adjacent canyons during winter to feed on the sagebrush and have been observed migrating through the site to Murphy Point (ER, Sect. 2.8.2.2). Winter deer use of the project vicinity, as measured by browse utilization, is among the heaviest in southeastern Utah [61 days of use per hectare (25 days of use per acre) in the pinyon-juniper–sagebrush habitats in the vicinity of the project site].[26] In addition, this area is heavily used as a migration route by deer traveling to Murphy Point to winter. Daily movement during winter periods by deer inhabiting the area has also been observed between Westwater Creek and Murphy Point.[26] The present size of the local deer herd is not known.

Other mammals present at the site include the coyote (*Canis latrans*), red fox (*Vulpes vulpes*), gray fox (*Urocyon cineroargenteus*), striped skunk (*Mephitis mephitis*), badger (*Taxidea taxus*), longtail weasel (*Mustela frenata*), and bobcat (*Lynx rufus*). Nine species of rodents were trapped or observed on the site, the deer mouse (*Peromyscus maniculatus*) having the greatest distribution and abundance. Although desert cottontails (*Sylvilagus auduboni*) were uncommon in 1977, black-tailed jackrabbits (*Lepus californicus*) were seen during all seasons.

Three currently recognized endangered species of animals[27] could occur in the project vicinity. However, the probability of these animals occurring near the site is extremely low. The project site is within the range of the bald eagle (*Haliaeetus leucocephalus*) and the American peregrine falcon (*Falco peregrinus anatum*), but the lack of aquatic habitat indicates a low probability of these species occurring on the site. Although the black-footed ferret (*Mustela nigripes*) once ranged in the vicinity of the site, it has not been sighted in Utah since 1952,[28] and the Utah Division of Wildlife feels it is highly unlikely that this animal is present (ER, Sect. 2.8.2.2).

Table 2.28. Birds observed in the vicinity of the proposed White Mesa Uranium Project

Species	Statewide relative abundance and status[a]	Species	Statewide relative abundance and status[a]
Mallard	CP	Pinyon jay	CP
Pintail	CP	Bushtit	CP
Turkey vulture	US	Bewick's wren	CP
Red-tailed hawk	CP	Mockingbird	US
Golden eagle	CP	Mountain bluebird	CS
Marsh hawk	CP	Black-tailed gnatcatcher	H
Merlin	UW	Ruby-crowned kinglet	CP
American kestrel	CP	Loggerhead shrike	CS
Sage grouse	UP	Starling	CP
Scaled quail	Not listed	Yellow-rumped warbler	CS
American coot	CS	Western meadowlark	CP
Killdeer	CP	Red-winged blackbird	CP
Spotted sandpiper	CS	Brewer's blackbird	CP
Mourning dove	CS	Brown-headed cowbird	CS
Common nighthawk	CS	Blue grosbeak	CS
White-throated swift	CS	House finch	CP
Yellow-bellied sapsucker	CP	American goldfinch	CP
Western kingbird	CS	Green-tailed towhee	CS
Ash-throated flycatcher	CS	Rufous-sided towhee	CP
Say's phoebe	CS	Lark sparrow	CS
Horned lark	CP	Black-throated sparrow	CS
Violet-green swallow	CS	Sage sparrow	US
Barn swallow	CS	Dark-eyed junco	CW
Cliff swallow	CS	Chipping sparrow	CS
Scrub jay	CP	Brewer's sparrow	CS
Black-billed magpie	CP	White-crowned sparrow	CS
Common raven	CP	Song sparrow	CP
Common crow	CW	Vesper sparrow	CS

[a]W. H. Behle and M. L. Perry, *Utah Birds,* Utah Museum of Natural History, University of Utah, Salt Lake City, 1975.

Relative abundance	Status
C = common	P = permanent
U = uncommon	S = summer resident
H = hypothetical	W = winter visitant

Source: ER, Table 2.8-5.

2.9.2 Aquatic biota

Aquatic habitat at the project site ranges temporally from extremely limited to nonexistent due to the aridity, topography, and soil characteristics of the region and consequent dearth of perennial surface water. Two small catch basins (Sect. 2.6.1.1), approximately 20 m in diameter, are located on the project site, but these only fill naturally during periods of heavy rainfall (spring and fall) and have not held rainwater during the year-long baseline water quality monitoring program. Although more properly considered features of the terrestrial environment, they essentially represent the total aquatic habitat on the project site. When containing water, these catch basins probably harbor algae, insects, other invertebrate forms, and amphibians. They may also provide a water source for small mammals and birds. Similar ephemeral catch and seepage basins are typical and numerous to the northeast of the project site and south of Blanding. The basin to the northeast of the present ore buying station has been filled with well water to be used during construction of the adjacent office and laboratory facilities. Present plans are for it to contain water for approximately six months. This basin has not been sampled for aquatic biota since filling.

Aquatic habitat in the project vicinity is similarly limited. The three adjacent streams (Corral Creek, Westwater Creek, and an unnamed arm of Cottonwood Wash) are only intermittently active, carrying water primarily in the spring during increased rainfall and snowmelt runoff, in the autumn, and briefly during localized but intense electrical storms. Intermittent water flow most typically occurs in April, August, and October in these streams. Again, due to the temporary nature of these streams, their contribution to the aquatic habitat of the region is probably limited to providing a water source for wildlife and a temporary habitat for insect and amphibian species.

No populations of fish are present on the project site, nor are any known to exist, in its immediate vicinity. The closest perennial aquatic habitat to the proposed mill appears to be a small irrigation basin (approximately 50 m in diameter) about 6 km (3.8 miles) upgrade to the northeast. This habitat was not sampled for biota by the applicant, who reports that the pond is intermittent and probably does not harbor any fish species.

The closest perennial aquatic habitat known to support fish populations is the San Juan River 29 km (18 miles) south of the project site. Five species of fish Federally designated (or proposed) as endangered or threatened occur in Utah (Table 2.29). One of the five species, the woundfin (*Plegopterus argentissimus*), does not occur in southeastern Utah where the proposed mill site is located.[29] The Colorado squawfish (*Ptychocheilus lucius*) and humpback chub (*Gila cypha*), however, are reported as inhabiting large river systems in southeastern Utah. The bonytail chub (*Gila elegans*), classified as threatened by the State and proposed as endangered by Federal authorities is also limited in its distribution to main channels of large rivers. The humpback sucker (razorback sucker; *Xyrauchen texanus*), protected by the State and proposed as threatened by the Federal authorities, is found in southeastern Utah inhabiting backwater pools and quiet areas of mainstream rivers. The closest habitat suitable for the Colorado squawfish, humpback chub, bonytail chub, and humpback sucker is the San Juan River, 29 km (18 miles) south of the proposed site.

Table 2.29. Threatened and endangered aquatic species occurring in Utah

Species	Habitat	Listing	Occurrence in southeastern Utah
Woundfin *Plegopterus argentissimus*	Silty streams; muddy, swift-current areas; Virgin River critical habitat[a]	Federal – endangered[b] State – threatened	No
Humpback chub *Gila cypha*	Large river systems, eddies, and backwater	Federal – endangered[b] State – endangered	Yes
Colorado River squawfish *Ptychocheilus lucius*	Main channels of large river systems in Colorado drainage	Federal – endangered[b] State – endangered	Yes
Bonytail chub *Gila elegans*	Main channels of large river systems in Colorado drainage	Federal – proposed endangered[c] State – threatened	Yes
Humpback sucker (razorback sucker) *Xyrauchen texanus*	Backwater pools and quiet-water areas of main rivers	Federal – proposed threatened[c] State – threatened	Yes

[a] "Endangered and Threatened Wildlife and Plants," *Fed. Regist.* 42(211): 57329 (1977).
[b] "Endangered and Threatened Wildlife and Plants," *Fed. Regist.* 42(135): 36419–39431 (1977).
[c] "Endangered and Threatened Wildlife and Plants," *Fed. Regist.* 43(79): 17375–17377 (1978).

2.10 NATURAL RADIATION ENVIRONMENT

Radiation exposure in the natural environment is due to cosmic and terrestrial radiation and to the inhalation of radon and its daughters. Measurements of the background environmental radioactivity were made at the proposed mill site using thermoluminescent dosimeters (TLDs). The results indicate an average total-body dose of 142 millirems per year, of which 68 millirems is attributable to cosmic radiation and 74 millirems to terrestrial sources. The cosmogenic radiation dose is estimated to be about 1 millirem per year.[30] Terrestrial radiation originates from the radionuclides potassium-40, rubidium-87, and daughter isotopes from the decay of uranium-238, thorium-232, and, to a lesser extent, uranium-235. The dose from ingested radionuclides is estimated at 18 millirems per year to the total body.[30] The dose to the total body from all sources of environmental radioactivity is estimated to be about 161 millirems per year.

The concentration of radon in the area is estimated to be in the range of 500 to 1000 pCi/m^3, based on the concentration of radium-226 in the local soil.[30,31] Exposure to this concentration on a continuous basis would result in a dose of up to 625 millirems per year to the bronchial epithelium.[32] As ventilation decreases, the dose increases; for example, in unventilated enclosures, the comparable dose might reach 1200 millirems per year.

The medical total-body dose for Utah is about 75 millirems per year per person.[33] The total dose in the area of the proposed mill from natural background and medical exposure is estimated to be 236 millirems per year.

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3. OPERATIONS

3.1 MINING OPERATIONS

The White Mesa Uranium Project will process ores originating in independent and company-owned mines. Mines within 160 km (100 miles) of Energy Fuels ore buying stations (in Blanding or Hanksville) are expected to supply virtually all of the ore processed by the facility. Energy Fuels controls reserves of approximately 8600 metric tons (MT) (9500 tons) of U_3O_8 with an average ore grade of 0.125% U_3O_8 (ER, p.1-1). Additional ore will be purchased from independent mines. There will be no onsite mining activity. The environmental effects of the Blanding ore buying station (on the project site) are included in this assessment.

3.2 THE MILL

The proposed mill will utilize an acid leach-solvent extraction process for uranium recovery. Provisions for vanadium byproduct recovery are included in the design. The nominal processing capacity of the mill is 1800 MT (2000 tons) per day. The expected average ore grade is 0.125% U_3O_8. The process will recover approximately 94% of the uranium in the ore. The proposed mill would operate on a 24 hr/day, 340 days per year schedule. Based on the above design parameters, the annual U_3O_8 production of the proposed White Mesa mill will be approximately 730 MT (800 tons). The estimated annual vanadium (V_2O_5) production is 1480 MT (1630 tons).

3.2.1 <u>External appearance of the mill</u>

The plant buildings will be mainly of prefabricated construction. Although the facility will resemble the artist's rendition (Fig. 3.1), the final layout may vary, depending on final equipment selection.

As viewed from U.S. Highway 163, the mill will consist of a series of long buildings. Portions of the mill will stand above the natural skyline. The ore buying station, ore stockpiles, and the natural terrain will obscure the view of portions of the mill. The proposed tailings impoundment should not significantly alter the landscape as seen from the highway, except around soil stock piles and borrow areas.

3.2.2 <u>The mill circuit</u>

3.2.2.1 <u>Uranium circuit</u>

The flow sheet for the uranium circuit of the proposed mill is shown in Fig. 3.2. The ore would undergo a sequence of crushing, grinding, leaching, counter-current decantation, and solvent-extraction steps. The extracted uranium would be precipitated, dried, and packaged for shipment.

Most ores would be fed to the mill via the ore buying stations. Because the ores will originate from many different mines, blending will be necessary to ensure optimal processing amendability. This blending will occur as the ore is fed to the mill.

Ore received at the ore buying stations is crushed to less than 3.8 cm (1.5 in.) during the sampling process. As the ore is fed to the mill, a semiautogenous grinding (SAG) mill will reduce the feed size to smaller than a 28-mesh (0.589 mm or 0.0232 in.) screen. The ore slurry produced by the SAG mill will be leached in two stages with sulfuric acid, manganese dioxide (or an equivalent oxidant), and steam in amounts that will produce an acid solution with a temperature of 71°C (160°F). Acid consumption will be reduced by neutralizing the alkaline

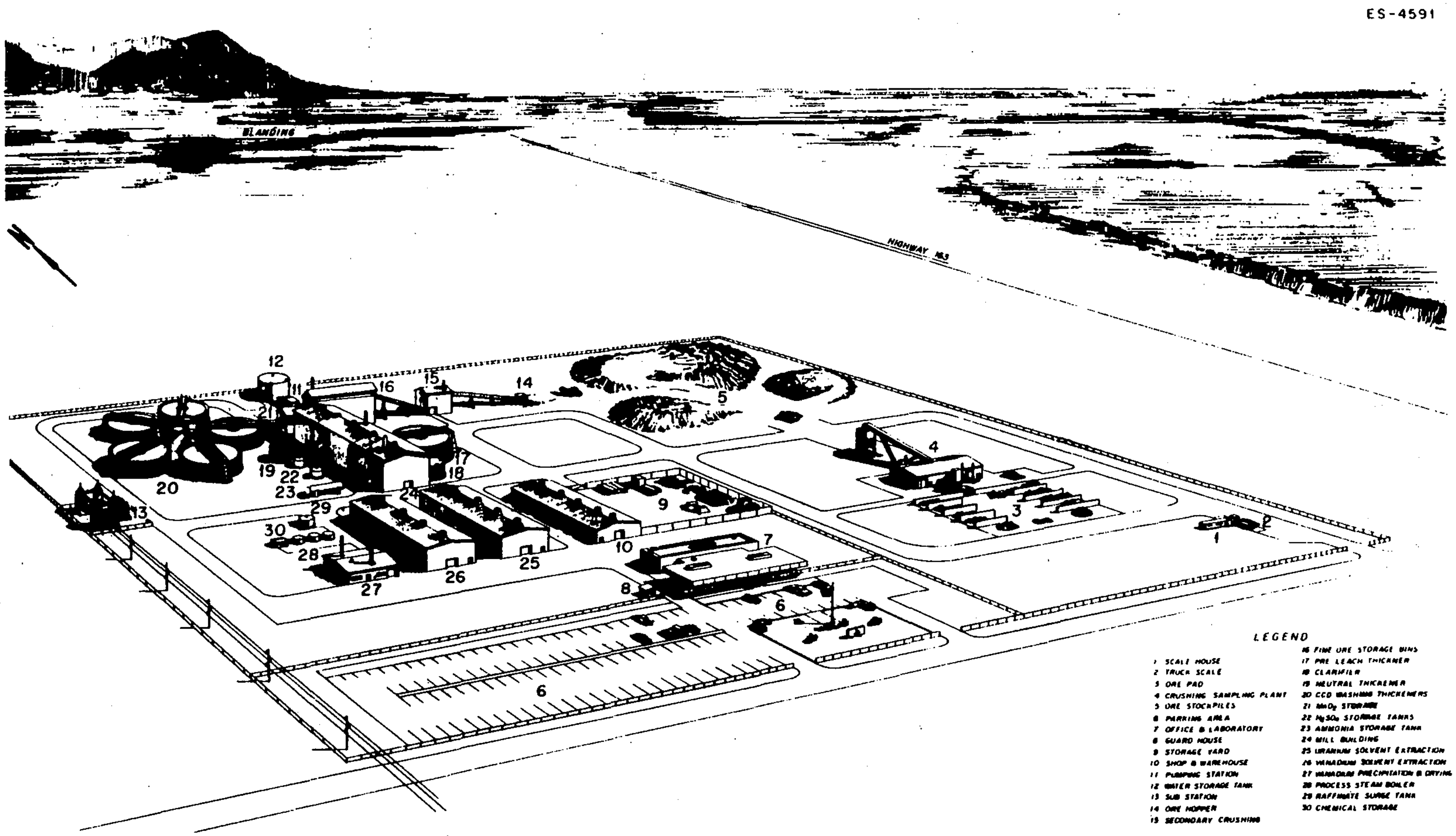

Fig. 3.1. View of the proposed White Mesa Uranium Project. Source: ER, Plate 3.1-1.

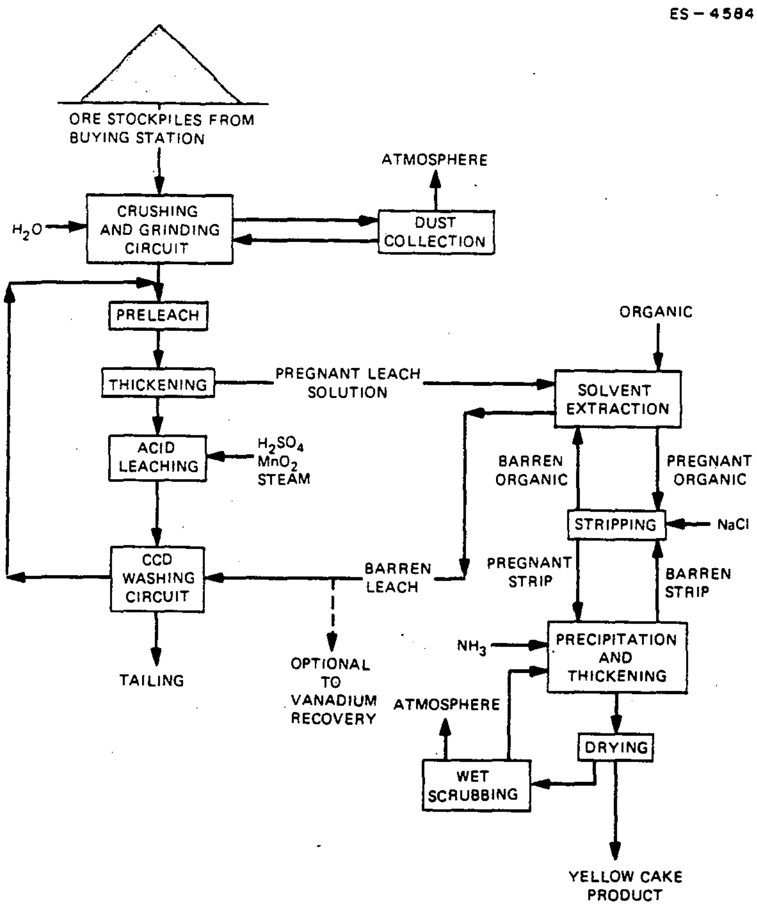

Fig. 3.2. Generalized flowchart for the uranium milling process. Source: ER, Plate 3.2-1.

components of the ore with excess acid in the pregnant leach solution in a preleach stage (Fig. 3.2). It is anticipated that approximately 95% of the uranium contained in the crude ore will be dissolved over a leaching period of up to 24 hr. The uranium-bearing solution will be separated from the barren waste by counter-current decantation using thickeners. Polymeric flocculants will be used to enhance the settling characteristics of the suspended solids. The decanted pregnant leach solution is expected to have a pH of approximately 1.5 and contain less than 1 g of U_3O_8 per liter. The barren waste will be pumped to the tailings retention area.

Solvent extraction will be used to concentrate and purify the uranium contained in the decanted leach solution. In a series of mixing and settling vessels, the solvent extraction process will use an amine-type compound carried in kerosene (organic) which will selectively absorb the dissolved uranyl ions from the aqueous leach solution. The organic and aqueous solutions will be agitated by mechanical means and then allowed to separate into organic and aqueous phases in the settling tank. This procedure will be performed in four stages using a counter-flow principle in which the organic flow is introduced to the preceding stage and the aqueous flow (drawn from the bottom) feeds the following stage. It is estimated that, after four stages, the organic phase will contain about 2 g of U_3O_8 per liter and the depleted aqueous phase (raffinate) about 5 mg per liter. The raffinate will be recycled to the counter-current decantation step previously described or further processed for the recovery of vanadium (Sect. 3.2.2.2). The organic phase will be washed with acidified water and then stripped of uranium by contact with an acidified sodium chloride solution. The barren organic solution will be returned to the solvent extraction circuit, and the enriched stripping solution containing about 20 g of U_3O_8 per liter will be neutralized with ammonia to precipitate ammonium diuranate (yellow cake). The yellow cake will be settled in two thickeners in series, and the overflow solution from the first will be filtered, conditioned, and returned to the stripping stage.

The thickened yellow cake slurry will be dewatered further in centrifuges to reduce its water content to about 40%. This slurry will then be pumped to an oil-fired multiple-hearth dryer (calciner) at 650°C (1200°F). The dried uranium concentrate (about 90% U_3O_8) will be passed through a hammer mill to produce a product of less than 0.6 cm (1/4 in.) size. The crushed concentrate, which is the final product of the plant, will then be packaged in 55-gal drums for shipment.

3.2.2.2 By-product vanadium recovery

Vanadium, which is present in some of the ores, will be partially solubilized during leaching. The dissolved vanadium will be present in the uranium raffinate. Depending on its vanadium content, the uranium raffinate will either be recycled to the counter-current decantation step (Sect. 3.2.2.1) or further processed for recovery of the vanadium before recycling.

The vanadium recovery process will consist of a separate solvent extraction step to treat the uranium raffinate and precipitate the vanadium from the stripping solution. The flowchart shown in Fig. 3.3 illustrates the process.

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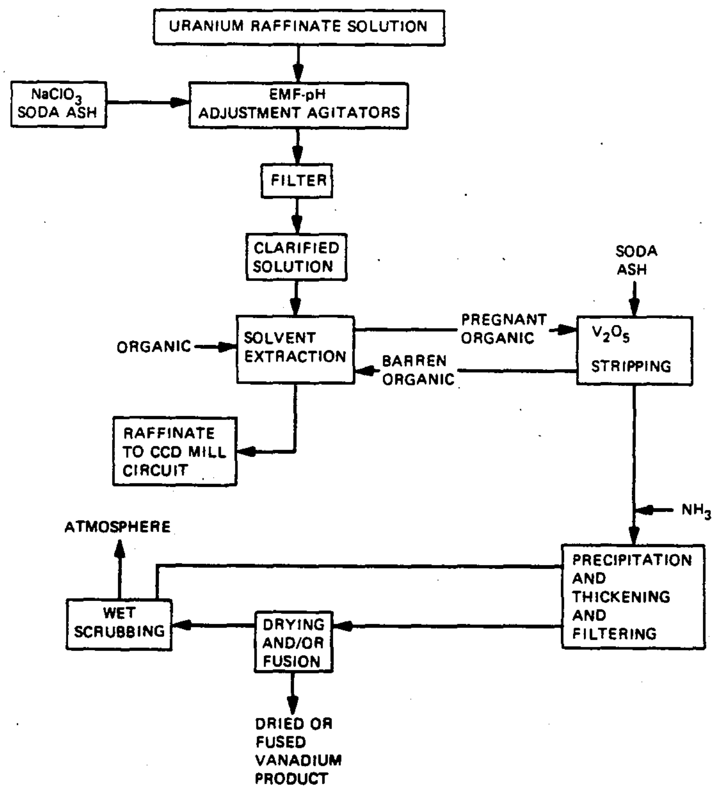

Fig. 3.3. Generalized flowchart showing recovery of vanadium. Source: ER, Plate 3.2-3.

The uranium raffinate will be pumped to a series of agitators where the electromotive force (oxidation potential) will be adjusted to -700 mV with sodium chlorate and the pH raised to 1.8-2.0. The solution may possess some turbidity after this step and will be filtered prior to passing to a five-stage solvent extraction circuit. Except for the one additional stage of extraction, the solvent extraction section will be essentially the same as utilized for the uranium. An amine-type compound carried in kerosene (Sect. 3.2.2.1) will selectively absorb the vanadium ions from the uranium raffinate solution. The organic solution will then be stripped of vanadium by contact with a soda ash solution. The barren organic solution will be returned to the solvent extraction circuit, and vanadium will be precipitated from the enriched stripping solution on a batch basis as ammonium metavanadate.

The vanadium precipitate will be thickened and filtered prior to drying in an oil-fired dryer. The dried precipitate will be subjected to a fusion step at approximately 800°C (1500°F) to produce V_2O_5 (black flake); packaging will be in 55-gal drums. Less than 0.005 percent U_3O_8 will be contained in the vanadium product.[39]

3.2.3 Nonradioactive wastes and effluents

3.2.3.1 Gaseous effluents

Milling operations will result in the release of nonradioactive vapors to the atmosphere.

Leaching

The leaching of ores in the uranium and circuit will produce carbon dioxide gas, sulfur dioxide gas, water vapor, and some sulfuric acid mist. Based on the projected calcite concentration in the ore and process conditions, the applicant estimates emissions of carbon dioxide to be 2200 kg/hr (4800 lb/hr) and emissions of sulfur dioxide and sulfuric acid mist to be 0.023 kg/hr (0.05 lb/hr) from leaching (ER, p. 3-10). The staff agrees with these estimates.

Solvent extraction

The solvent extraction processes used in uranium and vanadium recovery will release organic vapors consisting of kerosene (95%) and small quantities of amine and alcohol compounds used in the extraction. The applicant estimates the organic losses to be approximately 0.046 kg/hr (0.1 lb/hr) (ER, p. 3-10). There are no Federal or State emissions standards applicable to the release of this mixture. However, Federal and State ambient air quality standards have been set at 160 $\mu g/m^3$, averaged over 3 hr. The applicant states that operation of the proposed mill will not result in hydrocarbon concentrations exceeding this level (ER, p. 3-10).

Product dryers

The yellow cake and vanadium black flake dryers will burn approximately 11 liters/hr (3 gph) of No. 2 fuel oil (<1% sulfur), producing gaseous effluents containing nitrogen, carbon dioxide, water vapor, sulfur dioxide, and nitrogen oxides, as well as some ammonia from decomposition of the concentrate product. Radioactive effluent from this source is discussed in Sect. 3.2.4.6. The applicant estimates that dryer off-gas concentrations of sulfur dioxide and nitrogen oxides will be 0.91 kg/hr (2 lb/hr) and 0.23 kg/hr (0.5 lb/hr) respectively (ER, p. 3-11).

Because the heat input to the yellow cake and vanadium black flake dryers will be only 4.7 x 10^8 J/hr (4.5 x 10^5 Btu/hr), no Federal or State emission standards apply to this source. However, Federal and State ambient air quality standards will apply to nitrogen oxides, sulfur dioxide, and particulate concentrations due to dryer operation.

Building and process heating

Steam necessary for building and process heating will be generated from coal-fired boilers. Approximately 55 MT (60 tons) of coal per day will be required at a heat input of approximately 5.3 x 10^{10} J/hr (5 x 10^6 Btu/hr). As a result of the boiler combustion, various stack gases will be released to the atmosphere, including carbon dioxide, water vapor, sulfur dioxide, and nitrogen oxides.

State and Federal emission standards are not applicable to a steam generating boiler of this small size. However, Federal and State ambient air quality standards will apply to the resulting ambient concentrations. The combustion of 55 MT (60 tons) per day of 0.3% sulfur coal would generate approximately 33 kg (720 lb) of sulfur dioxide per day (ER, p. 3-21). Based on an industrial NO_x emmission factor of 10 kg/MT (20 lb/ton) of coal burned, the staff estimates nitrogen oxide emissions to be 545 kg/day (1200 lb/day). Fly ash emissions from this proposed boiler are discussed in Sect. 3.2.3.3.

Analytical laboratory

The mill facility will be complemented with an analytical laboratory that will routinely assay products of ore, process streams, and final products to assure adequate quality control and plant operating efficiency. The laboratory fume hoods will collect air and mixed chemical fumes for dilution and venting to the atmosphere. These gases will contain nonradioactive chemicals, such as CO_2, HCl, and NO_2. The volume of gaseous fumes emitted from the laboratory operations will be small and, considering the dilution in the collection stack and air eductors, should be inconsequential (ER, p. 3-22).

3.2.3.2 Liquid effluents

All mill process, mill laundry, and analytical laboratory liquid wastes will be discharged to the tailings impoundment for disposal by evaporation (Sect. 3.2.4). Sanitary wastes will be disposed of by a septic tank and leach field designed and operated in accordance with applicable State of Utah, Division of Health, and U.S. Public Health Service standards and regulations.

Storm runoff from above the mill, ore storage piles, ore buying station, and the initial tailings impoundment (cell 1 — initial) will be diverted to offsite drainages (Figs. 3.4 and 3.6). The runoff from the mill and facilities area will be impounded in a sedimentation pond located at the southwest corner of the mill and facilities area bounded by cells 1 and 2.

3.2.3.3 Solid effluents

Nonradioactive solid wastes will be generated by the coal-fired boiler, the ore buying stations, and by maintenance and administrative activities at the mill. Dusts will be emitted from ore crushing and handling operations, ore storage piles, unstabilized tailings, and from the uranium yellow cake and vanadium black flake dryer stacks. With the exception of the black flake dryer, the dusts from these sources are contaminated with low levels of radioactivity. Radioactive solid effluents are discussed in Sect. 3.2.4.

Building and process heating

The combustion of coal will produce two ash products, fly ash and bottom ash. With a coal usage rate of 55 MT (60 tons) per day, the total ash production would be less than 5.5 MT (6 tons) per day, which will be sent to the tailings retention system. These ash products would settle with the tailings solids and present no additional waste problems.

Stack emissions from the coal-fired boilers will pass through multiclones to remove fly ash, and less than 86 kg (190 lb) per day of particulate matter will be released to the atmosphere. Fly ash deposits from the precipitator will also be sent to the tailings impoundment (ER, p. 3-21).

Ore processing, maintenance, and administration

Scrap iron, wood, and other mine trash removed from the ore during crushing operations will be only slightly contaminated such that it may be disposed of as nonradioactive waste. Trash, rags, wood scrap, and other uncontaminated solid debris will result from maintenance and administrative activities. These materials will be disposed of in land fill areas approved by the State Division of Health and the appropriate local authorities.

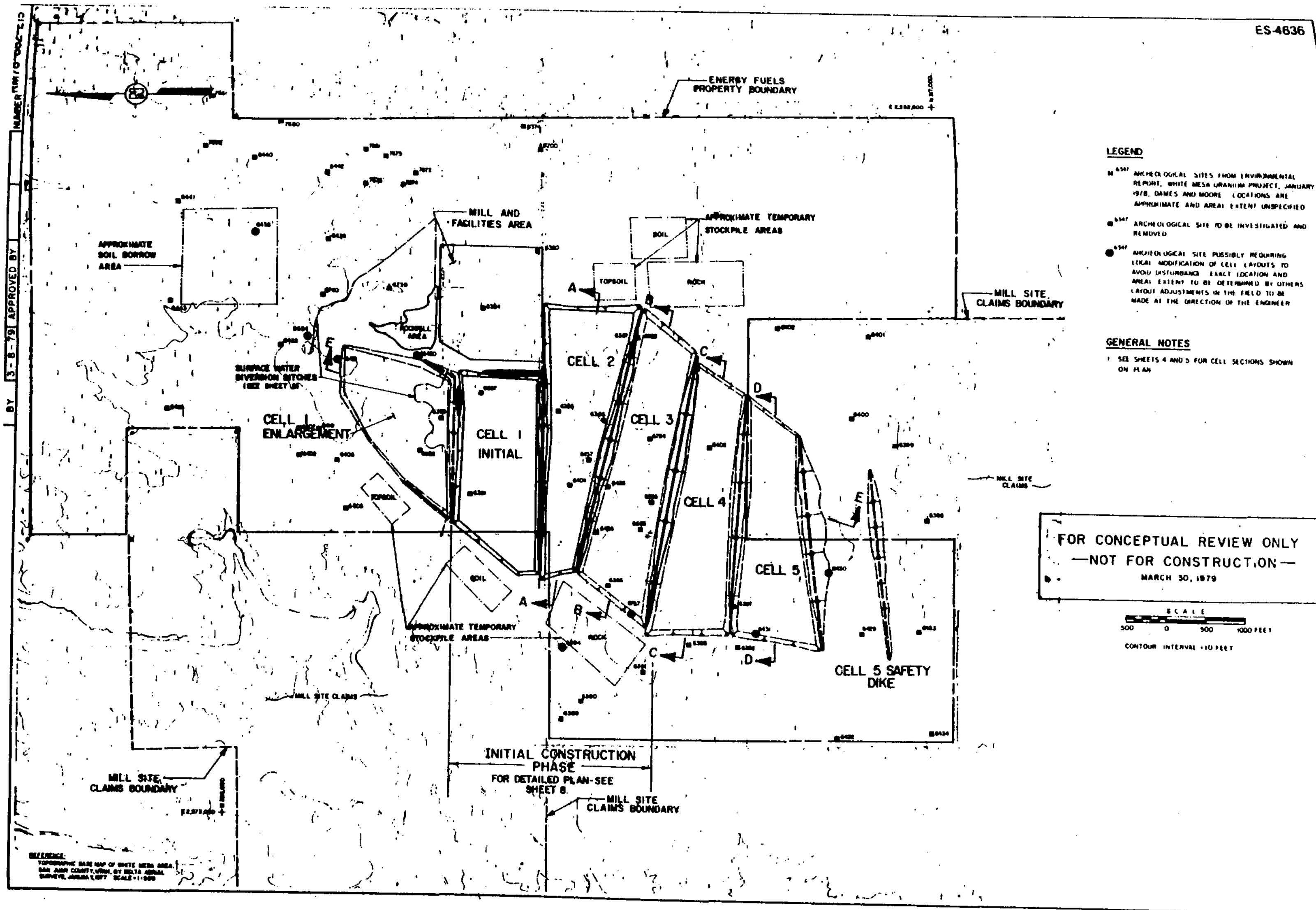

Fig. 3.4. Overall plot plan as proposed for the six-cell tailings disposal system including possible future cell additions. Source: Energy Fuels Nuclear, Inc., "Transmittal of Conceptual Review Construction Drawing Set and Synopsis, Tailings Management System, White Mesa Uranium Project, Blanding, Utah," Apr. 2, 1979.

Vanadium product dryer

When ore characteristics permit, the vanadium recovery circuit will extract the vanadium from the uranium circuit effluent (Sect. 3.2.2.2). The precipitated vanadium product will be dried in an oil-fired dryer to give vanadium pentoxide (black flake). Vanadium pentoxide is toxic. Therefore, drying and packaging will occur in an isolated building, and emissions will be controlled by a wet fan scrubber operating at an equivalent venturi scubber pressure of 51 cm (20 in.) of water and an efficiency of 99%. The applicant estimates the particulate release rate from this source to be 0.23 kg/hr (0.5 lb/hr).[1]

3.2.4 Radioactive wastes and effluents

Mining and milling of natural uranium releases some radioactivity to the environment. Uranium-238 and its daughter products in the ore are the most significant sources of radiation. The ore processed by the proposed White Mesa mill is expected to have an average grade of 0.125% uranium (as U_3O_8). Ore of this grade has an activity of about 320 μCi of uranium-238 per ton of ore. The activity from uranium-235 and its daughters is only 5% of that of the uranium-238 series and may be ignored as it is radiologically insignificant.

Ore buying, shipping, and milling processes offer several pathways for release of radioactive effluents to the environment (Fig. 3.5). The applicant's existing Hanksville and Blanding ore buying stations and the proposed mill are designed to minimize the releases through these pathways. The ore buying stations are the subject of NRC licensing actions independent from the mill source material license, which is the subject of this document. Effluents from the operation of these stations will be considered only as they impact the environment around the site. In the following sections each potential effluent source is discussed, and estimates of effluent releases based on operating data from other similar facilities will be presented.

3.2.4.1 Ore crushing and sampling

Run-of-mine ore will be received at the applicant's ore buying stations at Hanksville and Blanding. Ore from different mines will be segregated into "lots" to facilitate sampling and payment. The raw ore will pass through a primary crusher and be reduced to less than 3.8 cm (1.5 in.). A fraction of the ore will be subjected to a crushing and sampling process that will produce a representative sample of the entire ore lot being processed. During the sampling process, radon gas and low-level radioactive ore dust will be released.

The Blanding ore buying station is expected to process 114 MT (125 tons) of ore per hour, operating on one 8-hr shift per day. All feeders, crushers, screens, chutes, and transfer points are enclosed in hoods connected via ducts to the three baghouse dust filters used in the plant. The filters are cleaned by a reverse jet of air, which knocks the dust into a bin at the bottom of the baghouse. The collected dust is recombined with the ore at appropriate points, so the ore grade is not altered (ER, p. 3-32).

The bag filters have a dust removal efficiency of around 99.5% (ref. 2). Assuming the ore to be fairly dry (<6% moisture) and the dust load to the collector to be 0.008% by weight,[3] the dust loss from the total crushing and sampling process would be approximately 4×10^{-5}%. Conservatively assuming that the entire mill ore demand of 1800 MT per day is processed by the Blanding station primary crusher, the annual dust emission would be 0.245 MT per year. At an average grade of 0.15% U_3O_8, slightly higher than expected, the concentration of uranium-238 in ore would be about 423 pCi/g. Also, the uranium concentration of fine crusher dusts is reported to be about 2.5 times the concentration in the gross ore.[3] Based on these data, and the assumption of secular equilibrium, approximately 2.6×10^{-4} Ci per year of uranium-238 and each radioactive daughter would be released.

Radon-222 gas would be released as a result of disturbance of the ore during processing. Roughly 10% of the equilibrium amount of radon is released during crushing and grinding operations.[4] Use of this value for the Blanding ore buying station is conservative because secondary crushing and grinding do not occur. Based on a 10% radon loss, an ore process rate of 1800 MT per day, and an equilibrium ore concentration of 423 pCi/g, approximately 26 Ci of radon-222 would be released each year.

3.2.4.2 Transportation of ore to the mill

Crushed ore will be transported from the Hanksville buying station to the proposed mill in canvas-covered dump trucks of 30-ton capacity. The ore will not be heaped in the truck beds but will be evenly distributed to prevent ore spillage during transportation. The use of a canvas cover tied over the truck bed will minimize dust loss during haulage (ER, p.3-30).

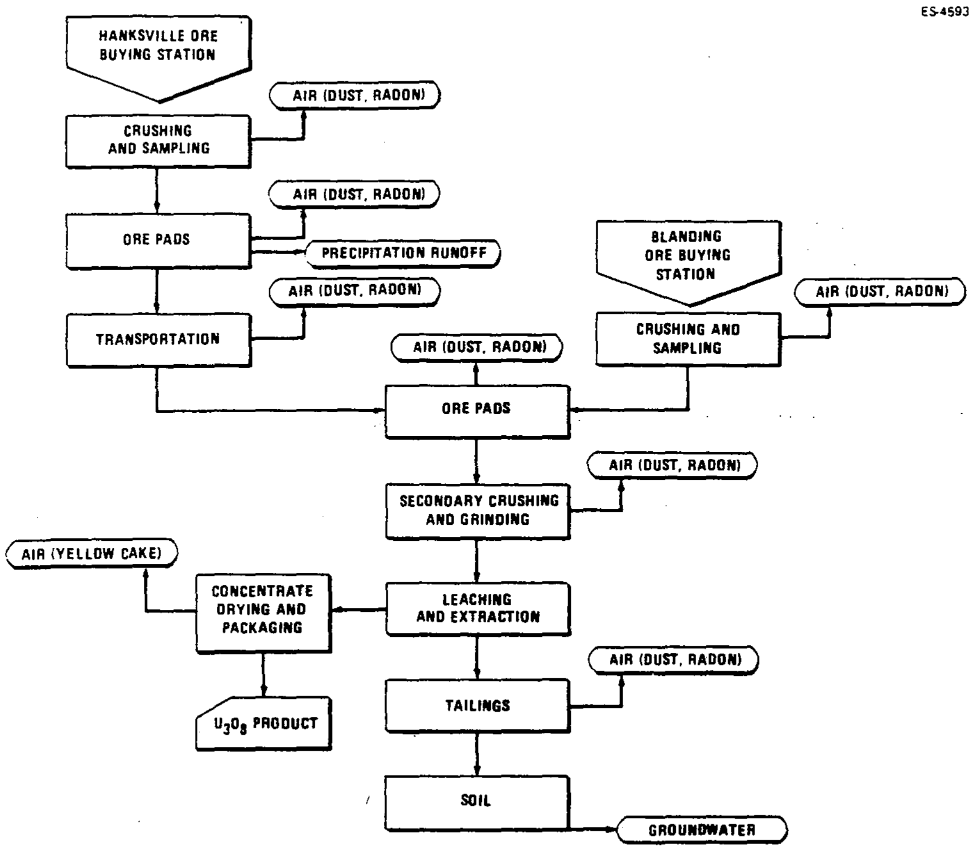

Fig. 3.5. Radionuclide dispersion pathways relevant to the White Mesa Uranium Project.

3.2.4.3 Ore pads

Quantities of ore will be stored in stockpiles at the applicant's ore buying stations at Hanksville and Blanding. These ore buying stations are the subject of two additional licensing actions separate from the mill application. The effluents from the ore pad at the Blanding ore buying station, however, would act in synergism with the effluents from the proposed mill; therefore, the Blanding ore pad operations and effluents are discussed.

Because of present ore buying operations, the applicant is accumulating ore in a 2.4-ha (6-acre) area north of the existing Blanding ore buying station. The applicant estimates that a maximum of 2.3×10^5 MT (2.5×10^5 tons) of ore will be stockpiled at the Blanding site at the time of mill startup. This quantity of ore would create a pile 6.7 m (22 ft) tall covering the 2.4-ha (6-acre) stockpile area. During operations, the stockpile would be reduced to under 9.1×10^4 MT (1×10^5 tons).

Particulates and radon-222 will be the main atmospheric emissions associated with the ore piles. Based on the meteorological data and the dusting rates for tailings sands (as a function of wind speed) presented in Appendix D, and assuming that ore pile dust emissions will be 1% of those from an equivalent area of fine-grained tailings, the annual average ore pile dusting rate is estimated to be about 1.8×10^{-7} g/m^2-sec. For a surface area of 6 acres (2.4 ha), accounting for side areas and surface roughness, the annual ore pile dust release is estimated to be 162 kg. At a gross ore concentration of 423 pCi/g and a fine concentration of 2.5 times that figure, the annual uranium-238 release from this source would be about 1.7×10^{-4} Ci/yr. The release of each particulate daughter in secular equilibrium would also be 1.7×10^{-4} Ci/yr.

The applicant intends to moisten pile surfaces after ore is added or removed and this will act to reduce these releases. As the release estimates presented here are basically proportional to the area of the ore storage piles, they would not be significantly affected by changes in the volume of stored material as long as it is distributed over the same surface area.

Radon-222 will be produced in the pile from decay of radium-226. Most of the radon decays in place with only a small fraction of the radon escaping the piles via diffusion. The staff estimates the annual radon release for the maximum stockpile case to be approximately 240 Ci/year (see Appendix F). As mill operations progress and the size of the pile decreases to an equilibrium value under 9.1 x 10^4 MT, the radon release from this smaller pile will depend on pile geometry. The radon flux from the pile surface is virtually independent of thickness for thicknesses greater than 3 m (10 ft). Therefore, if the same area [2.4 ha (6 acres)] is maintained for the equilibrium pile, the annual radon release would be the same as for the maximum stockpile, that is, 240 Ci/year (Appendix F).

Dust control measures such as moistening the surface of the stockpiled ore will also reduce radon releases because the moisture will decrease the diffusion coefficient. This effect is expected to be small.

3.2.4.4 Secondary crushing and grinding

The applicant proposes to use a semiautogenous mill to perform secondary crushing and grinding of the ore. The semiautogenous mill will also function as a primary crusher for ores received directly from mines (and not through ore buying stations). This process uses larger pieces of ore to crush and grind smaller pieces; thus the ore essentially grinds itself. Steel balls may be added as necessary to aid in grinding.

Because the semiautogenous mill is a wet process, particulate releases will be small. Assuming a release fraction of 1 x 10^{-4}%, a gross ore concentration of 423 pCi/g, a fine concentration 2.5 times higher, and a processing rate of 1800 MT/day, the annual release of uranium-238 and each daughter in secular equilibrium from secondary crushing and grinding is estimated to be 6.5 x 10^{-4} Ci. Based on a release fraction of 20% the annual release of radon-222 gas from this source is estimated to be 52 Ci.

3.2.4.5 Leaching and extraction

Leaching and extraction are wet processes and should not make any significant contribution to the release of particulates. Because the residence time of ore in the leaching circuit will be short (12 to 24 hr), radon-222 will not build up to concentrations high enough to give a significant gaseous release.

3.2.4.6 Yellow cake drying and packaging

Normally, the uranium concentrate (precipitated ammonium diuranate) will be dried at 650°C. The product (yellow cake) will be about 90% U_3O_8 and will contain about 94% of the uranium in the ore. In addition, yellow cake will contain about 5% of the thorium-230 and 0.2% of the radium-226 and daughters originally in the ore. The uranium product dryer and product crusher will be isolated from other mill areas. Emissions will be controlled by wet fan scrubbers operating at an equivalent venturi scrubber pressure of 0.5 m (20 in.) of water with an efficiency of about 99%. The solution and particulates collected from the scrubbers will be recycled to the No. 1 yellow cake thickener in the mill (ER, p. 3-19). Data presented in Table 9.13 of Reference 3 indicate that about 1.2% of the annual yellow cake production may be expected to reach the wet fan scrubbers. At a gross ore grade of 0.15% U_3O_8 and a recovery rate of 94%, the annual production of pure yellow cake (U_3O_8) would be about 863 MT. With a scrubbing efficiency of 99%, the annual yellow cake release would be about 115 kg of which about 104 kg would be U_3O_8. The uranium-238 release rate is then calculated to be about 0.029 Ci/yr. Releases of other isotopes would be about 1.6 x 10^{-3} Ci/yr of thorium-230 and 6.2 x 10^{-5} Ci/year each of radium-226 and lead-210. Releases of radon gas from this source are negligible.

3.2.4.7 Tailings retention area

The tailings discharged from the counter-current decantation unit of the mill is a slurry consisting of 897 kg (1977 lb) of solids and 0.9 m^3 (237 gal) of liquid per ton of dry ore fed to the mill. The tailings liquid contains residual acid from the leaching step and dissolved solids placed in solution by the leaching and solvent extraction steps. The estimated composition of the waste solution is given in Table. 3.1.

Both the liquid and solid portions of the tailings will be a source of low-level radiation due to the uranium and daughter products left in the wastes. Approximately 6% of the original uranium, 95% of the thorium, and 99.8% of the radium remain with the tailings. The radioactive components of the waste show generally low solubility and remain mostly in the solids. The applicant conducted assays of synthetic tailings generated under conditions expected to be found in the mill and measured the thorium-230 and radium-226 contents at 1.5×10^2 pCi and 3.7×10^2 pCi per gram of solids (ER, p. 3-12). The actual concentrations found in the mill tailings will depend on the actual grade of the ore fed to the mill. The soluble radioisotope concentrations are listed in Table 3.1.

Because of the adverse radiological and chemical nature of uranium mill tailings, permanent environmental isolation is required. The tailings management plan should prevent excessive release of solids by wind erosion and of liquids by seepage, leakage, or overflow during operation of the mill. Following the cessation of milling operations, the tailings management plan should also provide for adequate stabilization of the tailings against long-term erosion and minimize the leaching of radioactive solids, the diffusion of radon-222 gas, and the

Table 3.1. Composition of liquid in plant tailings slurry based on laboratory test work

Parameter	Amount
Composition (g/liter)	
V	0.24
U	0.0025
Na	4.90
NH_3	0.065
Cl	3.05
SO_4	82.2
Cu	1.62
Ca	0.48
Mg	4.06
Al	4.26
Mn	4.58
Zn	0.09
Mo	0.007
Organics	0.2[a]
pH	1.8–2.0
As	0.052
Ba	0.0003
Cd	0.0017
Cr	0.0060
Pb	0.001
Hg	0.000001
Se	0.00056
Ag	0.00006
F	0.0014
Si	0.30
Radiochemical assay (pCi/liter)	
Gross alpha emissions	2.5×10^5
Gross beta emissions	2.3×10^5
Th-230	1.3×10^5
Ra-226	2.3×10^2
Pb-210	2.8×10^2

[a]Measured in gallons oer 1000 gal.

Source: ER, p. 3–12, Energy Fuels Nuclear, Inc., "Responses to Comments on White Mesa Project DES," Mar. 6, 1979.

direct gamma radiation dose from the tailings. The tailings management plan proposed by the applicant is discussed in the remainder of this section. The merits of the proposed impoundment and alternative methods are discussed in Sect. 10.3.

The applicant proposes to build a six-cell impoundment system immediately to the west and south of the proposed mill (Fig. 3.4). The design storage volume of this system is 15 years. The impoundment would be constructed in a swale, a shallow natural basin. A cell would be constructed by excavating the bottom of the swale and placing an embankment across the swale to form the downstream side of the cell.

Each retention embankment will have a final embankment elevation matching the level of the adjacent natural ground that creates the ridges along the edges of the swale. Therefore, the embankments will only be as high as the undisturbed ground adjacent to the tailings cell. The maximum embankment heights will vary from 7.6 to 13.0 m (25 to 42 ft), depending upon the individual cell.

Each tailings cell will be filled to a level 1.5 m (5 ft) below the top of the embankment and the adjacent ground and will be covered with a sufficient amount of cover to reduce the radon emanation to twice background. This cover will create a slight rise where the swale formerly existed to gently drain waters away from the reclaimed tailings area while minimizing erosion of the cover material.

Seepage will be controlled in the first three cells [evaporation cells 1 — initial (1-I) and 1 — enlargement (1-E) and tailings cell 2] by state-of-the-art synthetic liners placed over and overlain by layers of packed silt-sand materials available onsite (see Sect. 10.3.2 for description). No seepage problems with this liner system are anticipated. The applicant proposes to line the remaining cells with a 2-ft layer of compacted clay (permeability of about 3×10^{-8} cm/sec) to control seepage. Cells 1-I and 1-E will be used only as evaporation ponds. As the tailings slurry in cells 2 through 5 drains, excess liquid will be pumped to these ponds for evaporation. Cell 1-I, cell 2, and the cell 2 "safety dike" will compose the first stage of construction (see Fig. 3.6.).

The embankments which dam the cells will be constructed of compacted soil available on the site. The embankments would vary in height from a meter or more near the ridges of the swale to as much 13 m (42 ft) for dikes at the lowest point in the swale. All dikes would be 6 m (20 ft) thick at the crest (allowing for an access road on the dike) and would have slopes no steeper than 3:1 (horizontal to vertical; Fig. 3.7). The final exterior slope of the last embankment on the perimeter of the impoundment will have a slope of 6:1 and will be constructed of excavated rock (Fig. 3.8). Because the dikes will not saturate during the brief period a given cell is in operation, engineered embankments are not utilized. Geotechnical studies performed for the applicant indicate that the proposed slopes would withstand an earthquake with a magnitude of VI on the Modified Mercalli Scale.

The proposed tailings system features simultaneous construction, operation, closure, and reclamation activities. The first two cells (cell 1-I and cell 2) and the cell 2 "safety dike" (which will ultimately be part of the cell 3 embankment) would be constructed before commencement of mill operation (Fig. 3.6), with tailings being initially deposited in the second cell and the liquids decanted and pumped back to the first cell (cell 1-I) for evaporation. The "safety dike" of the second cell would form a downstream catchment area for any release of tailings material in the event of failure of cell 1-I or cell 2 embankments. (Note that this failure is considered highly unlikely as the cell 2 embankment will be designed and constructed to meet Regulatory Guide 3.11.) During the filling of cell 2, cell 3 would be excavated and lined, and the "safety dike" for cell 3 would be constructed. After cell 2 is filled to its final grade, the tailings disposal pipeline would be moved to cell 3. While cell 3 is being filled, reclamation of cell 2 would commence after the tailings had dried, and excavation of cell 4 would begin. Except for a small channel, which would be maintained through the cover of the first cell (and each subsequent cell) for placement of the tailings slurry pipeline and tailings liquids return line (to evaporation ponds), the cells will be completely reclaimed. The slurry discharge pipe will also be contained in a second pipe (emergency containment pipe) where it passes through embankment sections to prevent embankment erosion in the event of slurry pipe failure. This pattern of operation would continue until the last cell is constructed. As with previous tailings cells, closure and reclamation of the last cell (cell 5) would be completed as soon as the tailings surface is sufficiently dry for movement of heavy equipment over the pile. Cells 1-I and 1-E will be allowed to dry, construction materials from cell 1-E will be placed in cell 1-I, and cells 1-I and 1-E areas will be reclaimed.

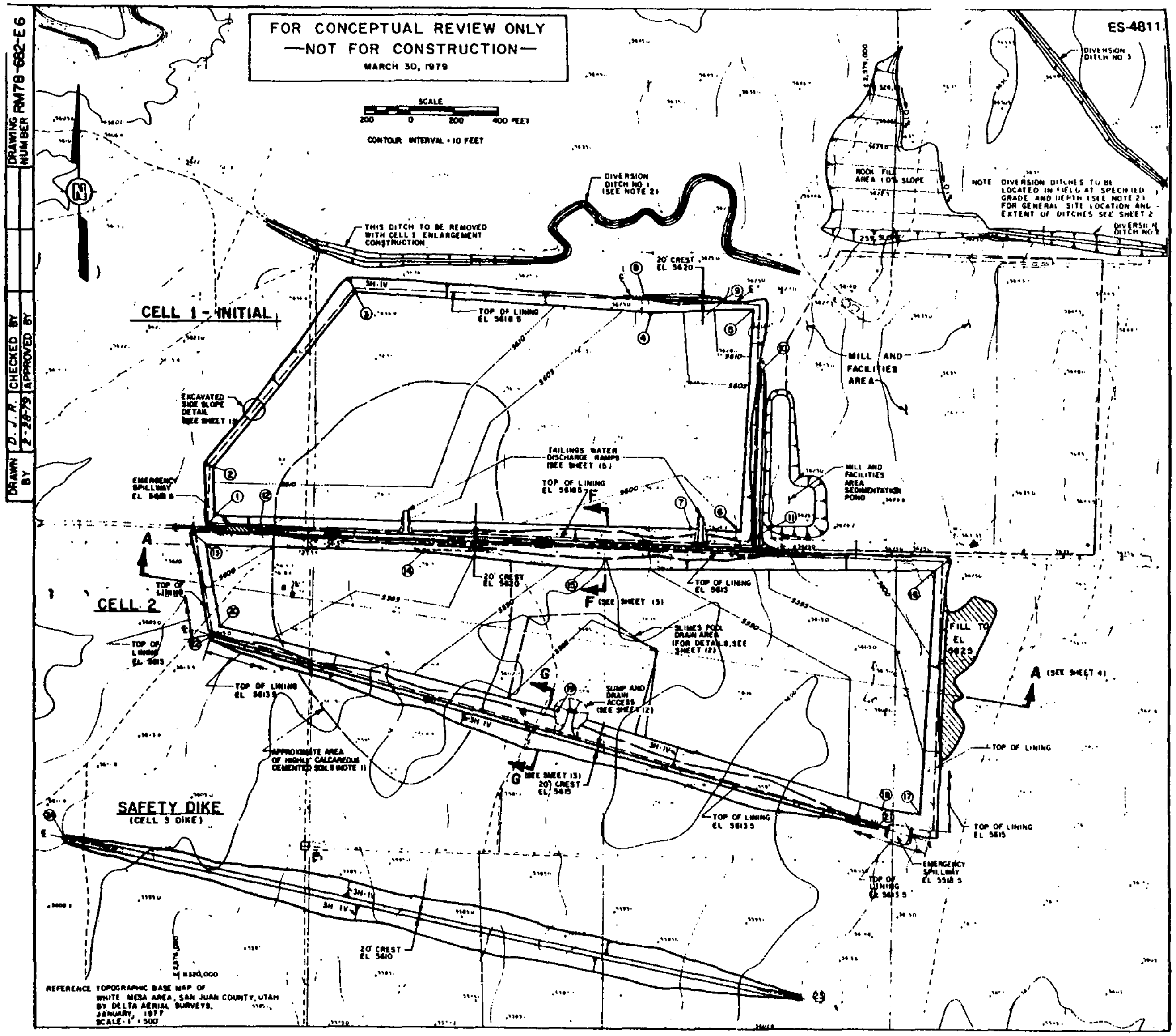

Fig. 3.6. Initial construction phase--detailed plan. Source: Energy Fuels Nuclear, Inc., "Transmittal of Conceptual Review Construction Drawing Set and Synopsis, Tailings Management System, White Mesa Uranium Project, Blanding, Utah," Apr. 2, 1979.

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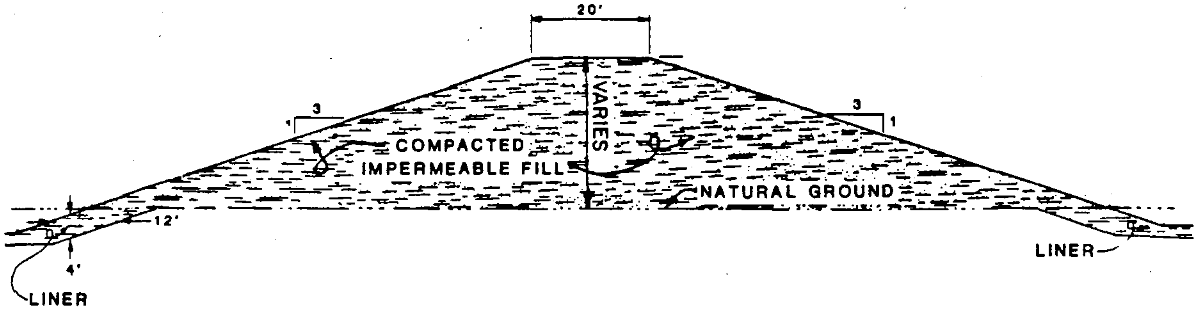

Fig. 3.7. Typical dike section. Source: Energy Fuels Nuclear, Inc., *Source Material License Application, White Mesa Uranium Mill, Blanding, Utah,* Energy Fuels Nuclear, Inc., Denver, Sept. 26, 1978, Appendix AA.

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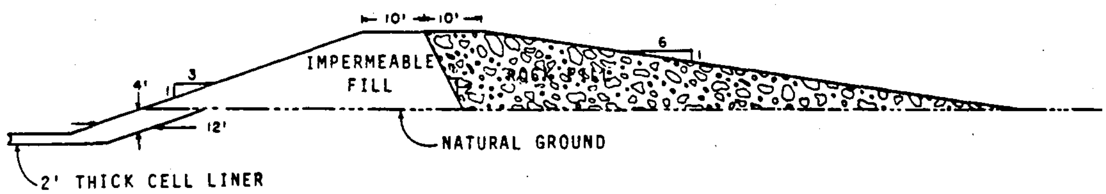

Fig. 3.8. Final dike section. Source: Energy Fuels Nuclear, Inc., *Source Material License Application, White Mesa Uranium Mill, Blanding, Utah,* Energy Fuels Nuclear, Inc., Denver, Sept. 26, 1978, Appendix AA.

The staff has examined the water balance for the system and concluded that the 40 ha (98 acres) of available free water surface (cells 1-I and 1-E; Fig. 3.4) plus evaporation from the slimes area and evaporation from the moist sand fraction in the tailings cells will enable the applicant to dispose of excess water. If difficulties are encountered, the applicant can recycle some of the ponded water for further mill use.

Effluents from the proposed impoundment will consist of wind-blown particulates, and radon-222. During tailings cell fill operations, wind erosion of the tailings will be minimized by keeping the entire tailings surface moist by regularly shifting the location of the slurry discharge spigot. However, as the final layer of sands is deposited in a cell, the tailings discharge line will be moved toward the downstream dike, allowing the upper end of the cell to dry out. Additional drying will be necessary to allow operation of heavy equipment during reclamation of the cell. The staff will require the use of crusting agents, water spray, or similar means to minimize the erosion of the tailings by wind. If no successful mitigating measures were taken (conservative calculation), the annual average dry tailings pile dusting rate, on the basis of data presented in Appendix D, would be about 1.8×10^{-5} g/m^2-sec which is equivalent to about 2.2 MT/acre-yr. Corresponding estimated radioactivity release rates are 1.4×10^{-4} Ci/acre-yr for U-238, 2.2×10^{-3} Ci/acre-yr for Th-230, and 2.3×10^{-3} Ci/acre-yr for Ra-226 and Pb-210 (each).

Due to uncertainties concerning the period of time necessary for drying prior to cell reclamation, the staff has conservatively assumed (for purposes of radiological impact analysis) that each cell would have an area of 40 ha (100 acres) and that there could be 2 cells drying out while a third was being filled. If the cell being filled is 50% beach, there could be a total of approximately 100 ha (250 acres) of tailings area available for dusting. The staff has assumed that control measures to be implemented by the applicant will reduce dust emissions from nonoperational cells by 80%. Under these conditions total annual radioactive particulate releases are estimated to be 0.013 Ci of U-238, 0.20 Ci of Th-230, and 0.21 Ci of Ra-226 and Pb-210 (each).

Radon-222 gas is expected to be released in significant quantities from dry tailings areas. Releases from saturated tailings, or tailings that are under water, are severely limited due to the low diffusivity of radon gas in water. The staff assumes that two 40-ha (100-acre) cells may be drying prior to reclamation while a third cell is being filled. Radon releases from the driest cell (8% moisture content), the other cell drying out prior to reclamation (15% moisture content), and the beach area of the filling cell (50% beach, 37% moisture content) are estimated to be 5550 Ci/yr, 2480 Ci/yr, and 30 Ci/yr, respectively (see Appendix F for details). The total annual radon-222 release is estimated to be 8060 Ci/yr. Radon releases from underwater tailings materials or reclaimed tailings cells are insignificant in comparison and have been ignored.

3.2.4.8 Uranium concentrate transportation

The uranium concentrate will be transported in 55-gal drums by truck because no rail transportation is available at the site. Uranium shipment, about 2000 drums each year, will result in an external radiation dose[5] to an individual of 2 mR/hr at any edge of the truckbed. Under normal operating conditions, no significant release of radioactive particulates would occur. However, release could occur during transportation accidents as discussed in Sect. 5.3.1.

3.2.4.9 Source terms

Sections 3.2.4.1 through 3.2.4.8 describe the nature and quantity of radioactive effluents conservatively estimated to be generated by milling operations at the White Mesa Uranium Project. Estimates employed in the above discussions were derived from project design parameters and data from similar mills.[6-37] The estimates reflect operation of the fully developed mill and tailings area. Initial releases from the tailings area will be lower than the estimated values for several years after startup. Therefore, the use of full-scale operation as the basis for estimates adds some additional conservatism to the analysis. Table 3.2 gives the design parameters used in estimates of radioactive release rates. The source terms for the milling operations and areas are presented in Table 3.3.

3.3 INTERIM STABILIZATION, RECLAMATION AND DECOMMISSIONING

3.3.1 Interim stabilization of the tailings area

Interim *stabilization* is defined as measures to prevent the dispersion of tailings particles by wind and water outside the immediate tailings retention area. Such measures will be required at the White Mesa mill during the 15 years of operation (for in-use and drying cells) and the years required to dry the final tailings cell and evaporation cells after operation (see Sects. 3.2.4.7 and 10.3.2, Alternative 1) prior to reclamation.

As a license condition, the staff will require that the applicant implement an interim stabilization program which minimizes dispersal (via airborne particulates) of blowing tailings to the maximum extent reasonably achievable. The program shall include the use of written operating procedures that specify the use of specific control methods for all conditions. The effectiveness of this control measure shall be checked at least weekly by means of a documented site inspection.

3.3.2 Reclamation of the mill tailings area

In accordance with the Utah Mined Land Reclamation Act of 1975 and the requirements of the NRC, the applicant has prepared a stabilization plan for the tailings area. The goal of the applicant's plan is to meet the performance objectives for tailings management (Sect. 10.3.1).

The proposed reclamation program calls for a 0.6-m (2.0-ft) layer of compacted clay, a 1.2-m (4-ft) layer of silt-sand overburden material, and a 1.8-m (6-ft) layer of rock overburden material over the tailings area. The proposed cover is considered sufficient to reduce

The cover would also be graded and sloped at a grade of 2% or less to prevent impoundment of surface runoff. Slopes on the perimeter of the cover would be no steeper than 6:1 (horizontal to vertical) and would be constructed of riprap. A layer of topsoil 0.15 m (0.5 ft) thick will be placed over the cover. The area would be fertilized and revegetated with a suitable mixture of grasses, forbs, and shrubs. Grasses and shrubs whose root structures would penetrate the cover will not be planted. The approximate volumes of material required would be 7.38 x 10^5 m^3 (9.65 x 10^5 yd^3) of clay, 1.76 x 10^6 m^3 (2.30 x 10^6 yd^3) of overburden, 2.2 x 10^6 m^3

Table 3.2. Principal parameter values used in the radiological assessment of the White Mesa Uranium Project

Parameter	Value[a]
General data	
Average ore grade, % U_3O_8	0.15
Ore concentration, pCi of U-238 and daughters per gram	423
Ore processing rate, MT/day	1800
Days of operation per year	340
Blanding ore crusher	
Ore processing rate, MT/day	1800
Fraction released as particulates	4×10^{-7}
Fraction of radon released	0.1
Dust:ore concentration ratio	2.5
Ore storage piles[b]	
Actual area, ha (acres)	2.4 (6)
Effective dusting area, ha (acres)	3.0 (7.3)
Annual average dust loss rate, $g/m^2 \cdot sec$	1.8×10^{-7}
Dust:ore concentration ratio	2.5
Semiautogenous grinder	
Ore processing rate, MT/day	1800
Fraction released as particulates	1×10^{-6}
Fraction of radon released	0.2
Dust:ore concentration ratio	2.5
Yellow cake drying and packaging	
Fraction U to yellow cake	0.94
Fraction Th to yellow cake	0.05
Fraction Ra and Pb to yellow cake	0.002
Annual U_3O_8 production, MT	863
Annual yellow cake production, MT	959
Fraction of yellow cake to scrubber	0.012
Scrubber release fraction	0.01
Tailings impoundment system[b,c]	
Fraction U to tailings	0.06
Fraction Th to tailings	0.95
Fraction Ra and Pb to tailings	0.998
Area, ha (acres) per cell	40 (100)
Area subject to dusting, ha (acres)	100 (250)
Annual average dust loss rate, $g/m^2 \cdot sec$	1.8×10^{-5}
Dust:tails concentration ratio	2.5

[a] Parameter values presented here are those selected by the staff for use in its radiological impact assessment of the White Mesa Uranium Project. These values, which include emissions from the Blanding ore buying station, represent conservative selections from ranges of potential values in instances where insufficient data has been available to be more specific.

[b] Appendix F provides additional information regarding the calculation of radon releases.

[c] Effective dusting area is 36 ha (90 acres); 20% of two 40-ha (100-acre) cells drying prior to reclamation and 50% of a 40-ha (100-acre) operational cell.

(2.89×10^6 yd^3) of rock, and 2.2×10^5 m^3 (2.88 yd^3) of topsoil. Staged constructed, operation, and reclamation will minimize stockpiling and handling requirements.

The reclamation plans have been developed from recommendations from the U.S. Department of Agriculture (USDA) Soil Conservation Service and Forest Service (ER, Sect. 9.4). These plans are also in accordance with the regulations of the State of Utah Division of Oil, Gas, and Mining.[38,39]

Table 3.3. Estimated annual releases of radioactive materials resulting from the White Mesa Uranium Project

Source	Annual releases (Ci)[a]			
	U-238	Th-230	Ra-226	Rn-222
Blanding ore crusher	2.6×10^{-4}	2.6×10^{-4}	2.6×10^{-4}	2.6×10
Ore storage piles	1.7×10^{-4}	1.7×10^{-4}	1.7×10^{-4}	2.4×10^{2}
Secondary crusher	6.5×10^{-4}	6.5×10^{-4}	6.5×10^{-4}	5.2×10
Yellow cake scrubber	2.9×10^{-2}	1.6×10^{-3}	6.2×10^{-5}	0.0
Tailings system	1.3×10^{-2}	2.0×10^{-1}	2.1×10^{-1}	8.1×10^{3}

[a] Releases of other isotopes in the U-238 decay chain are included in the radiological impact analysis. These releases are assumed to be identical to those presented here for parent isotopes. For instance, the release rate of U-234 is taken to be equal to that for U-238.

The project site will be revegetated to return it to the original uses of grazing and wildlife habitation. The soils are relatively uniform and adequate for these reclamation procedures (ER, Sect. 9.1.1). The reclamation schedule for the tailings impoundment site is depicted in Fig. 3.9. The tailings cells will be reclaimed sequentially as each cell is filled, beginning after about the fourth year of operation and every four years thereafter until termination of project operations. A clay cap [0.6 m (2 ft)], and onsite clayey-silt soil [1.2 m (4 ft)], and rock overburden [1.8 m (6 ft)], will be placed over the dried tailings. Except for the rock-lined drainage ditches, rock-filled slopes along the edges of the soil-covered tailings cells, and the rock-filled southernmost dike of cell 5, about 0.15 m (0.5 ft) of topsoil will be placed on the surface of all disturbed areas and seeded with a mixture of grasses, forbs, and shrubs (Table 3.4). Any excess rock will be disposed of at the 14.6-ha (36-acre) borrow area prior to its reclamation.

The applicant's selection of seeds is representative of the vegetation on the site prior to construction and will suffice in reclaiming the site to the preconstruction land condition. The staged reclamation plan will permit optimizing the seed mixture for a maintenance-free vegetative cover which will maximize soil stability. In the long term native vegetation is expected to return to the area. The seed should be obtained from those areas that have soil characteristics and climate similar to the project site.[40]

The mixture of seed will be planted in November with a rangeland drill. Because soil nitrogen is low (ER, Sect. 2.10.1), it may be necessary to apply an appropriate fertilizer prior to seeding. The applicant claims that the topsoil will contain sufficient debris so that mulching will not be required. However, by the time reclamation begins, much of the debris will be decomposed. Mulches increase infiltration and reduce erosion and evaporation, thereby encouraging seed germination and plant growth. Therefore, it may be necessary to crimp mulch into the soil of all disturbed areas prior to seeding. Revegetated areas will be monitored (Sect. 6.2.2).

The staff notes that the information developed in the Generic Environmental Impact Statement on Uranium Milling being prepared by NRC could be used to modify or change the procedures proposed herein. The generic statement will contain the results of ongoing research to assess the environmental impacts of uranium mill tailings ponds and piles, and will suggest means for mitigating any adverse impacts. The current NRC licensing action regarding the White Mesa mill will be subject to revisions based on the conclusions of the Final Generic Environmental Impact Statement on Uranium Milling Operations and any related rule making.

The applicant will be required to make financial surety arrangements to cover the costs of reclaiming the tailings disposal area and of decommissioning the mill.

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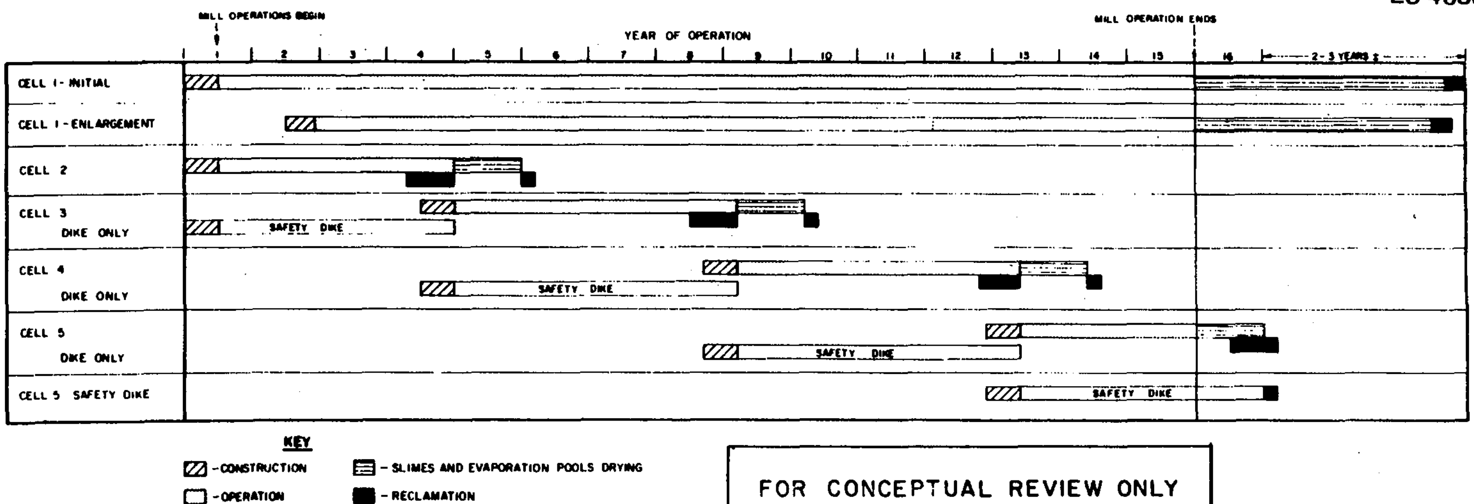

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Fig. 3.9. System schedule. <u>Source</u>: Energy Fuels Nuclear, Inc., "Transmittal of Conceptual Review Construction Drawing Set and Synopsis, Tailings Management System, White Mesa Uranium Project, Blanding, Utah," Apr. 2, 1979.

Table 3.4. Species, seeding rates, and planting depths of tentative seed mixture to be used in reclamation of the project site

Species	Seeding rate		Depth	
	kg/ha	lb/acre	cm	in.
Grasses				
"Luna" pubescent wheatgrass	6.16	5.5	0–0.64	0–0.25
Fairway (crested) wheatgrass	1.68	1.5	0–0.64	0–0.25
Forbs				
Yellow sweetclover	1.12	1.0	1.27–2.54	0.5–1.0
Palmer penstemon	0.112	0.1	0–0.64	0–0.25
Alfalfa	1.12	1.0	1.27–2.54	0.5–1.0
Shrubs				
Fourwing saltbush	0.56	0.5	0.64–1.27	0.5–1.0
Common winterfat	0.56	0.5	0.64–1.27	0.5–1.0
Big sagebrush	0.112	0.1	0.64–1.27	0.5–1.0
Total	11.424	10.2		

Source: Energy Fuels Nuclear, Inc., *Source Materials License Application, White Mesa Uranium Mill, Blanding, Utah,* Denver, Sept. 26, 1978.

Prior to the termination of the license the NRC will require that the reclaimed tailings impoundment area be deeded to the Federal government.

In addition, although revegetation is an effective erosion control method under normal climatic and edaphic conditions, it is not known whether continued growth of vegetation can be assured at this site without irrigation or other supportive measures. Therefore, to assure that a stable cover will be established, the staff recommends that riprap (or gravel cover) over the entire basin be planned as an optional erosion control method. The final choice between gravel and vegetation can be made based on some years of testing and research currently in progress, and on the performance of various reclamation schemes which are completed in the interim.

3.3.3 Decommissioning

Near the end of the useful life of this project and prior to the termination of the license the NRC will require a detailed decommissioning plan for the White Mesa mill, which will contain plans for decontamination, dismantling, and removing or burying all buildings, machinery, process vessels, and other structures and cleanup,regrading and revegetation of the site. This detailed plan will include data from radiation surveys taken at the site and plans for any mitigating measures that may be required as a result of these surveys and NRC inspections. Before release of the premises or removal of the buildings and foundations, the licensee must demonstrate that levels of radioactive contamination are within limits prescribed by NRC and the then-current regulations. Depending on the circumstances, the NRC may require that the applicant submit an Environmental Report on decommissioning operations prior to termination of the license.

REFERENCES FOR SECTION 3

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4. ENVIRONMENTAL IMPACTS

4.1 AIR QUALITY

4.1.1 Construction

The major nonradiological air pollutants associated with construction of the mill facility will be gaseous emissions from internal combustion engines and fugitive dust generated from moving vehicles and wind erosion. In general, these emissions will not produce significant impacts to air quality.

The maximum expected emission rate for any of the major pollutants (NO_2, SO_2, CO, and hydrocarbons) from each piece of construction equipment is less than 0.2 g/sec.[1] Using conservative χ/Q (sec/m^3) values (Appendix H, Table H.1), the staff calculated the annual atmospheric concentration of each pollutant per vehicle to be less than 1 $\mu g/m^3$ at the property boundary in the direction of the prevailing wind.

Fugitive dust associated with construction of the facility will average about 0.4 to 0.7 MT/ha (1 to 2 tons/acre) per month.[2] Based on a total of about 142 ha (344 acres) disturbed at any one time (Sect. 4.2.1), about 121 to 241 g/sec of particulates will be emitted. Annual average atmospheric concentrations of particulates were calculated by the staff using the χ/Q values (Appendix H, Table H.1) for the 16 compass directions at a distance of 2.4 km (1.5 miles). The average of these 16 concentrations indicates that particulate loading due to construction will range from 26 to 53 $\mu g/m^3$ (Table 4.1). These are conservative calculations because the χ/Q values assume a point source; the construction activities actually will be widespread, creating many scattered, diffuse sources. Furthermore, the larger dust particles would deposit rapidly, another condition not accounted for in the calculation. Although dust could cause occasional localized degradation of air quality at the site, the duration will be only during the construction phase. To minimize fugitive dust, the applicant will frequently water exposed areas and heavily traveled areas, and all vehicles will be operated at a reduced speed.[3]

4.1.2 Operation

Air quality during operation of the facility could be affected by atmospheric releases principally from the building and processing boiler, yellow cake and vanadium dryers, tailings disposal system, and ore stockpiles. The applicant's consultant's estimates of emissions from each primary source and their release heights are listed in Table 4.2. The staff estimates (Sect. 3) are somewhat different, but the conclusions drawn (below) remain the same. In addition, insignificant quantities will be released from other sources including the coal stockpiles, ore transport systems, and acid leach system. Atmospheric dispersion coefficients (χ/Q) for each release height are listed in Appendix H, Tables H.1 through H.4. Assuming all processes are operating simultaneously, annual atmospheric concentrations of particulates, SO_2, and NO_x at the property boundary in the direction of the prevailing wind were calculated by the staff to be approximately 13, 9, and 4 $\mu g/m^3$ respectively. These concentrations are well below applicable Federal and State air quality standards (Table 4.1). For reasons stated earlier, the particulate concentrations are quite conservative. The applicant calculated the atmospheric concentrations of the major pollutants using the CRSTER program, a program used by the U.S. Environmental Protection Agency.[4] Calculations were for five distances: 2, 4, 6, 8, and 10 km (3.2, 6.4, 9.7, 12.9, and 16.1 miles). Concentrations were the largest at the 2-km (3.2-mile) distance and are as follows: particulates, annual average = 0.26 $\mu g/m^3$, 24-hr average = 3.7 $\mu g/m^3$; SO_2, annual average = 1.1 $\mu g/m^3$, 24-hr average = 15.4 $\mu g/m^3$, 3-hr average = 66.6 $\mu g/m^3$; NO_x, annual average = 0.51 $\mu g/m^3$.

Although operation of the mill facility should not have any significant impact on air quality, Utah's Air Conservation Regulations[5] require that air pollution control equipment and processes be selected and operated to provide the highest efficiencies and the lowest discharge rates that are reasonable and practical. While the degree of control is subject to approval by the State Air Conservation Committee, the control must be a minimum of 85%. Utah regulations also restrict the sulfur content of coal and oil, used as fuels, to no greater than 1.0 and 1.5% respectively.

Table 4.1. Federal and State of Utah air quality standards

Pollutant	Averaging time[a]	Primary standard	Secondary standard
Nitrogen dioxide[b]	Annual	0.05 ppm (100 $\mu g/m^3$)	0.05 ppm (100 $\mu g/m^3$)
Sulfur dioxide	Annual	0.03 ppm (80 $\mu g/m^3$)	
	24 hr	0.14 ppm (365 $\mu g/m^3$)	
	3 hr		0.5 ppm (1300 $\mu g/m^3$)
Suspended particulates	Annual geometric mean	75 $\mu g/m^3$	60 $\mu g/m^3$
	24 hr	260 $\mu g/m^3$	150 $\mu g/m^3$
Hydrocarbons (corrected for methane)	3 hr 6 to 9 AM	0.24 ppm[c] (160 $\mu g/m^3$)	0.24 ppm (160 $\mu g/m^3$)
Photochemical oxidants	1 hr	0.08 ppm (160 $\mu g/m^3$)	0.08 ppm (160 $\mu g/m^3$)
Carbon monoxide	8 hr	9 ppm (10 mg/m^3)	9 ppm (10 mg/m^3)
	1 hr	35 ppm (40 mg/m^3)	35 ppm (40 mg/m^3)

[a] All standards except annual average are not to be exceeded more than once a year.
[b] Nitrogen dioxide is the only one of the nitrogen oxides considered in the ambient standards.
[c] Maximum 3 hr concentration between 6 and 9 AM.
Source: ER, Table 2.7–19.

Table 4.2. Emission rates, sources, and release heights of major air pollutants associated with operation of the White Mesa mill

Air pollutant and source	Emission rate (g/sec)	Release height (m)
Suspended particulate		
Boiler	1.0	27.4
Yellow cake dryer	0.05	13.7
Vanadium dryer	0.06	13.7
Tailings	1.01	1.0
Ore stockpiles	1.08	3.0–6.0
SO_2		
Boiler	4.0	27.4
Yellow cake dryer	0.25	13.7
Vanadium dryer	0.25	13.7
NO_x		
Boiler	2.0	27.4
Yellow cake dryer	0.06	13.7
Vanadium dryer	0.06	13.7

Sources: Dames and Moore, "Responses to Comments from the U.S. Nuclear Regulatory Commission, June 7, 1978, White Mesa Uranium Project Environmental Report," Denver, June 28, 1978; Dames and Moore, "Supplemental Report, Meteorology and Air Quality, Environmental Report, White Mesa Uranium Project, San Juan County, Utah, for Energy Fuels Nuclear, Inc.," Denver, Sept. 6, 1978; Dames and Moore, "Responses to Comments Telecopied from NRC to Energy Fuels Nuclear, 25 September 1978," Denver, Oct. 4, 1978.

Regulations promulgated by the U.S. Environmental Protection Agency[6] require any major source of air pollutants to comply with the Prevention of Significant Deterioration (PSD) regulations. The White Mesa Uranium Project is currently being evaluated by the appropriate regulatory authorities to ascertain if the project is defined as a major source. If the project is deemed to be a major source, then the applicant will be required to file for the appropriate PSD permit and to comply with all regulations therein. Initial indications are that the atmospheric concentrations of pollutants associated with mill operation will be well within the PSD allowable increments.

Southeastern Utah, known for its scenic qualities (Sect. 2.5.2.2), attracts many visitors. Stack emissions (primarily steam) will be visible to the public traveling Highway 163 east of the site. However, they are not expected to be visible from major recreational areas in the vicinity. The closest historical site included in the National Register of Historic Places (National Register) is located about 10 km (6 miles) north of the proposed mill site (Table 2.17).

4.2 LAND USE

4.2.1 Land resources

4.2.1.1 Nonagricultural

The proposed White Mesa Uranium Project is not expected to alter the basic pattern of land ownership in the area (Table 2.15). Area land uses will change, however, as a result of the proposed mill. About 600 ha (1480 acres) are owned by Energy Fuels Nuclear, Inc.; roughly 195 ha (484 acres) will be directly used during operations (Sect. 2.5.1) for milling, ore buying, and tailings disposal. Increased residential and commercial land use is expected in neighboring communities to serve mill-produced population growth (Sects. 4.8.1 and 4.8.2). The volume of traffic using the highways in this area is also expected to grow substantially (Sect. 4.8.5), and mineral extraction is expected to increase in the project area in response to the mill's demand for uranium ore (Sect. 4.8.1.2).

4.2.1.2 Agricultural

Construction and operation of the facility will disturb about 20 ha (50 acres) directly (Table 4.3). In addition, the tailings will cover a total of about 135 ha (333 acres), and 39 ha (98 acres) will be used for stockpile and borrow areas. Because the tailings disposal system will be constructed as six separate cells (two cells for evaporation and four for tailings disposal), with a full tailings cell being reclaimed as a new cell is opened, a total maximum surface area of about 89 ha (222 acres) will be disturbed at any one time by the tailings system. Also, a maximum of about 15 ha (36 acres) of borrow area will be exposed at any given time. Therefore, total land area disturbed at any one time by construction and operation of the mill facilities will be about 141 ha (343 acres). However, until all operations have terminated, at least 195 ha (484 acres) will be unavailable for grazing. Based on the capacity of the tailings cells, the mill has a potential to operate 15 years. The duration of the impact will be somewhat longer than this depending on the time required for construction, the length of time between disturbance and reclamation, and the length of time it takes for a suitable vegetative cover to become established on each reclaimed area. Therefore, a realistic estimate of the amount of time the land will be disturbed is about 20 years.

Upon termination of the mill operations, all remaining disturbed areas will be reclaimed to ultimately restore the land to its original grazing use (Sect. 3.3.2). Loss of nearly 195 ha (484 acres) of grazing land each year the land is disturbed represents less than 0.1% of the private rangeland in San Juan County (Table 2.16). With successful reclamation (Sect.3.3.2), this land could be returned to its original grazing capacity.

4.2.2 Historical and archeological resources

As discussed in Sect. 2.5.2.1, a historical survey was conducted. Of the six historical sites identified during that survey, five were considered to be eligible for inclusion in the National Register of Historic Places (National Register). Pursuant to 36 CFR Part 63.3, a request on March 28, 1979, for determinations of eligibility for the historic sites was submitted and is currently under review. Of the five sites considered eligible, only one ("Earthen Dam") will be adversely affected by the mill project, and mitigation will be specified if the site is in fact eligible. (See the proposal for a Memorandum of Agreement in Appendix E.)

As discussed in Sect. 2.5.2.3, archeological surveys and testing have been conducted on the site since the fall of 1977, and although additional field work will be required to determine the significance of all identified archeological sites, the NRC, after consultation with the Utah State Historic Preservation Officer (SHPO), determined that this area of White Mesa contains numerous sites which are likely to yield information important in the prehistory of the region. The NRC accordingly requested a determination from the Secretary of the Interior that the area on which the properties are located is eligible for inclusion in the National Register as an Archeological District. The resulting determination was that the White Mesa Archeological District is eligible for inclusion in the National Register. It is anticipated that the NRC will enter into a Memorandum of Agreement under 36 CFR 800, Procedures for the Protection of Historic and Cultural Properties. The proposed plan for mitigatory action is outlined in the proposal for a Memorandum of Agreement in Appendix E.

Table 4.3. Land disturbed by construction and operation of the White Mesa Uranium Project

Area	Area to be disturbed		Tailings capacity (years)
	ha	acres	
Mill[a]	20	50	
Evaporation cells I and E	40	98	
Tailings cell 2	25	61	3.2
Tailings cell 3	25	63	4.6
Tailings cell 4	23	58	3.8
Tailings cell 5	21	53	3.5
Safety dike	1	3	
Topsoil stockpiles	4	10	
Overburden stockpile	6	16	
Rock stockpile	15	36	
Borrow area	15	36	
Total	195	484	15.1

[a]Includes 6 ha (16 acres) occupied by an ore buying station.

Source: Energy Fuels Nuclear, Inc., "Transmittal of Conceptual Review Construction Drawing Set and Synopsis, Tailings Management System, White Mesa Uranium Project, Blanding, Utah," Apr. 2, 1979.

4.3 WATER

4.3.1 Surface waters

The construction and operation of the uranium mill should have minimal impact on the surface waters of the project site and vicinity. During construction of the mill, the ground surface will be disturbed by grading, excavation, road access, spoil and topsoil storage, and other construction-related activities. The soils of the project vicinity are normally subject to erosion due to lack of consolidation and poor vegetative cover (Sects. 2.8 and 2.9.1). During periods of flow in local intermittent streams, this natural erosion is reflected in values of total suspended solids which reach levels of >1500 mg/liter (Table 2.22). Storm runoff from above the mill, ore storage piles, and ore buying station will be diverted to offsite drainages. Runoff from the mill and facilities area will be impounded onsite in a sedimentation pond.

Sediment carrying runoff that can enter local streams will originate primarily from the steep sides of the temporary overburden stockpiles. Table 4.4 lists the effects of early construction (mill facilities, two evaporation cells, and the first two retention cells). The net change in tons of sediment transferred to local streams is about -2450 MT (-2700 tons), or a reduction in total sediment transfer.

Table 4.4. Effects of initial construction stages

Location	Area		Yearly sediment production to local streams		Yearly net change		Yearly change	
	ha	acres	MT/ha	tons/acre	MT/ha	tons/acre	MT	tons
Borrow area	15	36	0	0	−22	−10	−330	−360
Topsoil stockpile slopes	0.2	0.5	1120	500	1098	+490	220	245
Overburden stockpile slopes	0.4	1	1120	500	1098	+490	439	490
Topsoil central stockpile	3.6	9	0	0	−22	−10	−79	−90
Overburden central stockpile	6	15	0	0	−22	−10	−132	−150
Evaporation cells I and E	40	98	0	0	−22	−10	−880	−980
Tailing cells 2 and 3	50	124	0	0	−22	−10	−1100	−1240
Mill site drainage	24	60	0	0	−22	−10	−528	−600
Net							−2390	−2685

Source: Energy Fuels Nuclear, Inc., "Transmittal of Conceptual Review Construction Drawing Set and Synopsis, Tailings Management System, White Mesa Uranium Project, Blanding, Utah," Apr. 2, 1979.

There will be no discharge of mill effluents to local surface waters. In addition, sanitary wastes generated by mill operation will be retained in a sanitary drainage field (Sect. 3.2.3.2) and should not affect surface-water quality.

The construction and operation of the proposed uranium mill should not affect local surface waters to any significant extent.

4.3.2 Groundwater

4.3.2.1 Water usage

The applicant has obtained a permit to utilize up to 1.0 x 10^6 m^3 (811 acre-ft) although the mill will only use about 5.9 x 10^5 m^3 (480 acre-ft) of water per year, which will be withdrawn from the Navajo sandstone aquifer. All other wells within 8 km (5 miles) produce from other formations. This usage will have no effect on other users.

4.3.2.2 Potential degradation of groundwater

The mill will discharge about 1.12 m^3/min (310 gpm) of liquid to the proposed tailings impoundment (Fig. 3.4). The chemical and radiological composition of this waste liquid is given in Table 3.1.

The applicant has proposed to line the evaporation cells (1-I and 1-E) and tailings cell 2 with a multicomponent liner (of synthetic and onsite clayey-silt materials) and to line the remaining tailings cells with a 2 foot layer of compacted clay (permeability approximately 3x10^{-8} cm/sec) to essentially eliminate seepage into the underlying Dakota formation; therefore, the possibility of groundwater degradation caused by seepage of tailings liquids is considered to be remote. After reclamation, when deterioration of the liner may have occurred, the staff expects essentially no seepage into the Dakota formation because of the high net evaporation rate in the area. Preoperational and operational monitoring of the groundwater is required (Sect. 6.3), and mitigating measures will be taken if unexpected groundwater contamination is observed.

4.4 MINERAL RESOURCES

Only uranium, vanadium, and copper are present in sufficient quantities to warrant processing. At present copper extraction is uneconomic. If this copper, or any other mineral in the ore, becomes more valuable in the future, the overburden could be removed from the tailings and these minerals extracted; therefore, this project is not expected to have any impact on the availability of other minerals.

4.5 SOILS

Construction of the mill and tailings disposal system will disturb about 195 ha (484 acres) (Table 4.3). The top 15 cm (6 in.) of soil, removed from the mill site, tailings cells, and borrow area, will be stockpiled at two locations totaling 4 ha (10 acres) (Fig. 3.4). The remaining overburden and rock will be stockpiled at four areas, totaling 21 ha (52 acres). Removal of topsoil will disrupt existing physical, chemical, and biotic soil processes. Although topsoil will be replaced upon termination of the project operations, a temporary decrease in natural soil productivity is probable.[7]

Removal of topsoil and natural vegetation on the site will accelerate wind and water erosion. Generally, the duration of these impacts will be only during the construction phase, which is expected to take one year. To minimize fugitive dust resulting from construction activity, the applicant will frequently water exposed areas and heavily traveled areas, and all vehicles will be operated at a reduced speed.[3] The tailings impoundment will be constructed as six separate cells (Fig. 3.4), only four of which will be active at any given time. As a tailings cell is being reclaimed, another cell is being constructed. This construction sequence will result in a minimum disturbance of land at any given time. The material excavated from one cell can be hauled directly to a filled cell and placed over the tailings as part of the required cover, thus reducing handling of materials.

All mill facilities will be located upstream of the tailings cells. Evaporation cell 1-I and tailings cell 2, which will be constructed simultaneously with the mill facilities and a sedimentation pond, will capture mill site runoff (Fig. 3.6). Although sediment transfer will be increased within the site, the location of the mill facilities and tailings cells should minimize sediment transfer from the site, as discussed in Section 4.3.1. To minimize erosion, the overburden and topsoil stockpiles will be stabilized by seeding with cereal rye and yellow sweet clover.[8] Sunflowers, Russian thistle, and other annual plants will also become established and will aid in preventing erosion of the stockpiles.

Impacts to soils during operation of the mill include wind and water erosion. Soil over much of the site will be stabilized by gravel and the presence of structures. The topography of the site concentrates some of the surface water at two points directly north of the proposed mill (Fig. 3.4). During operations, diversion ditches will be constructed in this area to collect surface runoff from the drainage above the mill site [25 ha (62 acres)], and the discharge from these ditches will be directed to the east into Cottonwood Wash. Rock from excavation of the tailings cells will be placed as riprap in the drainage channels to help prevent severe erosion. Rock will also be used to construct the downstream slope of dike 5 and areas on the perimeter of the reclamation cover. Mill and facilities area runoff will be contained by a sediment pond (Fig. 3.4).

Upon termination of the mill operations, all remaining disturbed areas will be reclaimed to restore the land to preconstruction land uses (Sect. 3.3.2). Reclamation laws require successful establishment of a soil medium that is capable of sustaining vegetation without irrigation or continuing soil amendments. Assuming reclamation efforts will be successful, long-term impacts to the soil are not expected to be significant.

4.6 BIOTA

4.6.1 Terrestrial

The primary ecological impact of construction and operation of the mill and tailings disposal system will result from the loss of habitat. However, the majority (85%) of the vegetation that will be removed has been previously disturbed to varying degrees by either chaining, plowing, or reseeding (Figs. 2.10 and 3.4; Tables 2.26 and 4.5). Winter deer use of the project vicinity, primarily pinyon-juniper-sagebrush habitats, is among the heaviest in southeastern Utah.[9] However, because similar rangeland is very common throughout the region (Sect. 2.5), it is expected that loss of this relatively small parcel of land (less than 0.1% of the private rangeland in San Juan County) should not significantly reduce the amount of habitat for these animals.

Table 4.5. Community types and approximate expanse to be disturbed by construction and operation of the White Mesa mill

Community type	Area to be disturbed	
	ha	acres
Pinyon-juniper woodland	2	6
Big sagebrush	27	68
Reseeded grassland I	29	73
Reseeded grassland II	45	115
Tamarisk-salix	1	2
Controlled big sagebrush	89	225
Disturbed[a]	11	28

[a] Includes ore buying station.

Land clearing, operation of heavy equipment, and other construction activities will destroy small animals that move too slowly to escape or that retreat to burrows for protection. Other animals will be displaced and may be lost because of predation or increased competition for food, territory, and other habitat requirements. Although many of these species are important members of the food chain, their destruction would not be a significant impact because these animals comprise a very small percentage of the total regional populations. Habitat that will be disturbed as a result of construction and operation of the mill represents less than 0.05% of similar habitat in the county.

Suspended particulate matter will be emitted into the air by construction activities (Sect. 4.1). These particulates will eventually be deposited in part on the surrounding vegetation thereby reducing plant vigor or causing the plants to be less palatable to consumers. Although the magnitude of these potential impacts is not known, it is expected to be negligible. No significant deleterious effects have been demonstrated at other construction projects of similar or greater magnitude. Furthermore, if any impacts do occur from fugitive dust and/or gaseous emissions, they should be minor and short term.

Few data are available to demonstrate the effects of noise on wildlife, and much of what is available lacks specific information concerning noise intensity, frequency, and duration of exposure.[10] Probably, the noisiest period of construction will be during the excavation of the tailings cells. The applicant estimates the average sound level during the excavation phase to be about 66 dB(A) at 300 m (1000 ft) from the center of activity. Such noise is not expected to seriously affect the area wildlife. The noise initially may cause migration by some wildlife away from the immediate site vicinity, but those that remain or return will generally become habituated to construction noises and activities.[10]

To balance yearly water inputs with yearly net evaporation, the evaporation cell design will require a surface area of about 40 ha (98 acres) of tailings water.[11] These liquids will be unsuitable for use by wildlife due to radionuclides and other contaminants. However, the fencing around the tailings impoundment will exclude large animals, and the acidic nature of the pond (pH of about 1.8 to 2.0), and the high salinity will make it unsuitable for most aquatic organisms and subsequently an unattractive feeding place for waterfowl. However, a few waterfowl or other birds may rest on the impoundment for a short time during migration. Following termination of the mill operations, the tailings disposal area would remain fenced until released from its status as a restricted area and will not be used for any purpose other than tailings stabilization and reclamation.

Increased human population associated with construction and operation of the mill will adversely affect most wildlife in the area. Greater human population will cause an expansion of municipalities for commercial, residential, and recreational purposes. Although some species may benefit from large human populations, most of the larger mammals and predators will abandon habitats in close proximity to intense human activity. Additional stress will be placed on the terrestrial biota as a result of greater hunting pressure (both legally and illegally) and destruction of habitat by off-road recreational vehicles. Increased wildlife losses are expected to occur as a result of greater vehicular travel on highways.

None of the proposed endangered plant species[12] that have documented distributions in San Juan County[13] are expected to occur on the facility site or immediate vicinity. Although the endangered[14] American peregrine falcon (*Falco peregrinus anatum*) and bald eagle (*Haliaeetus leucocephalus*) range in the vicinity of the site, lack of suitable habitat indicates a low probability of these species utilizing the project site for feeding or nesting. The black-footed ferret (*Mustela nigripes*), which once ranged in the vicinity of the site, has not been sighted in Utah since 1952,[15] and the Utah Division of Wildlife Resources feels that the presence of this species is highly unlikely (ER, Sect. 2.8.2.2). Therefore, construction and operation of the proposed mill is not expected to impact any endangered species.

4.6.2 Aquatic

The operation of the uranium mill will not entail direct discharge into any surface waters. As the construction and operation of the proposed uranium mill should not affect local surface waters to any significant extent, the staff does not predict any adverse impacts on aquatic biota.

4.7 RADIOLOGICAL IMPACTS

4.7.1 Introduction

The primary sources of radiological impact to the environment in the vicinity of the proposed White Mesa Uranium Project are naturally occurring cosmic and terrestrial radiation, and naturally occurring radon-222. The average whole-body dose rate to the population in the site vicinity, including doses from natural background radiation and diagnostic medical procedures, is estimated to be about 236 millirems per year (see Sect. 2.10).

This section describes the results of the staff's analysis of the mill-contributed incremental radiological impacts to the environment and the population in the vicinity of the White Mesa mill site. This analysis is primarily based on the estimated annual releases of radioactive materials given in Table 3.3 and the models, data, and assumptions discussed in Appendix D. Detailed analyses of the radiological impacts of mill operations to nearby individuals and the entire population within 50 miles have been performed. All potential exposure pathways likely to result in significant fractions of the mill's total radiological impact have been included (see Fig. 4.1). Consideration has also been given to the occupational exposure received by mill employees and radiation exposure of biota other than man.

4.7.2 Exposure pathways

Potential environmental exposure pathways by which people could be exposed to radioactive mill effluents are presented schematically in Fig. 4.1. Estimates of dose commitments to man have been based on the proposed plant design, and actual characteristics of the site environs. The staff's analysis has included considerations of radioactive particulate and gaseous releases to the atmosphere.

There will be no planned or routine releases of radioactive waste materials directly into surface waters. While there is a possibility of some seepage of radioactive liquids from the tailings impoundments into the groundwater system, this possibility is considered remote and no significant contribution to dose via liquid pathways is expected. Furthermore, the applicant will be required to perform environmental and other monitoring programs to provide early detection of any seepage that might occur and to take appropriate mitigating measures.

Environmental exposure pathways of concern for airborne effluents from the White Mesa mill include inhalation of radioactive materials in the air, external exposure to radioactive materials in the air or deposited on ground surfaces, and ingestion of contaminated food products (vegetables and meat).

4.7.3 Radiation dose commitments to individuals

The nearest known resident lives approximately 4.5 km (2.8 miles) north-northeast of the proposed location of the mill building (ER, Plate 2.2-1). A mobile home about 3.2 km (2.0 miles) north of the mill was occupied until recently but has since been moved. The nearest residence in the direction of the prevailing winds is located about 6.4 km (4.0 miles) to the south. Nearby population groups include the community of White Mesa, about 8.0 km (5.0 miles) to the southwest with a population of about 300, and the city of Blanding, 9.6 km (6.0 miles) to the north-northeast with a population of about 3300 (ER, Plate 2.2-1).

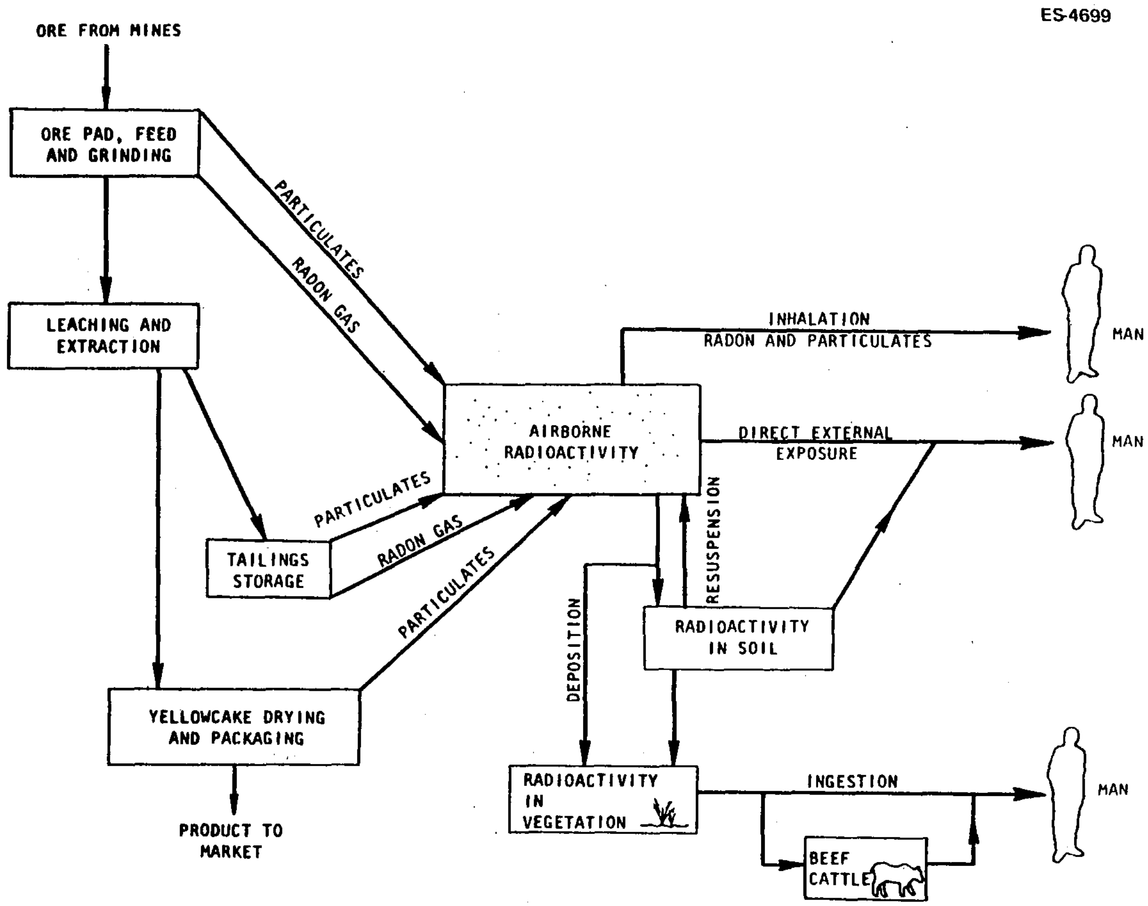

Fig. 4.1. Sources of radioactive effluents from the mill and exposure pathways to man.

The nearest potential residence locations are along the northern border of the site, about 1.9 km (1.2 miles) from the mill building. Substantial tracts of privately held acreage exist in this area. All other lands abutting the mill site to the east, south, and west are the property of Energy Fuels Nuclear, Inc., or the U.S. Bureau of Land Management. The area immediately to the north of the mill site, although suitable for residential structures, presently is believed to be used only for the grazing of meat animals (beef). It is assumed that meat animals could be grazed along the northern site boundary and eaten by the nearest actual residents. The calculated ingestion doses for consumption of beef grazed at this location are comparable to those calculated for other locations around the site at which grazing could be expected to occur.

Table 4.6 presents a summary of the individual dose commitments calculated for the nearest actual residence, the nearest actual residence in the prevailing wind direction, and the nearest potential residence. At each of these three locations, it is assumed that individuals ingest meat grown at the location of the nearest potential residence, along the northern site boundary. Table 4.6 also presents the inhalation and external doses calculated for the community of White Mesa and the city of Blanding.

Table 4.6. Annual dose commitments to individuals from radioactive releases due to operation of the White Mesa Uranium Mill

Location	Exposure pathway	Annual dose commitment (millirems)			
		Total body	Bone	Lung	Bronchial epithelium[a]
Nearest residence, 4.5 km (2.8 miles) north-northeast	Inhalation	0.039	1.0	0.89	19
	External from cloud	0.12	0.12	0.12	
	External from ground	0.87	0.87	0.87	
	Vegetable ingestion	0.34	4.0	0.34	
	Meat ingestion	1.0	10	1.0	
	Total	2.4	16	3.2	19
Nearest residence in prevailing wind direction, 6.4 km (4.0 miles) south	Inhalation	0.013	0.34	0.55	25
	External from cloud	0.22	0.22	0.22	
	External from ground	0.24	0.24	0.24	
	Vegetable ingestion	0.094	1.1	0.094	
	Meat ingestion	1.0	10	1.0	
	Total	1.6	12	2.1	25
Nearest potential residence, 1.9 km (1.2 miles) north	Inhalation	0.13	3.5	4.1	78
	External from cloud	0.20	0.20	0.20	
	External from ground	3.2	3.2	3.2	
	Vegetable ingestion	1.3	15	1.3	
	Meat ingestion	1.0	10	1.0	
	Total	5.8	32	9.8	78
Community of White Mesa, 8.0 km (5.0 miles) southwest	Inhalation	0.023	0.60	0.60	20
	External from cloud	0.19	0.19	0.19	
	External from ground	0.16	0.46	0.46	
	Total	0.37	1.3	1.3	20
City of Blanding 9.6 km (6.0 miles) north-northeast	Inhalation	0.0074	0.2	0.24	8.1
	External from cloud	0.090	0.09	0.09	
	External from ground	0.13	0.13	0.13	
	Total	0.23	0.42	0.46	8.1

[a] Doses to the bronchial epithelium result from the inhalation of the short-lived daughters of Rn-222.

4.7.4 Radiation dose commitments to populations

The annual doses to the population estimated to exist within 80 km (50 miles) of the site in the year 2000 are presented in Table 4.7 along with estimated annual doses to the same population from natural background radiation sources. Population dose commitments resulting from the operation of the White Mesa uranium mill represent less than 1% of the doses from natural background sources.

40 CFR part 61 (W) clean air act -

Table 4.7. Annual population dose commitments within 80 km (50 miles)

Organ	Population doses, man-rems/year[a]	
	Plant effluents	Natural background[b]
Total body	3.4	7,500
Bone	6.4	7,500
Lung	7.1	7,500
Bronchial epithelium	132	23,000

[a]Based on a projected year-2000 population of 46,500.

[b]The estimated natural background dose rate to the whole body is 161 millirems per year. The bronchial epithelium dose from naturally occurring Rn-222 is assumed to be 500 millirems per year (Sect. 2.10).

4.7.5 Evaluation of radiological impacts on the public

All radiation doses calculated to result to the surrounding population from uranium milling operations at the White Mesa site are small fractions of those arising from naturally occurring background radiation (see Table 4.7). They are also small when compared to the average medical and dental x-ray exposures currently being received by the public for diagnostic purposes.

Calculated annual individual dose commitments are only small fractions of present NRC limits for radiation exposure in unrestricted areas, as specified in 10 CFR Part 20, "Standards for Protection Against Radiation." Dose commitments to actual receptors are also well below limits specified in the EPA's "Radiation Protection Standards for Normal Operations of the Uranium Fuel Cycle" (40 CFR Part 190), which is to become effective for uranium milling operations in December 1980. Table 4.8 provides a comparison of maximum calculated annual dose commitments with the radiation exposure limits of 10 CFR Part 20 and 40 CFR Part 190.

As indicated in Table 4.8, radiation dose commitments to the bone of an individual living at the nearest potential residence could exceed the 25-millirem per year EPA limit by about 20%. The staff has also determined that bone doses from the ingestion of meat from animals grazed to the south of the present site would be in excess of 40 CFR Part 190 limits; however, the applicant is currently negotiating to obtain this land and would be able to restrict access by grazing cattle.[8] Meat and/or vegetable ingestion doses could exceed 40 CFR Part 190 limits at locations to the east if dusting of tailings sands is not controlled adequately. Therefore, the staff would require the applicant to

1. implement the environmental monitoring program outlined in Table 6.2;
2. perform and document an annual land use survey to determine changes in land use (e.g., for grazing, residence, and well locations); and
3. implement an interim stabilization program for all exposed tailings areas to minimize the blowing of tailings. The program would include a weekly, documented inspection to assess the effectiveness of the control methods being used.

4.7.6 Occupational Dose

Uranium mills are designed and built to minimize exposure of both the mill workers and the general public to radiation. Occupational exposures for workers are required to be monitored and kept below NRC limits. In addition, protection measures to reduce occupational exposures are periodically reviewed and revised in accordance with the requirement to make such exposures as low as is reasonably achievable.

Special studies[16] at selected mills have shown that the exposures of mill workers to airborne radioactivity are normally below 25% of the maximum permissible concentrations given in Appendix B of 10 CFR Part 20 and that external exposures are normally less than 25% of 10 CFR Part 20 limits.[16,17] A recent review[18] of mill exposure data by the NRC staff has indicated that only a few uranium mill employees may have exceeded, over a one-year period, 15 to 20% of the permissible exposure to ore dust, 25% of the permissible exposure to yellow cake, or 10% of the permissible exposure to radon concentrations. Except for a few individuals, the combined exposure of an average worker to these radioactive components over a one-year period probably does not exceed 25% of the total permissible exposure.

Table 4.8. Comparison of annual dose commitments to individuals with applicable radiation protection standards

Organ	Estimated dose, mrem/yr	Applicable limit, mrem/yr	Fraction of limit
Nearest actual residence, 4.5 km (2.8 miles) north-northeast			
Present NRC regulation (10 CFR Part 20)			
Total body	2.4	500	0.005
Bone	16	3000	0.005
Lung	3.2	1500	0.002
Bronchial epithelium	0.00015 WL[a]	0.033 WL	0.005
Future EPA standard (40 CFR Part 190)[b]			
Total body	1.4	25	0.06
Bone	15	25	0.6
Lung	2.2	25	0.09
Bronchial epithelium	19	*c*	
Nearest potential residence, 1.9 km (1.2 miles) north			
Present NRC regulation (10 CFR Part 20)			
Total body	5.8	500	0.01
Bone	32	3000	0.01
Lung	9.8	1500	0.007
Bronchial epithelium	0.00036 WL	0.033 WL	0.01
Future EPA standard (40 CFR Part 190)[b]			
Total body	2.5	25	0.1
Bone	29	25	1.2
Lung	6.5	25	0.3
Bronchial epithelium	78	*c*	

[a] Radiation standards for exposure to Rn-222 and its short-lived daughters are expressed in terms of working level (WL) concentrations. One WL is the amount of any combination of short-lived radioactive daughters of Rn-222 in 1 liter of air that will release 1.3 X 10^5 MeV of alpha energy during their decay to Pb-210.

[b] Doses computed for evaluation of compliance with 40 CFR Part 190 are less than total doses because dose contributions from Rn-222 released from the site, and any radioactive daughters that grow in from released Rn-222 have been eliminated. Limits in 40 CFR Part 190 do not apply to Rn-222 or its radioactive daughters.

[c] Not limited.

4.7.7 Radiological impact on biota other than man

Although no guidelines concerning acceptable limits of radiation exposure have been established for the protection of species other than man, it is generally agreed that the limits for humans are also conservative for those species.[19-26] Doses from gaseous effluents to terrestrial biota (such as birds and mammals) are quite similar to those calculated for man and arise from the same dispersion pathways and considerations. Because the effluents of the mill will be monitored and maintained within safe radiological protection limits for man, no adverse radiological impact is expected for resident animals.

4.8 SOCIOECONOMIC IMPACTS

4.8.1 Demography and settlement pattern

4.8.1.1 Population increase from direct employment

A peak employment of 250 construction workers will be reached in August 1979 and maintained for three months. Over a 12-month period, there will be an average of 175 employees. Mill operations are expected to employ 85 workers (Table 4.9). If 60% of the construction workers relocate from outside the project area,[27] an average of 105 workers and a peak of 150 workers will move into the region. If construction workers are accompanied by 0.9 nonworking dependents,[28] the population increase attributable to construction will be as shown in Table 4.10.

Table 4.9. Employment, White Mesa Uranium Project

	Construction		Operations
	Average	Peak	
Direct employment			
Salaried staff			25[a,b]
Construction workers	175	250	
Mill workers			85[b]
Total direct	175	250	110[b]
Indirect employment			
Salaried staff			26[a]
Mining			220–250[a]
Buying station			5[a]
Service (nonbasic)	100	100	578–626[a]
Total indirect	100	100	829–907[a]
Total employment	275	350	939–1017

[a] Represents increases over current employment.
[b] Full capacity.
Sources: ER, p. 4-13; Energy Fuels Nuclear, *Schedule of Projected Manpower Requirements;* Muril D. Vincelette, Vice President for Operations, Energy Fuels Nuclear, Inc., personal communication with Martin Schweitzer, Oak Ridge National Laboratory, July 12, 1978, and August 15, 1978; and Erik J. Stenehjem and James E. Metzger, *A Framework for Projecting Employment and Population Changes Accompanying Energy Development,* Argonne National Laboratory, Argonne, Ill., 1976.

Table 4.10. Population influx associated with the White Mesa Uranium Project

	Construction		Operations
	Average	Peak	
Direct employment			
In-moving workers	105	150	57[a]
Nonworking dependents[b]	95	135	120
Total direct	200	285	177
Indirect employment			
In-moving workers	47	47	432–587
Nonworking dependents[c]	99	99	907–1233
Total indirect	146	146	1339–1820
Total in-moving workers	152	197	489–644
Total influx	346	431	1517–1997

[a] Full capacity.
[b] To find the total number of nonworking dependents, multiply the number of construction workers and operations personnel by 0.9 and 2.1 respectively.
[c] To find the total number of nonworking dependents, multiply the number of workers by 2.1.
Sources: ER, p. 4-13; Energy Fuels Nuclear, *Schedule of Projected Manpower Requirements;* Muril D. Vincelette, Vice President for Operations, Energy Fuels Nuclear, Inc., personal communication with Martin Schweitzer, Oak Ridge National Laboratory, July 12, 1978, and Erik J. Stenehjem and James E. Metzger, *A Framework for Projecting Employment and Population Changes Accompanying Energy Development,* Argonne National Laboratory, Argonne, Ill., August 1976; and Mountain West Research, Inc., *Construction Worker Profile,* Old West Regional Commission, December 1975.

During operations, 75% of the jobs available could be filled from the "local" labor pool. Up to 30% of these workers may relocate closer to their new place of employment (Vice-President for Operations, Energy Fuels Nuclear, Inc., personal communication, July 12, 1978). In San Juan County, there are 2.1 nonworking dependents for every worker.[28] If this relationship holds for relocations, the population may grow by 177 individuals.

4.8.1.2 Population increase from indirect employment

Indirect employment is the total of new jobs created in industries that supply factors of production and that produce the goods and services demanded by project workers.[28] Between 0.3 and 0.9 indirect employees are generally needed for each construction worker during the construction phase of an energy project.[29] Because there is normally a lag between the creation of direct jobs and the indirect jobs they induce, it is likely that during the relatively short construction period in question indirect employment will stay at the low end of the scale and not rise above 100 (Table 4.9).

Because there are many clerical, sales, and service workers seeking employment in the Blanding area (Sect. 2.4.2.2), many of the indirect jobs created by mill construction may be filled from the local area. At most, the same proportion of workers will move in as is expected in the case of mill operators (47 employees or less). Including nonworking dependents, 146 persons will move into the area (Table 4.10).

During mill operation, the proportion of indirect to direct employment will increase. To operate at capacity, the White Mesa uranium mill requires 1800 MT (2000 tons) of ore daily, which will be supplied by area mines. According to the applicant, the ore buying stations (one located at the proposed mill site and the other in Hanksville) are currently buying slightly over one-fourth of the ore the mill will consume at peak operations. This fraction means that only one-fourth of the miners that will eventually be needed to supply the mill are already employed. An increase of 220 to 250 miners over current employment levels is expected (Table 4.9). If between one-half and two-thirds of these future jobs are filled by persons moving into the area, then about 110 to 165 miners will migrate in for a total population gain of 340 to 510, based on 2.1 nonworking dependents for every worker.

Currently, the Energy Fuels ore buying stations employ ten people. Five additional jobs at the Blanding station when mill operations start will mean an increase of five in area population. The 21 workers employed by Energy Fuels in ore exploration is not expected to change.

In San Juan County's economy, there are 1.6 nonbasic jobs for each basic job. The basic sector brings in revenues from outside the immediate area. The nonbasic sector provides goods and services in response to local demand. Because the White Mesa project is expected to add 361 to 391 new basic jobs to the area economy, it can be predicted that 578 to 626 new jobs will be created in the nonbasic sector. If the proportion of in-migrants taking nonbasic jobs is approximately the same as described earlier, roughly 300 to 400 jobs in the nonbasic sector will be taken by persons moving into the area, causing a population increase of 930 to 1240.

4.8.1.3 Total population increase

About 120 hourly workers and staff will be involved in mill operations. Nearly 60 of these employees should be new to the area. Indirect jobs stimulated by the mill are expected to be in the range of 830 to 910. The total population increase would range from approximately 1500 to 2000 (Table 4.10).

4.8.1.4 Distribution of new residents

The 431 new residents expected as a result of construction of the White Mesa Uranium Project represents 3.3% of the San Juan County population. Their settlement pattern will be determined by a number of factors including the availability of housing, public services, and amenities in the surrounding communities and the proximity of those communities to the mill site. Blanding, Monticello, and Bluff are all within 48 km (30 miles) of the proposed mill and are capable of absorbing the projected population growth.

Because it is closest to the site, Blanding is likely to experience more in-migration than the other two communities.

The population influx during the operations period will be much greater than that associated with construction. The 1500-2000 new residents expected represents 11.5 to 15.4% of San Juan County's current population.

The majority of mill-related personnel are expected to reside in the three above-named communities; however, since the mining operations selling ore to the applicant are geographically dispersed, some in-migrating miners will locate in the outlying rural areas.

4.8.2 Social organization

Studies of other areas impacted by energy projects indicate that rapid population growth can lead to inadequacies in the provision of housing and essential public services, such as water and sewage treatment, education, and health care. An annual growth rate of 15% is often cited as the point where these problems become severe.[30] Assuming that Blanding gets 70% of the population growth induced by the White Mesa uranium mill, Monticello gets 25%, and Bluff receives 5%, none of these communities will experience even a 10% population increase in the one-year construction period. However, during the three-year period from early 1980, when mill operations are scheduled to begin, through the end of 1982, when most of the direct and indirect population increases should have occurred, the number of in-migrants will be much greater (Table 4.11). If the total population influx reaches 2000, Blanding's rate of growth will average nearly 15% annually over the three years in question. While Monticello and Bluff will not grow at this rate, their increases will be substantial (see Sect. 2.4.1.2).

Balanced against this rapid growth are plans for providing additional housing and public services in the impacted communities. Action from both the public and private sector is anticipated, which will help reduce the adverse effects that can result from unmanaged growth (Sects. 4.8.2.1 and 4.8.2.2).

4.8.2.1 Housing

During the construction period, 197 workers are expected to relocate in the project area. It is likely that a number of these workers will share accommodations; therefore, between 145 and 197 new housing units will be demanded during this time.

Table 4.11. Mill-induced population influx for the communities of Blanding, Monticello, and Bluff, assuming a 70-25-5% split of the in-moving population

	Blanding	Monticello	Bluff
Population in 1977	3075	2208	280
Peak construction-period influx[a]	302	108	22
Peak construction-period influx as a percentage of 1977 population	9.8%	4.9%	7.7%
Operations-period influx[b]	1050–1400	375–500	75–100
Operations-period influx as a percentage of 1977 population	34.1–45.5%	17.0–22.6%	26.8–35.7%

[a] Peak construction-period influx is projected to be 431.
[b] Operations-period influx is projected to be approximately 1500–2000.

In the operations period, 489 to 644 new jobs are expected to be filled by in-migrants. Because these workers are much more likely to become permanent members of the community and to relocate with their families, it will be assumed that one housing unit is required for each of them.

Table 4.11 projects the future growth of each of these communities using previous assumptions (Sect. 4.8.2). If this distribution is used as a guide, roughly 100 to 140 housing units will be needed in Blanding, 35 to 50 in Monticello, and 7 to 10 in Bluff during the construction period. During operations, Blanding will need 340 to 450 units, Monticello 120 to 160, and Bluff 25 to 30 (Table 4.12). Although no new workers are anticipated at the Hanksville ore buying station, mining activity in the area may create some demand for additional housing in the town of Hanksville. Under current conditions this would not be easily accommodated although future improvements in the local water system (ER, p. 2-74) may make residential expansion possible.

Blanding

In August 1978, plans for a 117-space mobile home park, scheduled to be ready for occupancy by February 1979 were approved in a newly annexed portion of the city. At the same time, a 242-unit subdivision was approved in another newly annexed section; construction is scheduled to begin in January 1979.

Table 4.12. Housing demand and supply in Blanding, Monticello, and Bluff caused by the White Mesa Uranium Project

City	Construction period					Operations period				
	Demand[a]	Supply				Demand[a]	Supply[c]			
		Existing[b]	In process	Possible	Total		Existing[b]	In process	Possible	Total
Blanding	100–140	25	149		174	340–450	25	391	200	616
Monticello	35–40	35	23		58	120–160	35	23	200	258
Bluff	7–10	20			20	25–30	20		0–70	20–90
Total	142–200	80	172		252	485–640	80	414	400–470	844–964

[a] Assumes a 70-25-5% split of the in-moving population between Blanding, Monticello, and Bluff.
[b] As of August 1, 1978.
[c] Operations-period supply includes those units developed during the construction period.
Sources: ER, pp. 4-18 and 2-56; and Philip D. Taylor, President, Taylor & Associates, August 17, 1978; Terry Palmer, Palmer Builders, July 13, 1978; Richard Terry, Monticello City Manager, August 4, 1978, private communications with Martin Schweitzer, Oak Ridge National Laboratory.

The 117 mobile home spaces, combined with 25 existing spaces in Blanding (ER, p. 4-18), are sufficient to satisfy the maximum demand projected for the construction period. In addition, a 32-unit apartment complex is now in the financing stages and local builders estimate that 50 to 60 new single-family houses could be constructed annually for at least the next three years on the 200 vacant lots estimated to be available within the city limits (Palmer Builders representative, personal communication, July 13, 1978). The total number of potential additional housing units is around 600, nearly enough to absorb all mill-related growth. Counting only those units now existing or having city approval, the number is still nearly 400, mid-way between the high and low projections of Blanding's share of expected growth (Table 4.12).

Monticello

There are 35 vacancies in a local mobile home park (ER, p. 4-18), and a 23-unit apartment building is being constructed. In addition to these 58 units (more than the 35-50 needed during construction), 200 single family homes are expected to be built by 1981 (Monticello City Manager, personal communication, July 20, 1978). This quantity will be more than enough to accommodate Monticello's expected share of mill-induced growth during the operations period and indicates that this city has the potential of absorbing additional growth (Table 4.12).

Bluff

The 20 mobile home park spaces now available in Bluff (ER, p. 4-18) can accommodate twice the projected growth for the construction period and two-thirds of that expected during operations. Because the town also has 70 empty lots (ER, p. 2-56) suitable for development, it is possible that more growth than was postulated may occur here (Table 4.12).

4.8.2.2 Public services

Blanding

Population increases should not strain the existing electricity distribution or solid waste disposal systems. Streets and recreation facilities are also adequate. Water and sewage systems are adequate for the 300 new residents expected during the construction period (Blanding City Manager, personal communication, June 21, 1978), but they are not sufficient for the mill-induced newcomers. However, expansions in both water and sewer facilities, which are planned for completion by 1981, should be adequate to provide acceptable services to these in-migrants.

Additional public safety and health care services are likely to be necessitated by the operations period population influx. Blanding has plans to add a new full-time member to the police force in fiscal year 1979 (ER, p. 2-47).

Approximately 120 new school age children are expected during the construction period.[27,31] During the operations period, 384 to 504 new students will be entering Blanding's schools.[31] In the fall of 1978, a new high school in southeastern San Juan County will relieve current overcrowding in San Juan High School and leave it approximately 100 students below capacity. The opening of a second new high school in fall 1979 in southwestern San Juan County will leave roughly 300 vacancies in San Juan High School. Blanding's two elementary schools are currently 120 students below capacity; therefore, the influx of additional students during the construction period should not present a problem. However, the influx of 200 to 300 new elementary students during the operations period will necessitate operating at 80 to 180 students over capacity. The school district is prepared to provide new facilities as the need arises (San Juan County School District, personal communication, August 18, 1978).

Monticello

Existing solid waste disposal and recreation facilities appear adequate to accommodate the projected population influx, as does the local system of streets. Improvements in public safety and health care facilities are likely to be required. To supply future needs, the community is currently attempting to expand the city-run electricity transmission system.

The existing sewage treatment plant is currently operating at its design capacity; the growth associated with mill construction and operations would cause overloading. Improvements are being planned to allow service for 3000 residents, but completion is not anticipated until at least mid-1980. The city's share of the associated expenses will amount to roughly one-quarter million dollars and is likely to be financed through general obligation bonds. The remainder of the required funds will come from the Federal government. Monticello's water supply system is currently operating near capacity. However, improvements to the existing system are scheduled to be completed by August 1979. Until that time, lack of water is a limitation to growth. Afterward, the system will be able to accommodate nearly 800 new people. The city's share of project expenditures will be approximately $600,000, financed by general obligation and revenue bonds (Monticello City Manager, personal communication, July 11, 1978).

Because both the elementary and the high school are operating at approximately two-thirds capacity, with room for over 300 students between them, the addition of 140 to 180 new students during the operations period should not present a problem.[31]

Bluff

Most existing public services in the town of Bluff are currently adequate to handle the limited growth anticipated. The local water system is capable of accommodating a 79% increase in usage. Sewage disposal is currently handled by individual septic tanks. Public safety, recreation, and health facilities may all require incremental improvements to keep up with rising population. Educational facilities are also more than adequate for the expected in-migration. Growth beyond that shown in Table 4.11, however, may strain existing public services and call for improvements not considered here.

4.8.2.3 Culture

Nearly 45% of San Juan County residents are native Americans (predominantly Navajo), and another 35% are members of the Mormon Church.[32] Changes in the relative numbers of these two groups could alter the social climate in the area of the proposed mill.

In addition to potentially changing the racial and religious composition of the community, a substantial population influx could also create tensions between established "old-timers" and "newcomers." As area population grows, long-time residents may feel a loss of intimacy, and value conflicts may arise between those who favor a more "urban" lifestyle and those who wish to preserve a small town atmosphere.[33] However, because the greatest growth will occur during the operations period, when in-migrants are much more likely to settle permanently than during construction, it is expected that eventually a mutual accommodation of "old" and "new" values will occur.

4.8.3 Political organization

Changes in the political as well as the cultural characteristics of an area frequently accompany rapid growth. Expansion and "professionalization" of local government often occur in response to the changing size and characteristics of the population. This trend is evident in the area of the proposed White Mesa mill where the city of Blanding has recently hired a full-time city engineer in response to the accelerating growth rate (Blanding City Manager, personal communication, August 14, 1978), and Monticello anticipates the eventual need for more public employees to handle future in-migration (Monticello City Manager, personal communication, July 11, 1978).

The local power structure can also be altered by the growth associated with a project such as the White Mesa Uranium Mill. Political control may pass from the hands of established residents to those of newcomers associated directly and indirectly with mill operations.[33] As in the cultural arena, a balance is likely to be reached over time between divergent political interests.

4.8.4 Economic organization

4.8.4.1 Employment

Peak employment during the construction of the White Mesa mill is expected to be about 350; of these workers, approximately 150 are expected to come from the immediate area. During operations, between 939 and 1017 new jobs are expected to be created directly and indirectly by the mill. Roughly 300 to 500 of these jobs should be filled by area residents. At 8.1%, the unemployment rate in San Juan County is significantly higher than the state average of 5.3% (Sect. 2.4.2.2), and it is highly probable that mill-induced employment will result in a lowering of this figure.

4.8.4.2 Income

Of the additional 350 needed during construction, 250 will be construction workers whose wages are substantially higher than the local mean. The remaining 100 will be employed in lower-paying jobs in the nonbasic sector. During operations, nearly 40% of all new workers will be highly paid miners or mill personnel. According to the Utah State Department of Employment Security, the average monthly salary for a miner in this state is $1500 to $1833 and for a miller, $1000 to $1500.[33]

These high-paying new jobs will elevate average per capita income in San Juan County and increase the amount of money spent in the local communities. These increased expenditures may lead to the availability of a wider range of goods and services. Competition from the new, high-wage industries may also have the effect of raising salaries for other jobs.[33]

4.8.4.3 Tax revenues

During the construction period, San Juan County will continue to collect property taxes on the unimproved value of the White Mesa site (Sect. 2.4.2.2). Sales tax will also be paid on materials purchased in connection with this project. The communities of Blanding, Monticello, and Bluff each have the local option tax; outside of their boundaries the local tax goes to the county (Utah State Tax Commission representative, personal communication, August 23, 1978).

The applicant estimates that of the $18 million to be spent on equipment and supplies during construction, $432,000 in sales tax will accrue to the State, and $81,000 to the locales in which purchases are made. Of the local share, $13,500 will end up in the southeastern counties. The ore buying stations operated by Energy Fuels Nuclear, Inc., will also pay property taxes during this period.

Area mines selling ore to the applicant's ore buying stations will be subject to as many as four different taxes. Property tax will be levied at the normal county rate on twice the value of average net proceeds plus the value of the land, if patented, and the personal property and improvements onsite (Utah State Tax Commission representative, personal communication, July 14, 1978). A 1% mine occupation tax is levied on the gross value of all ore sold, less a standard exemption. These revenues go to the State general fund. Sales tax will be paid on all purchases, and a State corporate franchise tax of 4% on net taxable income will supply monies to the State's Uniform School Fund.

Workers will be subject to Federal and State income taxes; the applicant estimates that roughly $1.3 million will go to the Federal and State governments from construction worker incomes (ER, p. 4-23). Taxes on the salaries of nonbasic employees will contribute additional income tax revenues. Workers will also pay sales tax on all purchases and ad valorem taxes on any property owned in the area. Assuming nationwide expenditure patterns, 38.3% of family income (ER, p. 5-31), $2.82 million for construction workers alone (ER, p. 4-24), will be spent locally on personal consumption expenditures.[33] Sales tax on this will amount to $112,800 for the State and $21,150 for the jurisdictions in which the purchases are made.

During operations, the mill will pay property taxes of approximately $456,000 to San Juan County (ER, p. 5-28). Two-thirds of this amount goes to the school district. Sales tax will be paid on most equipment and materials purchased but not on the raw ore to be processed (Utah State Tax Commission representative, personal communication, August 23, 1978). Finally, the Federal and State governments will levy corporate franchise and income taxes.

If mining activity increases in the area the tax base of San Juan and neighboring counties will increase, as will the revenues received by the State. Corporate-owned property would be subject to the State franchise and Federal income taxes. The ore buying stations and independently owned mining operations would continue to pay taxes as outlined above.

San Juan County and the communities of Blanding, Monticello, and Bluff are also expected to benefit from increased property taxes due to the construction of new commercial and residential buildings and rising property values. Sales tax will be paid on roughly $4.5 million in personal consumption expenditures in the area.[33] Around $180,000 will go into the State treasury and $35,000 will be returned to the county or municipality where purchases are made.

During both construction and operations, the State of Utah receives a substantial portion of the tax revenues generated by the White Mesa mill and related activites. The State receives the entire mine occupation and corporate franchise taxes and splits personal income taxes with the Federal government. Sales tax revenues are split with local governments, with the majority of the funds being routed to the State government (Table 4.13).

Table 4.13. Taxes related to the White Mesa Uranium Project

Tax	Construction period		Operations period	
	Entity taxed	Recipient of tax	Entity taxed	Recipient of tax
Property tax	Unimproved mill site	San Juan County	White Mesa Mill	San Juan County
	Ore buying stations	San Juan and Wayne counties	Ore buying stations	San Juan and Wayne counties
	Uranium mines	San Juan and neighboring counties	Uranium mines	San Juan and neighboring counties
	Property-owning workers	San Juan County, Blanding, Monticello, and Bluff	Property-owning workers	San Juan County, Blanding, Monticello, and Bluff
Sales tax	Mill materials	Utah, San Juan County, Blanding, and Monticello	Mill supplies	Utah, San Juan County, Blanding, and Monticello
	Mine supplies	Utah, San Juan County, Blanding, and Monticello	Mine supplies	Utah, San Juan County, Blanding, and Monticello
	Worker purchases	Utah, San Juan County, Blanding, and Monticello	Worker purchases	Utah, San Juan County, Blanding, and Monticello
Mine occupation tax	Uranium mines	Utah	Uranium mines	Utah
Corporate franchise tax	Some uranium mines	Utah	Some uranium mines and White Mesa mill	Utah
Personal income tax	All workers	Utah, United States	All workers	Utah, United States

Both San Juan County and its municipalities will receive property and sales tax revenues from the mill and related activities (Table 4.13). Most purchases are likely to take place in Blanding and Monticello, which will receive the local option sales tax. During the operations period, these two communities may share as much as $35,000 annually from personal expenditures, which is relatively minor compared to the $456,000 in property taxes which San Juan County will receive from the mill itself. The ad valorem taxes paid to the county by area mines could also be substantial when mining activity is at its peak. Increased property tax revenues will accrue to the cities of Blanding, Monticello, and Bluff from new houses and businesses, but these added revenues will be significantly less than the amounts received by San Juan County.

4.8.4.4 Public expenditures

Financing improvements in public services needed as a result of rapid population growth can place a strain on local governments. Estimates of the required capital investment range from $1000 (ER, p. 5-27) to $5000 for each additional resident.[34] For the 1500 to 2000 in-movers expected as a result of operating the White Mesa mill, this amount would be approximately $1.5 to $10 million. As much as another $1000 per person should be expected for operating costs,[34] adding an extra $1.5 to $2 million annually to the expenditures of local governments in the vicinity of the proposed mill. The capital and operating expenses listed above would be shared by San Juan County and the communities of Blanding, Monticello, and Bluff.

Blanding and Monticello are expected to need improvements in their water and sewage systems as well as in their health and public safety services. Blanding will probably require additional education facilities, and Monticello will need an expanded electricity distribution system. The majority of the costs associated with these services will be borne by the impacted municipalities themselves.

Although the largest share of the new tax revenues generated by the White Mesa project will accrue to San Juan County, the communities of Blanding, Monticello, and Bluff will receive some of these monies. In addition, other sources are expected to provide funds for needed public service improvements. Capital outlays for water and sewage system expansion are expected to include Federal and State funds (Sect. 4.8.2.2), and tap fees will aid in repaying local water and sewer improvement bonds.[35] It is the judgment of the staff that, given all the revenue sources available, the impacted communities will be able to provide services for the expected population influx without long-range fiscal difficulties.

4.8.5 Transportation

Both heavy truck and automobile traffic will increase in the area as a result of the proposed White Mesa Uranium Project; therefore, traffic congestion, road wear, road noise, and traffic accidents will also increase.

During the peak construction period, 250 workers are expected to drive to and from the mill site each day. Because most workers are expected to live north of the site in the cities of Blanding and Monticello, traffic will increase substantially on U.S. Route 163. The 100 additional nonbasic workers expected during this time will also add to traffic on area roads, although a large portion of these employees are likely to live and work in the same community. Nonwork trips will also increase on area roads, as will traffic within the communities of Blanding, Monticello, and Bluff.

During the operations period, the number of automobile trips between Blanding and the mill site will decrease, but auto traffic in the surrounding area will rise. About 85 hourly mill employees plus 20 salaried staff and 10 buying station employees will travel to the White Mesa mill daily along U.S. Highway 163. In addition, approximately 220-250 new miners will be employed in the area and their trips between home and work will considerably increase traffic volumes. Finally, about 600 new workers in the nonbasic sector will add to local traffic, even though many will reside in their community of employment.

Heavy truck traffic will also increase substantially in the project area. During the operations period, when area mining is at expected peak levels, approximately 53 round trips per day will be made between area mines and the Blanding buying station. Another 17 round trips between other mines and the Hanksville station and an additional 15 round trips between the Hanksville and Blanding stations will occur each day (ER, p. 5-34).

The heaviest truck traffic will take place on U.S. Route 163 and Utah Route 95, but U.S. Route 666 and Utah routes 262, 276, 263, and 24 will also be affected. In addition to these paved roads, secondary roads are also expected to handle up to 15% of total truck traffic (ER, p. 5-34).

4.8.6 Impact mitigation

Energy Fuels Nuclear, Inc., has expressed concern about maintaining a stable work force and has instituted programs to mitigate potential negative impacts on the project area. The applicant has cooperated with a Denver-based developer to provide additional housing for expected in-migrants in Blanding. Preliminary plan approval was received in August 1978 for a 117-space mobile home park and a 242-unit single-family subdivision (Sect. 4.8.2.1) on land that was purchased by Energy Fuels Nuclear for resale to the developer (Vice-President for Operations, Energy Fuels Nuclear, Inc., personal communication, June 27, 1978). These dwelling units will satisfy a large portion of the total mill-induced housing need. Company benefits, such as an annual cash bonus and profit-sharing plan, encourage job stability.

Public action is also being planned to mitigate prospective social impacts at the area of the proposed mill. Section 4.8.2.2 details the steps being taken by local governments to provide additional public services to meet expected population increases.

Additional actions can be taken to further mitigate potential mill-induced impacts. Hiring unemployed area residents can keep the total population influx down and simultaneously reduce local unemployment. Negative impacts can be diminished by ensuring that planned improvements to public services are made before anticipated growth occurs. Early solicitation of Federal and State aid and early issuance of local bonds can provide funds for needed expansions before existing services become inadequate.

The ore trucks passing between the Hanksville and Blanding stations, and possibly additional mill-bound trucks originating at area mines, will travel along Utah Highway 95, which also provides access to the Natural Bridges National Monument. According to the Utah Department of Transportation, this increased activity could affect traffic movement during the summer months, but the extent of the impact is not currently quantifiable. The applicant will attempt to reduce possible negative impacts on area traffic flow by providing acceleration lanes and turnouts where the traffic will enter and exit the project site.[32]

Both San Juan County and its municipalities have the fiscal responsibility of providing needed services for new residents. Neither these costs nor the tax revenues generated by the White Mesa mill and related activities, however, are evenly distributed. The communities of Blanding and Monticello face substantial capital and operating costs for providing for new residents. A fraction of the additional taxes accruing to San Juan County and the State of Utah could be distributed by means of a revenue-sharing arrangement based on the distribution of the costs of new required services.

Although it is certain that residential and commercial growth will occur in the communities of Blanding, Monticello, and Bluff, the form of this growth is difficult to predict. Advance land-use planning should ensure that the spatial structure of eventual growth is compatible with community goals.

4.8.7 Conclusions

Both positive and negative socioeconomic impacts are probable as a result of the proposed White Mesa Uranium Project. The reduced unemployment, higher per capita income, increased tax base, and greater availability of goods and services, all of which are likely to accompany the mill and its related activities, could be considered benefits for the project area. On the negative side, public service expenditures will rise, existing cultural and political balances may be changed, and road traffic and associated impacts will increase as a result of increased road use. Although most project-related socioeconomic impacts can be mitigated, the distribution of impacts and responsibility for mitigation of the impacts may not coincide. The importance of a coordinated, joint planning effort by incoming industrial developers and local and state governments should be emphasized in order to mitigate some of the adverse impacts of the rapid population change expected in the Blanding area. The staff has concluded that the potential benefits of the proposed project outweigh the asscciated costs.

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5. ENVIRONMENTAL EFFECTS OF ACCIDENTS

The occurrence of accidents related to operation of the White Mesa mill will be minimized through the proper design, manufacture, and operation of the process components and through a quality assurance program designed to establish and maintain safe operations. In accordance with the procedures set forth in the appropriate regulations, Energy Fuels Nuclear, Inc., has submitted applications containing descriptions of the facility design, the organization of the operation, and the quality assurance program. These documents, together with the Environmental Report and supplements, have been reviewed by various agencies to ensure that there is a basis for safe operations at the site. Moreover, those agencies will maintain surveillance over the plant and its individual safety systems by conducting periodic inspections of the facility and its records and by requiring reports of effluent releases and deviations from normal operations.

Despite the above precautions, accidents involving the release of radioactive materials or harmful chemicals have occurred in operations similar to those proposed by the applicant. In this assessment, therefore, accidents that might occur during milling operations have been postulated and their potential environmental impacts evaluated. Section 5.1 deals with postulated accidents involving radioactive materials and Sect. 5.2 deals with those not involving radioactive materials. The probabilities of occurrence and the nominal consequences are assessed, using the best available estimates of probabilities and realistic assumptions regarding release and transport of radioactive materials. Where information adequate to a realistic evaluation was unavailable, conservative assumptions were used to compute environmental impacts. Thus, the actual environmental impacts of the postulated accidents would be less, in some cases, than the effects predicted by this assessment.

Exposure pathways considered in estimating dose commitments resulting from accidental releases were inhalation and immersion in contaminated air. It was assumed that exposure through the ingestion and surface pathways could be controlled if necessary.

5.1 MILL ACCIDENTS INVOLVING RADIOACTIVITY

The specific activities of the radioactive materials handled at the mill are extremely low: $\approx 10^{-9}$ Ci/g for the ore and tailings and $\approx 10^{-6}$ Ci/g for the refined yellow cake products.* The quantities of materials handled, on the other hand, are relatively large: 773 metric tons (MT) of yellow cake per year, representing ≈ 472 Ci of radioactivity. To be of concern, these very low specific activities require the release of exceedingly large quantities of materials; driving forces for such releases will not exist at the proposed White Mesa mill.

Guidelines have not been published for the consideration of accidents at uranium mills; therefore, the postulated plant accidents involving radioactivity are considered here in the following three categories:

1. trivial incidents (i.e., those not resulting in a release to the environment),
2. small releases to the environment (relative to the annual release from normal operation), and
3. large releases to the environment (relative to the annual release from normal operations).

*In contrast to the relatively high specific activities of a number of prominent radionuclides (i.e., $\approx 10^{-1}$ Ci/g for plutonium-239 and $\approx 10^{-3}$ Ci/g for cobalt-60).

Trivial incidents include spills, ruptures in tanks or plant piping containing solutions or slurries, and rupture of a tailings disposal system pipe in which the tailings slurry is released into the tailings pond. Small releases include failure of the air cleaning system serving the concentrate drying and packaging area, a fire or explosion in the solvent extraction circuit, and an explosion in the yellow cake dryer. Large releases include a major tornado.

For most of the postulated cases resulting in a release to the environment, the analysis gives the estimated magnitude of the release, the corresponding maximum individual dose at various distances from the mill, and the estimated annual likelihood of occurrence. The latter estimates are based on a diversity of sources, including incidents on record, chemical industry statistics, and failure prediction methodologies. Data and models for the behavior of radiation in accident situations were taken from AIRDOS-II computer code[1] and from the International Commission on Radiological Protection (ICRP)[2] and were updated by dose conversion factors based on the lung model of the ICRP Task Group on Lung Dynamics.[3]

During the three decades of nuclear facility operation, the frequency and severity of accidents have been markedly lower than in related industrial operations. The experience gained from the few accidents that have occurred has resulted in improved engineering safety features and operating procedures, and the probability of the occurrence of similar accidents in the future is very low. Based on analysis, it is believed that even if major accidents did occur there would probably not be a significant offsite release of contamination and that radiological exposures would be too small to cause any observable effect on the environment or any deleterious effect on the health of the human population.

5.1.1 Trivial incidents

The following accidents, due to human error or equipment failure, would not result in the release of radioactive materials to the environment.

5.1.1.1 Minor leakage of tanks or piping

Uranium-bearing slurries and solutions will be contained in several tanks comprising the leach, washing, precipitation and filtration, and solvent extraction stages of the mill circuit. Human error during the filling or emptying of tanks or the failures of valves or piping in the circuit would result in spills that might involve the release of several hundred pounds of contained uranium to the room; however, the overflow will be collected in sumps designed for this type of spill, and sump pumps will be used to return the materials to the circuit. Therefore, a rupture in a process tank or a leaking pipe would not affect the environment.

5.1.1.2 Major pipe or tank rupture

All mill drainage, including that from chemical storage tanks, will flow into a catchment basin upstream from the tailings impoundment site. The mill will deliver approximately 75.3 MT (83.3 tons) of solids per hour and approximately 76.1 m^3 [75.95 MT (84.02 tons)] of solution per hour to the tailings cell. Should the rupture of a pipe in the tailings distribution system occur, the liquid would flow into the catchment basin where it could be pumped to the tailings cell. Chemicals could be recovered, transferred to the tailings cell, or neutralized in the catchment basin. Residue from a slurry loss would be cleaned up and the contaminated soil removed to the tailing retention area.

5.1.2 Small releases

The following accidents, due to human or equipment failure, would release small quantities of radioactive materials to the environment. The estimated releases, however, are expected to be small in comparison with the annual release from normal operations.

5.1.2.1 Failure of the air cleaning system serving the yellow cake drying area

Because of system designs, this type of accident is unlikely to occur or go undetected. A loss of water pressure to the scrubber or the failure of the fan drive would sound an alarm. In the event of electrical or mechanical failure, however, it was estimated that approximately 14.83 kg (27.97 lb) of U_3O_8 would be lost from the stack over an 8-hr shift. All of this insoluble uranium was assumed to be in the respirable size range.

Because the meteorological data at the time of the postulated accident is unpredictable, it was assumed that for this stack release the conservative meteorological conditions of 1 m/sec wind speed and a Pasquill type-B stability would exist. It was also assumed that all the material was distributed over a single 22.5° sector. The maximum dose commitments to the nearest resident [4.8 km (3 miles) from the point of release] were as follows: total-body, 0.0009 millirem; bone, 0.026 millirem; lung, 0.32 millirem; and kidney, 0.008 millirem. The maximum dose commitments to the potential nearest resident [1.6 km (1 mile) from point of release] were as follows: total-body, 0.009 millirem; bone, 0.25 millirem; lung, 3.0 millirems; and kidney, 0.072 millirem.

5.1.2.2 Fire in the solvent extraction circuit

The solvent extraction circuit will be located in a separate building that is isolated from other areas due to the large quantities of kerosene present. From chemical industry data, the probability of a major fire per plant-year[4] is estimated to be 4×10^{-4}. However, at least two major solvent extraction circuit fires are documented in the literature, one of which destroyed the original solvent extraction circuit at one mill in 1968.[4] There have been approximately 540 plant-years of mill operation in the United States, equivalent to about 320 plant-years handling 390,000 metric tons of ore per year. Thus, judging from historical incidents, the likelihood of a major solvent extraction fire at the proposed mill is assumed to fall in the range of 4×10^{-4} to 6×10^{-3} per year.

In the event of a major fire, it is conservatively assumed from previous estimates that 1% of the maximum uranium inventory, or approximately 4.5 kg (10 lb), would be released into the environment.[5,6] It was assumed that the conservative meteorological conditions of 1 m/sec wind speed and a Pasquill type-D stability would exist for the ground-level release. It was also assumed that all the material was distributed over a single 22.5° sector. The maximum dose commitments to the nearest resident [4.8 km (3 miles) from point of release] were total-body, 0.0004 millirem; bone, 0.01 millirem; lung, 0.122 millirem; and kidney, 0.003 millirem. The maximum dose commitments to the potential nearest resident [1.6 km (1 mile) from point of release] were total-body, 0.005 millirem; bone, 0.15 millirem; lung, 1.8 millirem; and kidney, 0.04 millirem.

5.1.3 Large releases

Incidents that might release large quantities of radioactive materials to the environment compared with annual releases from normal operations are considered in this section. By virtue of complex and highly variable dispersion characteristics, however, the individual impacts will not necessarily be proportional to the total amount of radioactivity released to the environment.

5.1.3.1 Tornado

The probability of occurrence of a tornado in the 1° square in which the White Mesa mill is located is negligible. Using closest available data, the probability is approximately 8×10^{-5} per year.[7] The area is categorized as region 3 in relative tornado intensity[8] [i.e., for a "typical" tornado, the wind speed is 385 km/hr (239 mph/hr) of which 305 km/hr (190 mph/hr) is rotational and 79 km/hr (49 mph/hr) is translational]. None of the mill structures are designed to withstand a tornado of this intensity.

The nature of the milling operation is such that little more could be done to secure the facility with advance warning than could be done without it. Accordingly, a "no-warning" tornado was postulated. Moreover, because it is not possible to accurately predict the total amount of material dispersed by the tornado, a highly conservative approach was adopted. Because the yellow cake product has the highest specific activity of any material handled at the mill and as much as 45 MT of product may be accumulated prior to shipment, it is assumed that the tornado lifts 4550 kg (10,031 lb) of yellow cake.

A conservative model, which assumes that all of the yellow cake is in respirable form, was used for the dispersion analysis.[9] The model assumes that all of the material is entrained in the tornado as the vortex passes over the site. Upon reaching the site boundary, the vortex dissipates, leaving a volume source to be dispersed by the trailing winds of the storm. The material is assumed to exist as a volume source representative of the velocities of the tornado, and it disperses through an arc of 45°. Due to the small particle sizes postulated, the settling velocity is assumed to be negligible.

The model predicts a maximum exposure at a distance of approximately 4 km (2.5 miles) from the mill, where the 50-year dose commitment to the lungs of an individual is estimated to be approximately 1.1×10^{-7} rem. The 50-year lung dose commitment as a function of distance is plotted in Fig. 5.1.

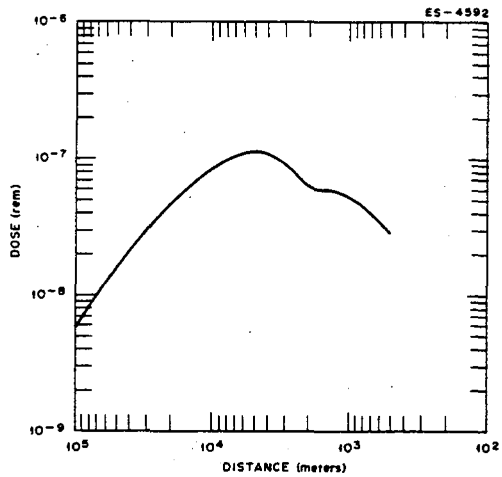

Fig. 5.1. Tornado damage: 50-year dose commitment to lungs.

5.1.3.2 Tailings dam failure

Because of the multiple cell design (Sect. 3.2.4.7; Fig. 3.4), the tailings retention embankment design (in accordance with Regulatory Guide 3.11), the short period of cell use, and the low head [<9 m (30 ft)], a large release of tailings and tailings fluid is not credible. Small releases would be retained by downstream catchment ponds.

5.2 NONRADIOLOGICAL ACCIDENTS

The potential for environmental effects from accidents involving nonradioactive materials at the White Mesa mill is small. Failure of a boiler supplying process steam could release low-pressure steam to the room, possibly causing minor injuries to workers, but would not involve the release of chemicals or radioactive materials to the environment. Forced-air ventilation systems are provided in several stages of the process to dilute the chemical vapors emitted and protect the workers from the hazardous fumes. Failure of these ventilation systems might result in the interim collection of these vapors in the building air. Such a failure might affect individual plant employees but would have no persistent effect on the environment.

A number of chemical reagents used in the process will be stored in relatively large quantities on the site. Minor leaks and spillage of reagents will be captured in sumps and returned to the mill circuit. Major spills could flow across the mill site and enter the drainage diversion ditch protecting the tailings impoundment. The staff recommends either the construction of dikes around storage tanks or the construction of a catchment basin below the mill for any major spills. Spillage in the mill will be washed down and pumped back into the mill circuit.

The only chemical that might seriously affect the environment is ammonia. A break in the external piping of the anhydrous ammonia tank would not result in a release, because, upon a drop in pressure, an excess flow valve would automatically close, thus preventing any loss. The line carrying ammonia to the storage tank from the tank truck possibly could be ruptured, in which case the release rate would be limited to 100 g/sec of the vapor.[10] Beyond a distance of 10 km (6 miles), the resulting concentration would be below the 600 $\mu g/m^3$ short-term air quality standard derived from State of Colorado regulations, the most restrictive current regulation.[11] Beyond a distance of 700 m (2300 ft) from the mill, concentrations of ammonia from the accident would be less than the 40,000 $\mu g/m^3$ needed to produce a detectable odor and would not be noticeable by offsite residents; these concentrations would pose no health risk because they would be less than the 69,000-$\mu g/m^3$ limit for prolonged human exposure.[12] Thus, the released ammonia would not be noticed by offsite residents and would pose no health risk to the environment.

The solvent extraction and dryer units in the vanadium circuit will be similar to the corresponding units in the uranium circuit with respect to fire and explosion potential (Sect. 5.1). Vanadium pentoxide (V_2O_5) and/or organic complexes of vanadium would be released as would very minor amounts of thorium-230 and uranium, which may also be present in the organic solvent. Thorough washing of contaminated areas would minimize the risk to mill employees. The general public should receive no significant health effects from accidents in the vanadium circuit.

5.3 TRANSPORTATION ACCIDENTS

Transportation of materials to and from the mill can be broken down into three categories: (1) shipments of ore from the mine to the mill, (2) shipments of refined yellow cake from the mill to the uranium hexafluoride conversion facility, and (3) shipments of process chemicals from suppliers to the mill. An accident for each of these categories has been postulated and analyzed. The results are given in the following discussion.

5.3.1 Shipments of yellow cake

Refined yellow cake product is generally packaged in 55-gal, 18-gage drums holding an average of 364 kg (800 lb) and classified as Transport group III Type A packaging (49 CFR Parts 170-189 and 10 CFR Part 71). It is shipped by truck an average of 2100 km (1300 miles) to a conversion plant, which transforms the yellow cake to uranium hexafluoride for the enrichment step of the light-water-reactor fuel cycle. An average truck shipment contains approximately 45 drums, or 16 MT (17.5 tons), of yellow cake. Based upon the White Mesa mill capacity of 618,200 MT (680,000 tons) of ore annually and a yellow cake yield of 773 MT (850 tons), an average of approximately 48 such shipments are required annually.

From published accident statistics,[13,14] the probability of a truck accident is in the range of 1.0×10^{-6} to 1.6×10^{-6} per kilometer (1.6×10^{-6} to 2.6×10^{-6} per mile). Truck accident statistics include three categories of traffic accidents: collision, noncollision, and other event. Collisions involve interactions of the transport vehicle with other objects, whether moving vehicles or fixed objects. Noncollisions are accidents in which the transport vehicle leaves the transport path or deviates from normal operation in some way, such as by rolling over on its top or side. Accidents classified as other events include personal injuries suffered on the vehicle, records of persons falling from or being thrown against a standing vehicle, cases of stolen vehicles, and fires occurring on a standing vehicle. The likelihood of a truck shipment of yellow cake from the mill being involved in an accident of any type during a one-year period is approximately 0.13.

The ability of the materials and structures in the shipping package to resist the combined physical forces arising from impact, puncture, crushing, vibration, and fire depends on the magnitude of the forces. These magnitudes vary with the severity of the accident, as does the frequency with which they occur. A generalized evaluation of accident risks by NRC classified accidents into eight categories, depending upon the combined stresses of impact, puncture, crushing, and fire.[15] On the basis of this classification scheme, conditional probabilities (i.e., given an accident, the probabilities that the accident is of a certain magnitude) of the occurrence of the eight accident severities were developed. These fractional probabilities of occurrence for truck accidents are given in Column 2 of Table 5.1. To assess the risk of a transportation accident, the fraction of radioactive material released in an accident of a given severity must be known. Two models are postulated for this analysis, and the fractional releases for each model are shown in Columns 3 and 4 of Table 5.1. Model I assumes complete loss of the drum contents; Model II, based upon actual tests, assumes partial loss of the drum contents. The packaging is assumed to be type A drums containing low specific activity (LSA) radioactive materials. Considering the fractional occurrence and the release fractions (loss) for Model I and Model II, the expected fractional release in any given accident is approximately 0.45 and 0.03 respectively.

Table 5.1. Fractional probabilities of occurrence and corresponding package release fractions for each of the release models for LSA and type A containers involved in truck accidents

Accident severity category	Fractional occurrence of accident	Model I	Model II
I	0.55	0	0
II	0.36	1.0	0.01
III	0.07	1.0	0.1
IV	0.016	1.0	1.0
V	0.0028	1.0	1.0
VI	0.0011	1.0	1.0
VII	8.5E-5	1.0	1.0
VIII	1.5E-5	1.0	1.0

Source: U.S. Nuclear Regulatory Commission, *Final Environmental Statement on the Transportation of Radioactive Materials by Air and Other Models,* Report NUREG-0170, Office of Standards Development, February 1977 (draft).

Model I and Model II estimate the quantity of yellow cake released to the atmosphere in the event of a truck accident to be about 7400 kg (16,200 lb) and 500 kg (1100 lb) respectively. Most of the yellow cake released from the container would be deposited directly on the ground in the immediate vicinity of the accident. Some fraction of the released material, however, would be dispersed to the atmosphere. Expressions for the dispersal of similar material to the environment based on several years of actual laboratory and field measurements have been developed.[14] The following empirical expression was derived for the dispersal of the material to the environment via the air following an accident involving a release from the container:

$$f = 0.001 + (4.6 \times 10^{-4})[1 - \exp(-0.15ut)]u^{1.78} ,$$

where

f = the fractional airborne release,

u = the wind speed at 15.2 m (50 ft) expressed in m/sec,

t = the duration of the release, in hours.

In this expression, the first term represents the initial "puff" immediately airborne when the container is in an accident. Assuming that the wind speed is 5 m/sec (10 mph) and that 24 hr are available for the release, the environmental release fraction is estimated to be 9×10^{-3}. If insoluble uranium (all particles of which are in the respirable size range) is assumed and a population density of 160 people per square mile (which is characteristic of the eastern United States) is supposed,[16] the consequences of a truck accident involving a shipment of yellow cake from the mill would be a 50-year dose commitment* to the general population of approximately 13 and 0.9 man-rems to the lungs for Models I and II respectively.

In a recent accident (September 1977), a commercial truck carrying 50 steel drums of uranium concentrate overturned and spilled an estimated 6800 kg (15,000 lb) of concentrate on the ground and in the truck trailer. Approximately 3 hr after the accident, the material was covered with plastic to prevent further release to the atmosphere. Using the above formula and values of wind speed for a fractional airborne release for this 3-hr duration of release, approximately 56 kg (123 lb) of U_3O_8 would have been released to the atmosphere. The consequence of this accident would be a 50-year dose commitment to the general population of 11 man-rems for a population density of 160 people per square mile. The consequence for the accident area, where the population density is estimated to be 2.13 people per square mile, would be a 50-year dose commitment of 0.146 man-rem, which can be compared to a 50-year integrated lung dose of 19 man-rems from the natural background.

The applicant will submit to the NRC an emergency-action plan for yellow cake transportation accidents. This emergency-action plan is intended to ensure that personnel, equipment, and materials are available to contain and decontaminate the accident area.

5.3.2 Shipments of ore to the mill

Hanksville and Blanding are ore buying stations servicing small- and intermediate-sized mines throughout southeastern Utah and southwestern Colorado. Because of the small sizes of the mines, shipments of ore will be sporadic; therefore, the average shipping distance for the ore will vary throughout the life of the project. The applicant estimates the radii of the Hanksville and Blanding buying station service areas to be 160 km (100 miles) and 201 km (125 miles) respectively. Ore collected at the Hanksville station will be shipped an additional 193 km (120 miles) to the mill at Blanding. Based on projected capacities of the two ore buying stations, approximately 25% of the total ore requirements would be supplied by the Hanksville station. On this basis the ore will be shipped an average of 258 km (160 miles). This value is an upper limit because most of the mines will be well within the service areas. To deliver 618,200 MT (680,000 tons) of ore in trucks with a 30-ton capacity would require 22,670 trips per year, or a total of 5.84×10^6 vehicle-km (3.63×10^6 vehicle-miles). For the accident probability cited in the previous section, 1.0×10^{-6} to 1.6×10^{-6} accidents per kilometer (1.6×10^{-6} to 2.6×10^{-6} per mile), accidents involving ore trucks would occur at the rate of 7.6 per year. However, because of the low specific activity of the ore and the ease with which the contaminant can be removed, the radiological impact is considered to be insignificant.

5.3.3 Shipments of chemicals to the mill

Truck shipments of anhydrous ammonia to the mill, if involved in a severe accident, could conceivably result in a significant environmental impact. Approximately 17 shipments of anhydrous ammonia will be made annually in 18 MT (20-ton) loads from a supplier located approximately 320 km (200 miles) from the mill.

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*Doses integrated over a 50-year commitment following exposure.

The annual U.S. production of anhydrous ammonia shipped in that form is approximately 6.9×10^6 MT (7.6×10^6 tons). About 26% of the shipments are made by truck (the remainder by rail, pipeline, and barge). If the average truck shipment is 19 MT (21 tons), the approximately 93,000 truck shipments of anhydrous ammonia are made annually. According to accident data collected by the Department of Transportation, there are about 140 accidents per year involving truck shipments of anhydrous ammonia. For an estimated average shipping distance of 560 km (350 miles), the resulting accident frequency is roughly 2.7×10^{-6} per kilometer (4.3×10^{-6} per mile). Data from the Department of Transportation also reveal that a release of ammonia [an average of 770 kg (1700 lb)], occurred in approximately 80% of the reported incidents and that an injury to the general public occurred in roughly 15% of the reported incidents that involved a release (most of the injuries were sustained by the driver).

Utilizing these data, the probability of an injury to the general public resulting from an average shipment of anhydrous ammonia is roughly 3×10^{-7} per kilometer (4.8×10^{-7} per mile). This estimate is probably too high for shipments near the White Mesa mill because of the relatively low population density. Nevertheless, if this estimate is used, the likelihood of an injury to the general public resulting from shipments of ammonia to the mill is predicted to be roughly 1.6×10^{-3} per year.

Sulfuric acid shipments to the White Mesa mill will amount to about eight truck loads per day. Tentative plans are to ship acid into Moab or Thompson, Utah, by rail; the acid will then be loaded into specifically designed tank trucks for transportation to the White Mesa mill. Moab is about 130 km (80 miles) from the site. Using statistical data from Sect. 5.3.2, less than 0.1 accident per year should be observed. Because sulfuric acid is not volatile, the risk to the general public is no greater than that from other collisions.

Amine shipments will be made by truck into the White Mesa mill. Only one truck load about every 45 days will be required, and the risk of injury to the general public should be no greater than 8×10^{-4} per year. Transport of all such commodities will be in accordance with all applicable State and Federal rules and regulations.

REFERENCES FOR SECTION 5

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14. Battelle Northwest Laboratories, *An Assessment of the Risk of Transporting Plutonium Oxide and Liquid Plutonium Nitrate by Truck,* Report BNWL-1846, Richland, Washington, August 1975.

15. U.S. Nuclear Regulatory Commission, *Final Environmental Statement on Transportation of Radioactive Materials by Air and Other Modes,* Report NUREG-0170, February 1977 (draft).

16. U.S. Bureau of the Census, *Statistical Abstract of the United States: 1976,* 97th ed., 1976.

6. MONITORING PROGRAMS

6.1 AIR QUALITY

Particulate matter, measured by dustfall samplers, and sulfation rates, measured by lead dioxide plates, were monitored at four locations on the project site for one year beginning in March 1977. Beginning in October 1977, total suspended particulates were measured for five months at one location by a high-volume air sampler. The ore buying station located on the project site (Fig. 2.10) began operation in May 1977.

An estimate of SO_2 concentrations (ppm) was obtained by multiplying sulfation plate data (milligrams per 100 cm^2 per day) by 0.03.[2] In addition to the onsite monitoring, the Utah Bureau of Air Quality operates a monitoring station for suspended particulates and sulfur dioxide approximately 106 km (66 miles) to the southwest, at Bull Frog Marina. The applicant will be required to conduct a monitoring program to collect onsite meteorological data, e.g., wind speed and direction at one hour intervals, the results of which will aid in the determination of compliance with 40 CFR Part 190.

The applicant did not present an operational monitoring program for nonradiological air quality. Because no significant impacts to air quality due to operation of the facility are expected (Sect. 4.1), the staff does not recommend an operational monitoring program for air quality.

6.2 LAND RESOURCES AND RECLAMATION

6.2.1 Land Resources

6.2.1.1 Land

The applicant acquired land-use data from published reports (ER, Sect. 13), discussions with personnel of various Federal, State, and local offices, and onsite visits. The staff would condition the license to require the licensee to conduct and document a land use survey on an annual basis.

6.2.1.2 Historical, Scenic and Archeological Resources

The existing condition of the site was determined as described in Sect. 2.5.2. Additional monitoring, will be performed as described in Sect. 4.2.2.

6.2.2 Reclamation

Reclamation plans are in accordance with the regulations of the Utah Division of Oil, Gas and mining.[1,2] The vegetation on reclaimed areas will be monitored and maintained until stand establishment and perpetuation is assured.[2] In accordance with the State of Utah Division of Oil, Gas, and Mining (Reclamation Regulation, Rule M-10), the revegetation will be deemed accomplished and successful when the species

1. have achieved a surface cover of at least 70% of the representative vegetative communities surrounding the operation (vegetation cover levels shall be determined by the operator using professionally accepted inventory methods approved by the Division),
2. have survived for at least three growing seasons,
3. are evenly distributed, and
4. are not supported by irrigation or continuing soil amendments.[3]

In addition, the applicant states that aerial photographs will be taken every third year to monitor the progress of reclamation efforts.[2]

The staff feels that the applicant's revegetation procedures and monitoring programs are adequate to ensure successful reclamation. Sufficient records must be maintained by the applicant to furnish evidence of compliance with all monitoring. The applicant will file a performance bond with the State of Utah to ensure performance of land reclamation.[4]

6.3 WATER

6.3.1 Surface water

Quarterly monitoring of surface-water quality will continue throughout the life of the project. Sample locations are described in Table 2.21 and Fig. 2.5, and the chemical and physical parameters to be measured are given in Table 2.20. Because of the temporary nature of many of the watercourses in the site vicinity, it is recommended that the applicant take advantage of seasonal rainfall and snowmelt in scheduling the collection of water samples.

6.3.2 Groundwater

The applicant has supplied chemical constituent data for samples from each of two abandoned stock wells on the project site. Water from these wells (G6R and G7R on Fig. 2.5), completed in the Dakota Sandstone, is of poor quality. Total dissolved solids are in excess of 2000 ppm, which would have adverse effects on many crops. Total sulfate is in excess of 1300 ppm compared with an acceptable value of 250 ppm; dissolved iron is in excess of 3 ppm compared with an acceptable value of 0.05 ppm; and lead is in excess of 0.12 ppm compared with an acceptable value of 0.05 ppm.[5] Data from local springs indicate that the water is suitable for stock and wildlife use only.

Additional sampling in accordance with Table 6.1 will be required. During operation, the applicant will be required to monitor the groundwater from wells installed and located as specified in the Source Material License to detect potential groundwater contamination (as discussed in Sect. 4.3.2.2) until reclamation is completed. The applicant is also required to submit a plan to mitigate such contamination if observed.

6.4 SOILS

During September 1977, an existing soil survey of the site was field-verified by a retired USDA Soil Conservation Service scientist, and a soil scientist for the applicant's consultant (ER, Sect. 6.1.4.1). At least one soil profile for each mapping unit was located and sampled. Soil analyses for potential uses in reclamation operations included contents and characteristics such as texture, water-holding capacity, saturation percentage, pH, lime percentage, gypsum, electrical conductivity, exchangeable sodium percentage, sodium adsorption ratio, organic carbon, cation exchange capacity, boron, selenium and available phosphates, potassium, and nitrate/nitrogen (ER, Sect. 6.1.4.1).

6.5 BIOTA

6.5.1 Terrestrial

Plant communities at the project site were mapped by aerial photographs and field verification (ER, Sect. 6.1.4.3). Vegetation on the site was surveyed during the spring and summer of 1977 (Fig. 6.1). Five 1.0-m^2 quadrats were placed every 10 m along 100-m transects. The number of transects varied depending upon the size and homogeneity of the community. The larger and more diverse communities had the greatest number of transects. Species collected were tentatively identified in the field and later verified at the Rocky Mountain Herbarium of the University of Wyoming. The density of each species was determined by counting the number of individual plants in each quadrat. The percentage of cover for each community was estimated visually within each quadrat, and all quadrats were then summed and divided by the total number of quadrats to reach a mean percentage of cover for the entire community. Production studies were also conducted during the 1977 growing season (April through September) and expressed as kilograms per hectare (pounds per acre). The number of 1.0-m^2 samples taken in each community on the site to measure production varied from 5 to 40, depending upon the size and homogeneity of the community.

Table 6.1. Preoperational monitoring program

Type of sample	Sample collection: Number	Sample collection: Location	Sample collection: Type and frequency	Sample measurement: Test frequency	Sample measurement: Type of measurement
Air					
Particulate	3	Locations onsite at or near site boundaries	Continuous; weekly	Quarterly composites of samples	Natural uranium, Ra-226, Th-230, and Pb-210
Particulate	1	Locations offsite including nearest residences	Continuous; weekly	Quarterly composites of samples	Natural uranium, Ra-226, Th-230, and Pb-210
Particulate	1	Background location remote from site	Continuous; weekly	Quarterly composites of samples	Natural uranium, Ra-226, Th-230, and Pb-210
Radon gas	5	At same locations where particulates are sampled	Continuous (one week per month; same period each month); samples collected for 48-hr intervals	Each 48-hr sample	Rn-222
Water					
Groundwater	3	Wells located around tailings disposal area (one downgradient and two crossgradient; deep)	Grab; quarterly	Quarterly	Dissolved natural uranium, Ra-226, Th-230, and chemicals[a]
				Semiannually	Dissolved Pb-210 and Po-210
	1 (from each well)	Wells within 2 km of tailings disposal areas (could be used for potable water or irrigation)	Grab; quarterly	Quarterly	Total and dissolved natural uranium, Ra-226, Th-230, and chemicals[a]
				Semiannually	Total and dissolved Pb-210 and Po-210
	1	Well located up gradient from disposal area for background	Grab; quarterly	Quarterly	Dissolved and natural uranium, Ra-226, Th-230, and chemicals[a]
				Semiannually	Dissolved Pb-210 and Po-210
Surface water	1 (from each body of water)	Onsite or offsite streams (Westwater Creek, Corral Creek, Cottonwood Wash, etc.) which may be potentially contaminated by direct surface drainage or tailings impoundment failure	Grab; quarterly	Quarterly	Suspended and dissolved natural uranium, Ra-226, Th-230
			Grab; semiannually	Semiannually	Suspended and dissolved Pb-210 and Po-210
Vegetation (forage)	3	Grazing areas near the mill site in different sectors having the highest predicted particulate concentrations during milling operations	Grab; three times during grazing season	Three times	Natural uranium, Ra-226, Th-230, Pb-210, and Po-210
Food (crops, livestock)	3 (of each type)	Within 5 km of mill site	Grab; three times during harvest or slaughter	One time	Natural uranium, Ra-226, Th-230, Pb-210, and Po-210
Fish	Each body of water	Collection of game fish (if any) from streams in the site environs which may be contaminated by surface runoff or tailings impoundment failure	Grab; semiannually	Two times	Natural uranium, Ra-226, Th-230, Pb-210, and Po-210

Table 6.1. (continued)

Type of sample	Sample collection: Number	Sample collection: Location	Sample collection: Type and frequency	Sample measurement: Test frequency	Sample measurement: Type of measurement
Site survey					
Gamma dose rate	80	150-m intervals to a distance of 1500 m in each of eight directions from a point equidistance between the milling area and tailings pond	Gamma dose rate; once prior to construction	One time	Pressurized ionization chamber or properly calibrated portable survey instrument
	10	150-m intervals in both horizontal and vertical transverses across the milling areas	Gamma dose rate; once following preparation of milling site	One time	Pressurized ionization chamber or properly calibrated portable survey instrument
	5	At same locations as used for collection of particulate samples	Gamma dose rate; quarterly	Quarterly	Pressurized ionization chamber or properly calibrated portable survey instrument
Surface soil	40	300-m intervals to a distance of 1500 m in each of eight directions from a point equidistance from mill and tailings pond sites	Grab; once prior to site construction	One time	All samples for Ra-226; 10% of samples for natural uranium, Th-230, and Pb-210
	6	300-m intervals in both a horizontal and vertical transverse across the milling area	Grab; once following site preparation	One time	All samples for Ra-226; one sample for natural uranium, Th-230, and Pb-210
	5	At same locations as used for collection of air particulate samples	Grab; once prior to site construction	One time	Natural uranium, Ra-226, Th-230, and Pb-210
Subsurface soil profile	5	750-m intervals in each of four directions from a point equidistance from the mill and tailings pond sites	Grab; once prior to site construction	One time	All samples for Ra-226; one set of samples for natural uranium, Th-230, and Pb-210
	1	At center of mill building area	Grab; once following site preparation	One time	Natural uranium, Ra-226, Th-230, and Pb-210
Sediment	2 (from each stream)	Upstream and downstream of waters that may receive surface water runoff from potentially contaminated areas or that could be affected by tailings impoundment failure	Grab; once following spring runoff and once in late summer following period of extended low flow	Two times	Natural uranium, Ra-226, Th-230, and Pb-210
Radon-222 flux	10	At center of mill site and at 750 and 1500 m in each of four directions from the site	Two- to three-day period; one sample during each of three months (normal weather)	Each sample	Rn-222 flux

[a] Nonradiological chemical parameters listed in Table 2.25.

Source: "Branch Position for Preoperational Radiological Environmental Monitoring Program for Uranium Mills," U.S. Nuclear Regulatory Commission, Memorandum from L. C. Rouse, Chief of Fuel Processing and Fabrication Branch, Jan. 9, 1978.

A census of birds was taken in February, May, late June, and October by roadside counts (ER, Plate 2.8-3) and a walked-transect count (Fig. 6.1). For the roadside count, all birds were tallied within a 0.4-km (1/4-mile) radius every 0.8 km (1/2 mile) along the transect. The roadside count is an adequate method for determining the composition and abundance of birds. The walked-transect counts, described by Emlen,[6] are useful for estimating densities in specific habitats. Raptor nests were investigated by visiting possible nesting sites.

Data on big game were based on signs (scat, tracks, etc), direct observation, and information supplied by the Utah Division of Wildlife Resources (ER, Sect. 6.1.4.3). Livestock information was obtained from the U.S. Bureau of Land Management. Rabbits and hares were counted along two roadside transects on two consecutive evenings each season (ER, Plate 2.8-3). A census of small mammals was taken at three trap grids placed on the site for each of three consecutive nights in August and October 1977. Each grid consisted of 12 rows and 12 columns of traps spaced 15 m (49 ft) apart for a total of 144 traps. Sherman live traps were used in the study and all traps were checked each morning and night. The captured animals were eartagged and released to estimate the population through a standard capture/recapture method.[7] However, not enough animals were captured to make a meaningful population estimate (ER, Sect. 6.1.4.3). In addition to the grids, two traps lines consisting of 20 to 26 traps each were placed in pinyon-juniper and tamarisk-salix habitats to determine relative abundance, diversity and distribution of small mammals (Fig. 6.1).

Although potentially harmful amounts of radionuclides and other contaminants in the tailings impoundment are not expected to result in any significant impacts to wildlife, the actual extent of this impact cannot be quantified (Sect. 4.6.1). Therefore, the staff will require that the applicant monitor the use of the impoundment by wildlife in conjunction with the program to monitor the tailings discharge system (Sect. 3.2.4.7). The monitoring plan should be submitted to the Utah Division of Wildlife Resources for their evaluation and approval. Because surface water is limited in the area, daily monitoring would be especially important during the fall and spring migration periods of waterfowl and shorebirds. The data should be submitted to the Utah Division of Wildlife Resources and the NRC on a yearly basis for evaluation to determine if there is a need for additional monitoring.

6.5.2 Aquatic

Because of the lack of aquatic habitat (Sect. 2.6.1.1), subsequent paucity of aquatic biota (Sect. 2.9.2), and the low probability that the aquatic habitat could be significantly impacted by mill construction and/or operation (Sect. 4.6.2), an extensive, long-term aquatic biota monitoring program is not considered necessary by the staff. However, because the local, ephemeral streams (Corral Creek, Westwater Creek, and Cottonwood Wash) have not been sampled for aquatic biota during times of water flow, the staff will require the applicant to undertake a biotic survey of these environments under appropriate conditions to characterize any temporal aquatic biota, if the groundwater monitoring program indicates levels of potential contaminants are increasing.

6.6 RADIOLOGICAL

6.6.1 Preoperational program

A preoperational, radiological monitoring program is being developed at the proposed White Mesa mill site to establish the baseline radiation levels and concentrations of radioactive materials occurring in air, biota, and soil, as well as in regional surface water and local groundwater. The sampling program, begun in July 1977, is ongoing, and results are incomplete. The preoperational monitoring program will conform to that recommended by the NRC and shown in Table 6.1.

6.6.2 Operational effluent and environmental monitoring program

The objectives of the effluent monitoring program are to ensure that the proposed mill discharges are as low as reasonably achievable, to develop criteria that can be used in the design of new operational procedures, and to aid in the interpretation of the results of such other studies as the environmental monitoring program. The procedures for controlling effluent release and performing monitoring and surveys will conform to applicable U.S. Government regulations. The program that will be implemented (Table 6.2) will consist of measurements of radioactivity in the air, surface water and groundwater, soil, and biota.

ES-4599

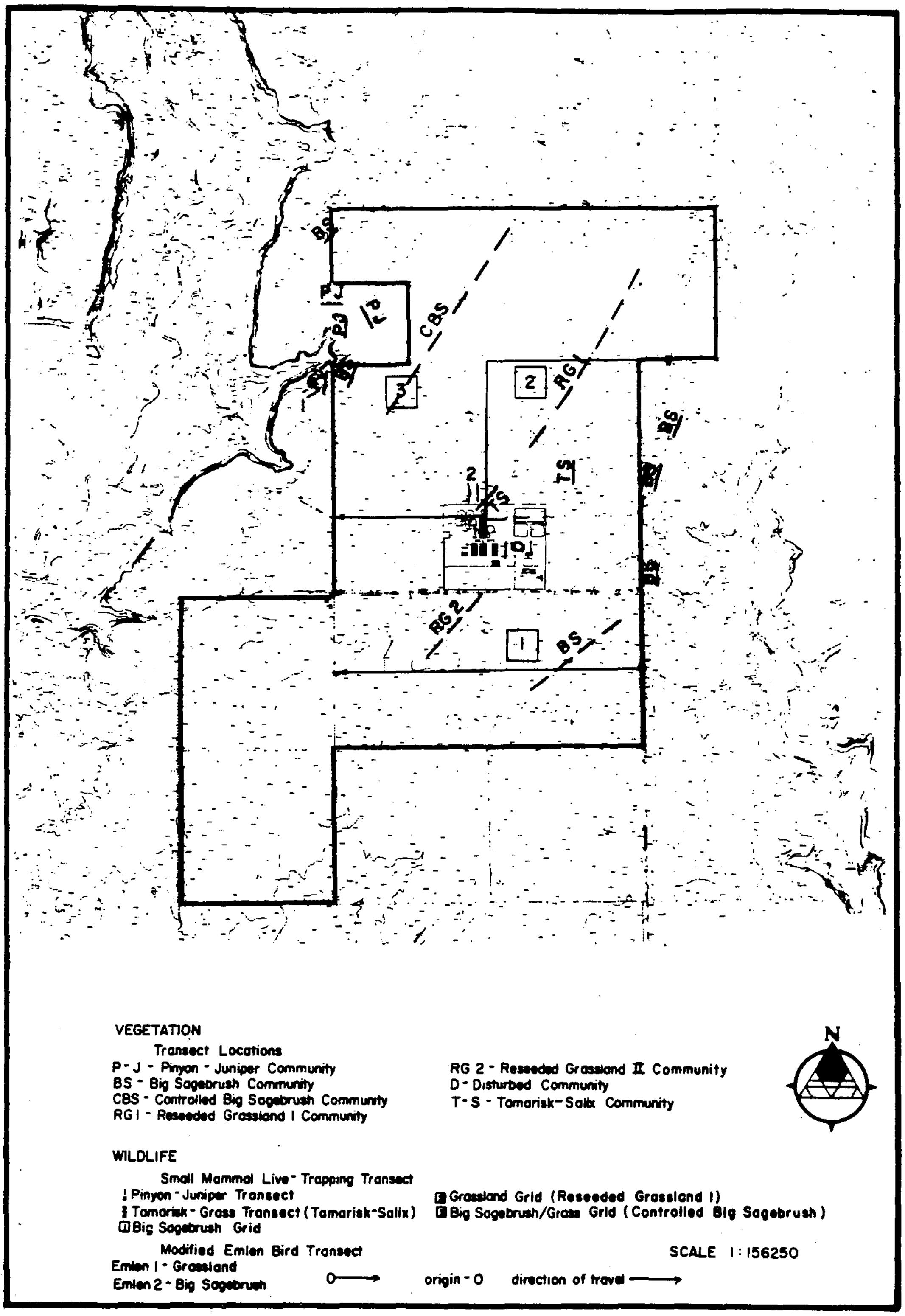

Fig. 6.1. Sampling locations for terrestrial ecological characteristics in the vicinity of the White Mesa project. Source: ER, Plate 2.8-1.

Table 6.2. Operational radiological environmental monitoring program

Type of sample	Sample collection			Sample measurement	
	Number	Location	Method and frequency	Test frequency	Type of measurement
Air					
Particulates	3	At site boundaries and in different sectors having the highest predicted concentrations	Continuous; weekly or more frequently as required by dust loading	Quarterly composite	Natural uranium, Ra-226, Th-230, and Pb-210
	1	At nearest residence	Continuous; weekly or more frequently if required by loading	Quarterly composite	Natural uranium, Ra-226, Th-230, and Pb-210
	1	Control location—more than 15 km from mill site in least prevalent wind direction	Continuous; weekly or more frequently if required by dust loading	Quarterly composite	Natural uranium, Ra-226, Th-230, and Pb-210
Radon gas	5	Same as for air particulates	Continuous; at least one week per month at approximately the same period each month, samples collected for 48-hr intervals	Each 48-hr sample	Rn-222
Particulates	1	Ore crusher stack	Isokinetic and representative[a] semiannual stack sample	Semiannual	Natural uranium, flow rate
				Semiannual for first year	Ra-226, Th-230, Pb-210
	1	Yellow cake dryer and packaging stack	Isokinetic and representative[a] monthly stack sample and either (1) semiannual stack sample or (2) semiannual product (yellow cake) sample	Quarterly	Natural uranium, flow rate
				Semiannual, 1 or 2	(1) Ra-226 and Th-230 or (2) natural uranium, Ra-226, and Th-230
				Semiannual for first year, 1 or 2	Pb-210

Table 6.2 (continued)

Type of sample	Sample collection			Sample measurement	
	Number	Location	Method and frequency	Test frequency	Type of measurement
Water					
Groundwater	9	Two deep downgradient, two deep crossgradient, and five shallow wells west & south, initially.	Grab; monthly (quarterly after first year)	Monthly; quarterly after first year	Dissolved natural uranium, Ra-226, Th-230, Pb-210, and Po-210; chemicals[b] and TDS[c]
	1	Control location–hydrologically up gradient (not influenced by tailings seepage)	Grab; quarterly	Quarterly	Dissolved natural uranium, Ra-226, Th-230, Pb-210, and Po-210; chemicals and TDS
	1 (from each well)	Each well used for drinking water or watering livestock or crops within 2 km of tailings pond or mine[d]	Grab; quarterly	Quarterly	Total natural uranium, Ra-226, Th-230, Pb-210, and Po-210; chemicals and TDS
Surface water	2 (from each stream)	Surface waters passing through or close to the mill; one sample upstream and one downstream of location of potential influence	Grab; quarterly when flowing or following precipitation event	Quarterly when flowing or following precipitation event	Total natural uranium, Ra-226, Th-230, Pb-210, and Po-210; suspended solids
Direct radiation	5	Same as for air particulate samples	Pressurized ionization chamber, properly calibrated portable survey instrument or thermoluminescent dosimeters with two or more phosphors each	Quarterly	Measurement of x-ray and gamma-exposure rates
Soil	5	Same as for air particulate samples	Grab; annually	Annually	Natural uranium and Ra-226
Vegetation or forage	3	From animal grazing areas near mill site which have the highest predicted concentration (including nearest ranches)	Grab; three times during grazing season (i.e., April, July, and October)	Each sample	Ra-226 and Pb-210

[a]To be taken during operation of the stack ventilation system and the respective process system. Minimum sampling time, 3 hr per stack.
[b]Chemical parameters to be analyzed will be determined from an analysis of samples taken from the tailings pond once mill operations have begun.
[c]TDS = total dissolved solids.
[d]If a large number of wells are located within 2 km, only those wells nearest tailings impoundment or the mine need be sampled.

REFERENCES FOR SECTION 6

1. A. P. Plummer, D. R. Christensen, and S. B. Monsen, *Restoring Big-Game Range in Utah*, Utah Division of Fish and Game, Publication No. 68-3, Salt Lake City, 1968.

2. Energy Fuels Nuclear, Inc., "Responses to Comments from the U.S. Nuclear Regulatory Commission, June 7, 1978, White Mesa Uranium Project Environmental Report," Denver, June 28, 1978.

3. State of Utah, Division of Oil, Gas, and Mining, "Changes and Adoptions to the General Rules and Regulations," adopted by the Board of Oil, Gas, and Mining on March 22, 1978; effective June 1, 1978.

4. Energy Fuels Nuclear, Inc., "Responses to Comments Telecopied from NRC to Energy Fuels Nuclear, Sept. 25, 1978," Oct. 4, 1978.

5. Office of Water and Hazardous Materials, USEPA, *Quality Criteria for Water*, Washington, D.C., 1976.

6. J. T. Emlen, "Population Densities of Birds Derived from Transects Counts," *Auk* 88: 323-342 (1971).

7. R. L. Smith, *Ecology and Field Biology*, 2d ed., Harper and Row, New York, 1974.

7. UNAVOIDABLE ENVIRONMENTAL IMPACTS

7.1 AIR QUALITY

An unavoidable impact of construction and operation of the mill facility would be a slight increase in particulate matter and ambient concentrations of gaseous emissions. Because the concentration of these pollutants would be below the Federal and State air quality standards, the staff feels that they will not significantly contribute to the decline of the regional air quality.

7.2 LAND USE

7.2.1 Land resources

7.2.1.1 Nonagricultural

Area land uses will change as a result of the population growth that would be induced by the proposed mill and any related mining activities. Possible adverse impacts are those which would result from increased traffic on the highways.

7.2.1.2 Agricultural

Construction and operation of the mill would result in an unavoidable loss of nearly 195 ha (484 acres) of potential grazing land. Following project termination, about 70% of this total area [approximately 135 ha (333 acres)] would be occupied by the reclaimed tailings impoundment area and would be considered permanently committed to tailings disposal. This area might be available for grazing after it has been released from its status as a restricted area. The remaining land would be reclaimed to permit unrestricted use.

7.2.2 Historical and archaeological resources

If the program of mitigation outlined in Sect. 4.2.2 is followed (avoidance of sites when possible, full excavation of those which cannot be avoided, and protection of potential or currently unidentified sites), adverse impacts should be minimized.

7.3 WATER

7.3.1 Surface water

Erosion of disturbed soils during construction and operation would minimally impact the local streams and only during heavy, erosion-producing rainfall. No adverse impacts due to mill-site runoff are expected, because this runoff will be impounded on the mill site during operations. No adverse impacts on surface water caused by groundwater transport of tailings material are expected. Overall, no adverse impacts to surface waters are expected.

7.3.2 Groundwater

Operation of the proposed mill should result in the use of about 5.9×10^5 m^3 (480 acre-ft) of water (drawn from the Navajo aquifer) per year. The usage of water by the applicant should have no adverse effect on other users. Preoperational and operational monitoring of the groundwater is required (Sect. 6.3.2), and mitigating measures will be taken if unexpected groundwater contamination is observed.

7.4 SOILS

Construction and operation of the mill facility would disturb about 195 ha (484 acres). Topsoil will be removed from the construction areas and stockpiled for replacement upon termination of operations. However, a temporary decrease in natural soil productivity is probable (Sect. 4.5). Some soil will be unavoidably lost, primarily from wind erosion, but proper mitigating measures (Sect. 4.5) would minimize this impact. Reclamation laws require successful establishment of a soil medium that would be capable of sustaining vegetation without irrigation or continuing soil amendments (Sect. 3.3.2). Long-term impacts to the soil are not expected to be significant.

7.5 BIOTA

7.5.1 Terrestrial

The proposed project would result in a temporary unavoidable loss of about 195 ha (484 acres) of vegetation and a concomitant loss of wildlife (Sect. 4.6.1). Although some vegetation and wildlife loss would be unavoidable, such loss should not result in any long-term adverse impacts.

7.5.2 Aquatic

The impact on limited available aquatic habitat due to mill construction or operation is projected as insignificant (Sect. 4.6.2 and 7.3.1). No adverse impacts on aquatic biota are expected.

7.6 RADIOLOGICAL

Radioactive emissions from transportation, storage, and milling of the ore would increase the level of radioactivity in the surface environment.

7.7 SOCIOECONOMIC

The infusion of people into the local area would strain certain public services and the housing market, unless these areas are expanded rapidly. Both old and new residents would be affected.

The present consumer prices for goods and services in the area of the site would be stimulated by the project. A rising cost of living primarily affects original residents who have not increased their income at the same rate as energy-development workers.

The general inconvenience caused by expansion to meet the needs of the new residents — such as construction activities, temporary buildings, and decline in services — can rarely be avoided in large projects such as uranium mill construction. The staff expects that such inconveniences will affect many in the area of the White Mesa Uranium Project but that these effects cannot be avoided.

8. RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

8.1 THE ENVIRONMENT

8.1.1 Air quality

The short-term increases in suspended particulates during plant construction and the increases in suspended particulates and chemical emissions associated with mill operation are expected to have no impact on the long-term quality of the atmosphere in the region.

8.1.2 Land use

The land on which the mill is located could be returned to its present state and capacity by reclamation activities. The tailings area, however, under present regulations may be unavailable for further productive use.

While uranium milling is a short-term activity, a mill tailings disposal site will constitute a permanent disturbance of the land surface, rendering it unsuitable for future archaeological investigation. Therefore, any such investigation must be conducted prior to the initial surface disturbance.

8.1.3 Water

Because water for milling operations will be drawn from a deep and lightly used aquifer, no changes in the water-use patterns of the area are expected to occur as a result of mill operation.

8.1.4 Mineral resources

No mineral resources are known to exist on the site. Reworking of tailings for extraction of other minerals could occur if economics warrant.

8.1.5 Soils

The applicant's reclamation program is designed to return the soils to a condition of productivity that is consistent with their present and historic usage — that is, the production of forage and habitat for livestock and wildlife. The program will begin as soon as practicable and will continue throughout the life of the project. As a result, about half the disturbed soils should be back in production by the time mill operation ceases.

8.1.6 Biota

8.1.6.1 Vegetation

Revegetation of disturbed areas will begin as soon as practicable and will continue throughout the life of the project. A satisfactory vegetative cover is expected to be established in two or three years. About half the disturbed area will be revegetated by the time mill operations cease, and the remainder will be revegetated shortly thereafter.

8.1.6.2 Wildlife

Terrestrial vertebrates now inhabiting the project site will either perish or will escape to undisturbed areas surrounding the mill, where populations will be controlled by natural means. After reclamation, the more adaptable individuals and species will repopulate the area as favorable stages in the vegetative succession are reached.

8.1.7 Radiological

The tailings will be impounded in lined cells. Such enclosures would be overlain with cover material to meet radon release standards, and then reclaimed. The reclaimed tailings area will constitute a source of radon emission of about twice the natural background flux.

8.2 SOCIETY

No significant long-term impacts on the socioeconomic character of local communities can presently be attributed to the project with certainty. The nature of such impacts will depend on the prevailing community conditions when operations of this mill cease:

1. If the local economy and population continues to grow when the operation terminates and project personnel migrate from the area, the additional housing and public facilities built to accommodate project-related personnel will help to accommodate needs of the expanding economy.
2. If, at project termination, the economic activity and populations of communities are declining and surpluses of facilities and housing exist, some of the resources initially invested to accommodate needs of the White Mesa mill employees will not have been amortized. This situation could be aggravated if bonds used to finance public facilities directly attributable to this development have not been amortized during the operating (or other taxpaying) life of the project.

A loss of long-term productivity may result from disturbance of archeological sites. However, the mitigating actions that would be taken should result in preservation of archeological materials that might otherwise have been destroyed. This is consistent with the opinion of the Utah State Historic Preservation Officer who has advised as follows[1]:

> The work to identify significant sites and sites that will be adversely effected is nearly complete and while certain sites within the property may be significant under the federal criteria, as more fully explained in the State Archaeologist's report, you should be aware that the significance of these sites lies not with their becoming public attractions or monuments, but rather with the information they have yielded about certain prehistoric cultures. Sites of this nature are plentiful throughout the southeastern part of Utah, but have not been tested. It is only the opportunity presented by the desire of Energy Fuels to build a uranium mill in this area that permitted us to devote the time and energy to a thorough study of such sites. In essence, Energy Fuels project will permit the recovery of archaeological data that without the project probably never would have been recovered.

REFERENCES FOR SECTION 8

1. Utah State Historic Preservation Officer, letter to NRC, dated December 5, 1978.

9. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

9.1 LAND AND MINERAL

9.1.1 Land

The land occupied by the reclaimed tailings cells may not be available for further productive use. This would be considered an irreversible commitment of resources.

Work to reclaim archaeological sites may result in an incomplete recovery of archaeological data or resources, or in an inadvertent destruction of a portion of those resources.

9.1.2 Mineral

No major irreversible or irretrievable commitments of mineral resources are anticipated other than (1) the uranium and vanadium that will be recovered; (2) the 23,000 MT (25,000 tons) of coal that will be burned each year; and (3) the yearly consumption of 6.6 MT (7.3 tons) of kerosene and 95 m^3 (25,000 gal) of fuel oil in processing operations.

9.2 WATER AND AIR

9.2.1 Water

Ground and surface waters are not expected to be impacted by the proposed project. Because of the large volume of groundwater available, use of that water during mill operations is not considered an irreversible or irretrievable commitment of resources.

9.2.2 Air

Air is not depleted as a result of construction and operation of the mill facility but there is a potential for the air quality to be impaired primarily as a result of an increase in total, suspended particulate matter. However, because the atmosphere is self-cleaning of the pollutants at the anticipated low concentrations, no irreversible or irretrievable commitments of air resources are expected.

9.3 BIOTA

9.3.1 Terrestrial

Although a total of about 195 ha (484 acres) of soils and associated vegetation will be temporarily disturbed or lost for the life of the project, the land and wildlife habitat can be restored in time to acceptable levels as a result of approved reclamation efforts (Sect. 3.3.2). Current regulations, however, require the tailings disposal area [about 135 ha (333 acres)] to remain fenced until it is released from its status as a restricted area. Wildlife will undoubtedly use this area after it is fully reclaimed. This restriction is not considered an irreversible commitment of resources.

9.3.2 Aquatic

The staff does not expect any irreversible or irretrievable commitments of aquatic biota or habitat from project operation.

9.4 MATERIAL RESOURCES

Major irretrievable and irreversible commitments of material resources* incurred per year of White Mesa mill operation are 6.04×10^4 MT (6.66×10^4 tons) of sulfuric acid; 4.8×10^3 MT (5.3×10^3 tons) of manganese dioxide, 2.47×10^3 MT (2.72×10^3 tons) of sodium chlorate; 1.92×10^3 MT (2.12×10^3 tons) of soda ash; 4.39×10^2 MT (4.84×10^2 tons) of ammonium sulfate; 2.93×10^2 MT (3.23×10^2 tons) of anhydrous ammonia; and 0.91×10^2 MT (1.0×10^2 tons) of flocculent. In addition small amounts of Isodecanol, Amine, and various laboratory chemicals will be consumed.

These materials are not in short supply and are common to many industrial processes.

*Assuming 25% of the ore is processed for vanadium.

10. ALTERNATIVES

10.1 ALTERNATIVE SITES

The following factors were among those considered in selecting and evaluating mill and tailings disposal sites:

1. availability of suitable land; accessibility, but with limited public exposure (population doses);

2. proximity to producing mines and known ore bodies for reducing haulage costs and decreasing the impacts associated with ore transport;

3. geotechnical, meteorological, and hydrological factors: (1) direction and intensity of prevailing winds, (2) presence of mineral resources, (3) subsurface structural stability, (4) availability of natural tailings impoundment liner materials (5) adequate quantity and quality of materials available for reclaiming the tailings disposal area and other disturbed surface areas, and (6) suitable drainage and flood characteristics;

4. topographical factors such as (1) surface suitability for construction of facilities with minimum alteration of terrain, and (2) minimal drainage area above the tailings impoundment;

5. proximity to natural and man-made areas that could be adversely affected by the construction, operation, and reclamation activities related to the project;

6. existence of unique habitats that might support protected, threatened, or endangered species;

7. availability of industrially important services such as transportation, power, and communications.

The staff has determined that the most important factors to be considered during the site selection process are those which ensure an acceptable tailings management program. The NRC tailings management performance objectives for siting and design are listed in Section 10.3.1.

10.1.1 Alternative Mill and Tailings Disposal Sites

The applicant's Hanksville and Blanding ore-buying stations were located to collect uranium ore from small producing mines in southeast Utah. The majority of the ore for the mill will not be coming from company-owned mines located in close proximity in a specific geographical area but will be collected thru ore-buying from widely scattered mining operations in the Four Corners region. There are, theoretically, a multitude of potential sites in the Blanding - Hanksville region.

As was the case with the existing ore-buying stations, alternate sites for the mill would be optimally located with respect to the ore to be processed to minimize hauling distances, i.e., transportation impacts.

In addition to the alternative sites discussed below, the following alternatives were evaluated:

1. The alternative of storing the mill wastes in the mines from which the ore was extracted. This alternative is not feasible for a central milling operation that will be processing ore from approximately 100 small, widely distributed mines with diverse ownerships. Adequate control of the transportation, handling, and storage of the tailings would be difficult, and accessing and monitoring the effects of the tailings on the scattered, site-specific environments would be both difficult and expensive.

2. The alternative of milling the ore purchased at the buying stations at existing uranium mills (see Section 10.4 for discussion).

The applicant evaluated two basic siting options: (1) locating the mill and tailings impoundment in the Hanksville area, and (2) siting the processing and waste disposal facilities in the vicinity of Blanding.

The option of locating the mill and tailings disposal facilities in the Hanksville area was considered unacceptable by the staff for the following reasons:

1. Socioeconomic limitations (Section 2.4.2). These limitations include (1) limited capacity of Hanksville to absorb growth (excess housing is nonexistent); and (2) limited availability of power, communications, and transportation (air and rail) services. Hanksville (population 160) could not support the population increase that would be necessary to implement this project. The population change would be similar to that projected for Blanding (Section 4.8.1); however, the impacts would be significantly greater.

2. Increased ore haulage distances. Approximately 75% of the known uranium ore deposits available for processing are located near Blanding (ER. p. 10-2).

Based on a consideration of socioeconomic and transportation impacts, the staff has concluded that other potential alternative sites in the southeastern Utah region would be no better than those located in the vicinity of Blanding, Utah. Four alternative mill and waste disposal sites in the Blanding area were evaluated by the applicant (Fig. 10.1): (1) Zekes Hole (Area I), (2) Mesa (Area II), (3) Calvin Black property (Area III), and (4) White Mesa (Area IV). Zekes Hole is publicly-owned land located approximately 8 km (5 miles) southwest of Blanding, adjacent to and on the south side of State Highway 95. The Mesa site alternative is located approximately 6.4 km (4 miles) southwest of Blanding, adjacent to and on the south side of State Highway 95 and consists of two sections of public land. The Calvin Black property encompasses approximately 290 ha (720 acres) of privately owned land and is located approximately 3.2 km (2 miles) south of Blanding along the north side of State Highway 95. The White Mesa site is composed of 600 ha (1480 acres) of privately owned land and is located approximately 10 km (6 miles) south of Blanding on the west side of Highway 163 and is crossed by the Black Mesa Road and an existing power line. (The site is owned by Energy Fuels Nuclear).

These sites were evaluated primarily with respect to the availability of suitable land, hydrological and topographical considerations, and accessibility of services:

1. <u>Availability of Suitable Land</u>. A drawback for the Calvin Black property is that it is 3.2 km (2 miles) from Blanding and there are private residences within a 0.4-km (0.25-mile) radius of the site. The White Mesa site, 10 km (6 miles) south of Blanding, on the other hand, is bounded on east, west, and south sides by publicly-owned land and the nearest potential residence is 1.6 km (1 mile) north (the nearest current resident is approximately 3 miles north).

2. <u>Hydrological and Topographical Considerations</u>. Cottonwood Wash drains through the middle of the Zekes Hole site and the drainage at this location is greater than 500 km^2 (193 square miles). The Calvin Black property lies directly in the Westwater Creek drainage. The Mesa and White Mesa sites are both located on gently sloping lands and are not crossed by major drainages.

3. <u>Accessibility of Services</u>. There is limited accessibility to commercial power at the Zekes Hole and Mesa sites; power is available at the Calvin Black property and White Mesa sites. The applicant claims that the water supplies at the Mesa site and at the Calvin Black property might be inadequate to support the proposed mill. Access to roads is not a problem at any of these sites.

Based on a comparison of the four areas with respect to the characteristics listed above the staff concluded that the mill site area chosen by the applicant (White Mesa) was as environmentally suitable (or was better) than any of the other three.

10.1.2 <u>Alternative Tailings Disposal Sites in the White Mesa Area</u>

The applicant evaluated four potential sites for mill tailings disposal in the White Mesa area (see Fig. 10.2). At two of the sites (East and West), the tailings would be stored in canyons; and dams of considerable height would be required as part of the impoundments. At the North and South sites, tailings impoundments would cover larger surface areas and would be shallow, requiring the construction of dikes of low height.

The West site is located in Westwater Creek Canyon. The terrain in the area is steep, and a 15-year impoundment would require a dam approximately 70.1 m (230 ft) high. A single-cell, above-grade impoundment, sized to hold 15 years of tailings, would cover a small area [approximately 28 ha (68 acres)], and the drainage area would be about 340 ha (850 acres). The applicant rejected this tailings disposal site alternative for the following reasons (ER, Appendix H, p. 5):

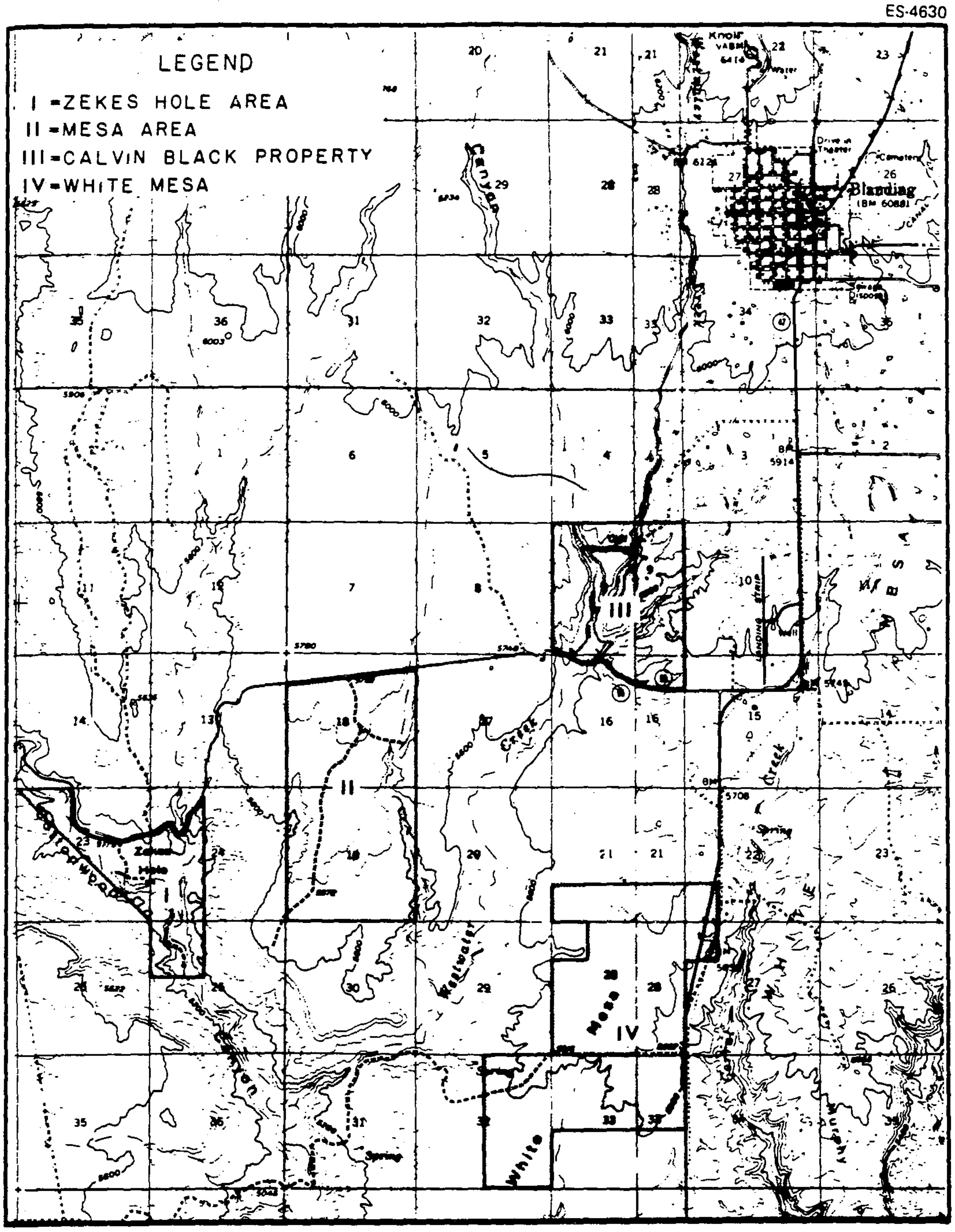

Fig. 10.1. Alternative areas near Blanding studied by applicant for the White Mesa Uranium Project. Source: ER, Plate 10.2-1.

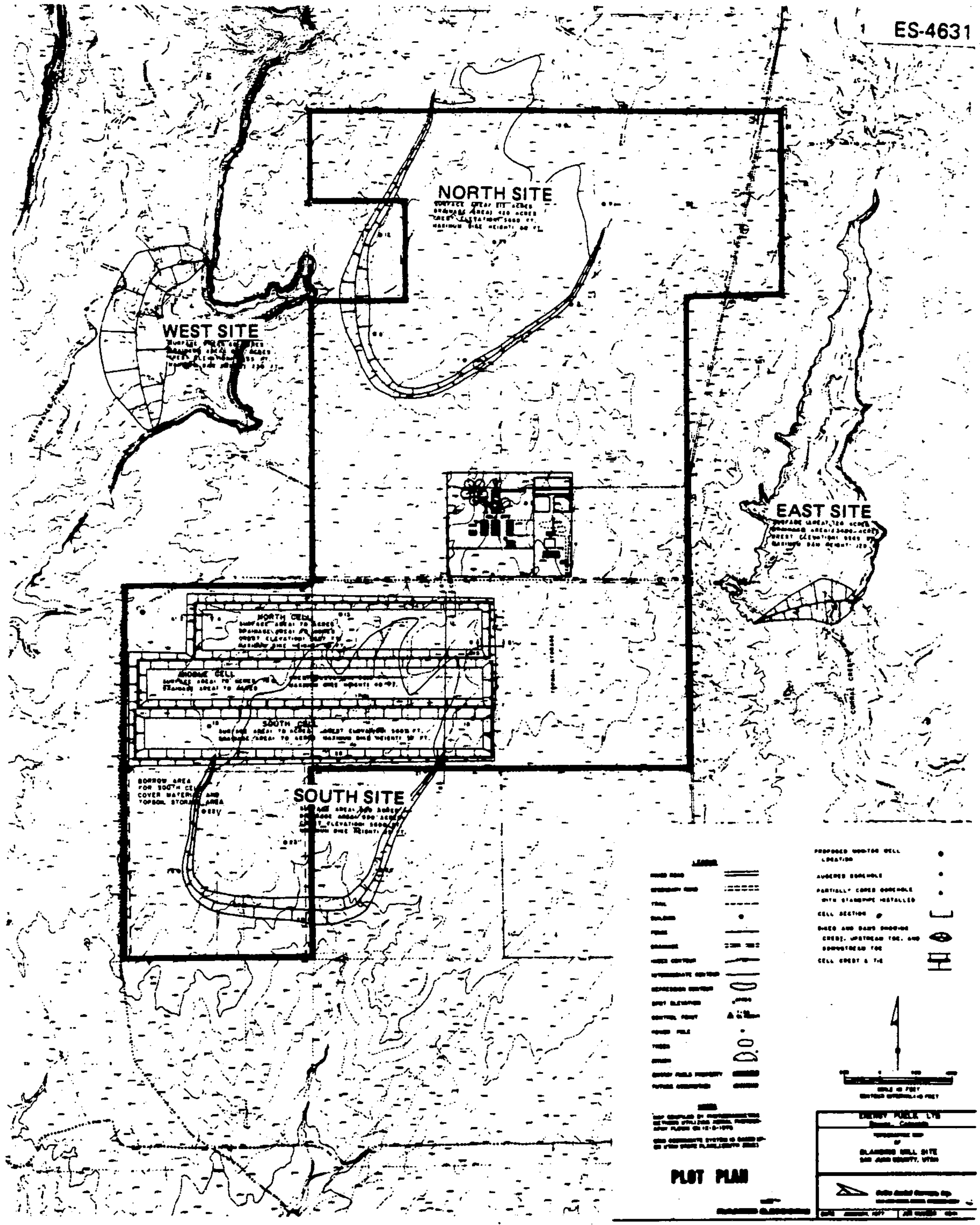

Fig. 10.2. Alternative tailings disposal sites in the White Mesa area. Source: ER, Appendix H, Plate 2.

1. Because the dam would have to be quite high to provide the required storage capacity and the toe of the dam would be in the flood plain of Westwater Creek, the long-term stability of the impoundment would be questionable.

2. Prevention of excessive seepage into the nearby vertical sandstone canyon walls would be difficult.

The East site is located in Corral Creek Canyon. A conventional, above-grade tailings impoundment, designed to hold 15 years of mill tailings, would cover approximately 49 ha (120 acres), would require a dam approximately 36.6 m (120 ft) high, and would have a drainage area of about 1400 ha (3400 acres). This tailings disposal site alternative was rejected by the applicant for the following reasons (ER, Appendix H, p. 6):

1. Although the reservoir surface area would be small, which is beneficial for reclamation purposes, the drainage area is large; and water erosion over the long term is potentially severe.

2. Prevention of excessive seepage into the steep, mostly sandstone canyon walls would be difficult.

The South site, which was picked by the applicant as the optimum site, is downgradient from the proposed mill site. The area is gently sloping, disturbed rangeland containing a slight swale in the general area where the tailings impoundment would be placed. A single-cell, above grade, 15-year impoundment at the South site would cover approximately 100 ha (250 acres), would require a dam approximately 19.8 m (65 ft) high, and would have a drainage area of about 240 ha (590 acres). The impoundment that is part of the tailings management system proposed by the applicant is to be located at the South site and is discussed in detail in Sects. 3.2.4.7 and 10.3.2 (Alternative 1).

The North site is located on gently sloping land upgradient from the proposed mill site. If a conventional, above-grade, dam/pond disposal facility, sized to hold 15 years of mill wastes, were to be constructed in the area, the applicant estimates that the impoundment would cover 87 ha (215 acres), would require a dam approximately 24.4 m (80 ft) high, and would have a drainage area of approximately 170 ha (420 acres). With the exception that the tailings would have to be pumped uphill for a slightly greater distance, there are no significant differences between this site and the South site.

Assuming that the mill would be located at White Mesa and utilizing the following criteria to screen feasible site alternatives from a multitude of potential sites in the Blanding area, the staff located and evaluated three additional alternative tailings disposal sites:

1. To minimize long-term wind and water erosion problems, the areas chosen for further study contained naturally excavated basins which 1) are almost completely enclosed by substantial rock barriers (such as cliffs) and would require a dam with a small length, and 2) which would have minimal drainage areas above the tailings impoundment.

2. Only basins that could be impounded to contain at least 15 years of mill tailings and which could be readily accessed by road or by slurry pipeline were considered.

The three additional alternative tailings disposal sites evaluated by the staff were 1) Recapture Creek, 2) Brown Canyon, and 3) Alkali Canyon. The Recapture Creek site is located in Section 26, T37S, R22E, east of the Corral Canyon tailings disposal site ("East site") investigated by the applicant, and east of the White Mesa site boundary. The Brown Canyon site is located northeast of the White Mesa mill site in sections 13, 14, and 23, T37S, R22E (the majority of the tailings impoundment would be in section 14). The Alkali Canyon site is located east-northeast of the White Mesa mill site in sections 10, 11, 14 and 15, R23E, T37S.

A tailings impoundment at the Recapture Creek site would cover approximately 37 ha (90 acres) and would require a dam approximately 48.8m (160 ft) high. At the Brown Canyon site an impoundment would cover approximately 84 ha (205 acres) and would require a dam approximately 30.5m (100 ft) high. A tailings retention area at the Alkali Canyon site would cover approximately 66 ha (161 acres); the dam required would be about 54.9m (180 ft) high. All sites are accessible by road; the haulage distances would be approximately 5.3 km (3.3 mi) to Recapture Creek, 8.5 km (5.3 mi) to Brown Canyon, and 19.5 km (12.2 mi) to Alkali Canyon.

The tailings retention areas at these sites would be smaller than the proposed impoundment at White Mesa, and the local topographies offer excellent protection from wind and water erosion. However, the dam heights would be greater, and the canyon walls are steep and consist of highly permeable and fractured sandstone; the prevention of seepage from the tailings retention areas would be difficult, and the long-term stability of the dams would be questionable. The staff concluded that no appreciable additional environmental benefits could be gained by storing the tailings at these sites.

10.1.3 Evaluation of Alternative Mill and Tailings Disposal Sites

The staff has concluded that no net environmental advantages would accrue if the mill and tailings disposal facilities were to be located at sites other than the site proposed by the applicant (White Mesa); i.e., the site proposed for the projected facilities is better, from a environmental standpoint, or at least as suitable as other potential locations. It must be emphasized that this conclusion is only possible because a similar conclusion can be made concerning the acceptability of the proposed tailings management system (Section 10.3.2, Alternative 1), which enhances the environmental suitability of the chosen site.

10.2 ALTERNATIVE MILL PROCESSES

10.2.1 Conventional Uranium Milling Processes

The milling processes proposed by the applicant are conventional and conform with those commonly used by the domestic uranium milling industry. In general, yellow cake is produced by the milling of uranium ore via the following procedure: (1) ore preparation (involving primarily the crushing and grinding of the ore), (2) leaching, (3) separation of pregnant leach liquids from waste solids (tailings), (4) concentration and purification of the uranium by extraction from the pregnant solution, (5) precipitation of the uranium from the extract solution, and (6) drying and packaging. The specific manner in which each of these steps, singly or in combination, is accomplished varies from mill to mill, depending on differing ore characteristics. Normally, process decisions are based on overall economic considerations, including costs of controlling chemical and radiological effluents to air, water, and land.

Crushing and grinding of ore are needed to reduce overall particle size to ensure efficient contact with the uranium-dissolving reagent. Normally, the ore is moved from stockpiles to the crusher by trucks, bulldozers, or by front-end loaders.[1] Conventional crushing equipment usually reduces the size of the ore particles to approximately minus 1.9 cm (3/4 in.). Control of the moisture level in the feed ore is crucial in the crushing process and generally should be less than 10% to prevent crusher malfunctions. In most mills the crushed ore is stored temporarily in bins before further processing. Grinding is usually accomplished by rod or ball mill, with the ore being ground to approximately 28 mesh for acid leaching and to approximately 200 mesh for alkaline leaching.[1] At the White Mesa mill the ore [which has already been crushed to less than 3.8-cm (1.5-in.) size at the ore buying stations] will be fed by a front-end loader through a primary grizzly to a secondary grizzly and then fed by conveyor belt to a semiautogenous wet grinding mill. The mill will operate in closed circuit with screens, with the minus 28 mesh output (underflow from the screens) being pumped to three mechanically agitated, wet-slurry storage tanks.

The leaching method chosen for removal of the uranium from the ground ore is heavily dependent on the chemical properties of the ore. Ores containing low levels of basic materials (primarily lime) are usually leached with sulfuric acid. An alkaline leach reagent (normally sodium carbonate-bicarbonate solution) is usually used when the lime content of the ore is high and uneconomical quantities of acid would be required, significantly increasing processing costs. Some processes add acid in "stages" to minimize excessive initial frothing and to monitor acid content (pH control). The applicant evaluated the effectiveness of acid and alkaline leaching processes on ores purchased by the ore buying stations (ER, p. 10-6). Although some of the ore could be successfully treated by alkaline leaching, acid leaching usually resulted in higher recovery rates; therefore, a conventional sulfuric acid leach process was chosen by the applicant. The leaching circuit at the White Mesa mill will be designed for the extraction of vanadium as well as uranium. The ore will be leached in two stages utilizing sulfuric acid, manganese dioxide (depending on availability and delivery, an equivalent oxidant such as sodium chlorate might be used), and steam. The overall uranium recovery rate is expected to be about 95%.

The separation of the pregnant leach solution from waste solids is usually accomplished by thickening or by filtration. The majority of the acid leaching mills in the United States use counter-current decantation in thickeners for liquid-solid separation.[2] The applicant has also chosen to achieve liquid-solid separation by counter-current decantation washing and thickening methods. (The belt filtration alternative is described in Sect. 10.2.2.) Either conventional, multistage, counter-current thickeners or Enviro-Clear type thickeners will be employed. To reduce freshwater requirements, barren raffinate will be added to the final thickner for washing the leached residue. Polymeric flocculants will be used to increase separation efficiency, and the waste solids (underflow slurry from the last thickener containing 50% water) will be pumped to the tailings impoundment area.

Concentration and purification of the uranium from the pregnant leach solution is necessary for the production of a high-grade uranium product. This is usually performed by either a solvent extraction or an ion exchange process. The applicant has decided to utilize a solvent extraction method where the decanted, aqueous uranium-bearing leach solution will be contacted with an organic solution consisting of an amine-type compound dissolved in a kerosene diluent. The dissolved uranyl ions are more soluble in (and transfer into) the organic solution. Resin-based processes, such as resin-in-pulp and resin ion exchange in clarified solution, were evaluated by the applicant and rejected for economic reasons, primarily because of relatively higher operating costs. The solvent extraction process will be carried out in a series of mixer and settling vessels, with the organic and aqueous solutions being mechanically agitated and separated into organic and aqueous phases in the settling tanks. This separation operation would be performed in four stages using a counter-flow principle where the organic flow is introduced to the preceding stage and the aqueous flow feeds the following stage. The depleted aqueous phase (raffinate) will be recycled to the counter-current decantation stage or processed for the recovery of vanadium (Sect. 3.2). The uranium-loaded extract (organic solution) will be washed and stripped of uranium by contact with an acidified sodium chloride solution; the resulting barren organic solution will be returned to the solvent extraction circuit.

The milling process generally concludes with the recovery of the uranium from solution by chemical precipitation. When acid leach methods are utilized, the uranium is precipitated by neutralization with a base such as ammonia, lime, magnesia, or hydrogen peroxide.[2] The precipitate is then dewatered, dried, and packaged. At the White Mesa mill, the uranium-rich solution from the stripping operation will be treated with ammonia to neutralize the solution, precipitating ammonium diuranate, or yellow cake. The precipitate will then be thickened, dewatered by centrifuge, dried in a multiple-hearth, oil-fired dryer (calciner), crushed to minus 0.6-cm (0.25-in.) size in a hammer mill, and then packaged in 55-gal drums for shipment. The drying, crushing, and packaging operations will be isolated and enclosed in an area that is maintained at a negative air pressure to contain and collect (by wet scrubbing) airborne U_3O_8 particles. As an alternative to the drying, crushing, and packaging operations, yellow cake slurry can now be shipped directly to a UF_6 conversion facility. The applicant investigated this alternative processing option but rejected it because of uncertainties concerning the long-range availability of sufficient capacity at this type of conversion facility.

10.2.2 Uranium Milling Processes which Produce Low-moisture Tailings

There are several alternative uranium milling processes currently in use in other countries which produce low-moisture tailings, which might be amenable to direct burial in unlined disposal retention areas, such as depleted open-pit mines or specially prepared pits. For example, a dewatering method developed by Burns and Roe/Pechiney/Ugine Kuhlmann utilizes a belt-filtration process instead of conventional vacuum drum filters and thickeners to separate the pregnant leach solution from waste solids. The liquid-solid separation method proposed by the applicant will produce tailings that will be approximately 50% water by weight; the rate of discharge will be approximately 1800 MT (2000 tons) of tailings and 1800 MT (2000 tons) of water per day. If the Pechiney milling technique, which uses a belt filter, were to be implemented, the "cake" would be counter-currently washed in two stages, with the barren tailings being dewatered to a moisture content of approximately 22%. The tailings can be neutralized before or on the belt filter. The tailings would then be belt-conveyor or truck transported to the tailings disposal site. Because the tailings are essentially "dry," the area required for tailings storage might be reduced; and the problems associated with the control and monitoring of seepage from a disposal site might also be decreased. The possibility of using this type of belt filtration process is dependent on consistent physical characteristics in the ore processed, as this is the basis for the design of the filter. The ore to be processed at the White Mesa mill will have a wide range of physical and chemical characteristics.

The applicant evaluated the effectiveness of utilizing a belt filter or disk filter system to reduce the moisture content of the mill tailings. The filtration circuit evaluated, however, would not replace the proposed "thickener" liquid-solid separation process but would accept the tailings from the thickener circuit and segregate the slimes and sands for separate disposal. This alternative tailings disposal method is discussed in greater detail in Sect. 10.3.2 (Alternative 3).

10.2.3 Evaluation of Proposed Milling Process

The milling processes proposed by the applicant are conventional, state-of-the-art techniques utilized in the domestic uranium milling industry and are as environmentally sound as other commonly used processing combinations. Further unforeseen developments, such as increased processing costs due to changes in the characteristics of the ore or changes in the relative costs of reagents, may result in the applicant proposing changes in the mill circuit. When such changes are suggested, the environmental impacts associated with their implementation will be assessed.

10.3 ALTERNATIVE METHODS FOR TAILINGS MANAGEMENT

10.3.1 Introduction

For the purposes of this section, tailings management is defined as the control of the tailings and waste solutions following removal of the uranium values. Engineering techniques to control pollutants from tailings, both during operational and post-operational stages of a milling project, have been proposed. The unique characteristics of each facility must be identified, and then appropriate environmental controls must be applied. The staff has examined alternatives considered by the applicant,[3-5] as well as alternatives considered for other mills in preparing this section.[6-10] Alternatives presently available or feasible (i.e., potentially available with existing technology and at a reasonable cost) are described in Sect. 10.3.2 and evaluated in Sect. 10.3.3. A list of additional alternatives for tailings management that the staff has concluded are not feasible with existing technology is presented in Sect. 10.3.4.

Each alternative tailings management plan has been evaluated against the following set of performance objectives developed by the staff:

Siting and design

1. Locate the tailings isolation area remote from people so that population exposures will be reduced to the maximum extent reasonably achievable.
2. Locate the tailings isolation area so that disruption and dispersion by natural forces is eliminated or reduced to the maximum extent reasonably achievable.
3. Design the isolation area so that seepage of toxic materials into the groundwater system will be eliminated or reduced to the maximum extent reasonably achievable.

During operations

4. Eliminate the blowing of tailings to unrestricted areas during normal operating conditions.

Post reclamation

5. Reduce direct gamma radiation from the impoundment area to essentially background.
6. Reduce the radon emanation rate from the impoundment area to about twice the emanation rate in the surrounding environs.
7. Eliminate the need for an ongoing monitoring and maintenance program following successful reclamation.
8. Provide surety arrangements to ensure that sufficient funds are available to complete the full reclamation plan.

10.3.2 Feasible alternatives for tailings management

Alternative 1: Tailings disposal in impoundment cells built, filled, and reclaimed in stages

This alternative involves the construction of a six-cell impoundment system with a safety dike in a swale (shallow natural basin) immediately to the west and south of the proposed mill site. Two of the cells will be used as evaporation ponds. As proposed by the applicant, the total tailings disposal area would be sized to contain 1800 metric tons (MT; 2000 tons) per day of tailings produced during 15 years of mill operation (see Fig. 3.4). The proposed tailings system involves simultaneous construction, operation, and reclamation of individual cells. As one cell is being used for tailings disposal, the previous used cell will be drying and the next cell downgradient will serve as an emergency catchment basin (Sect. 3.2.4.7). An individual cell would be sized to hold approximately four years production of tailings and would cover approximately 24 ha (60 acres) of surface area. Cells would be constructed by excavating the bottom of the impoundment and by building successive embankments across the open (southern) end of the swale to contain the tailings. The excavation of a limited amount of bedrock material [1.5 to 1.8 m (5 to 6 ft) deep], in addition to overburden soil, would be necessary. Because a high degree of weathering is anticipated at these depths, excavation would be accomplished by ripping; no blasting would be used for excavation of the rock (except for localized lenses of unweathered rock). Excavation slopes no steeper than 3:1 (horizontal to vertical) are specified for slope and lining system stability. The dikes would be homogeneous, compacted, earth-filled embankments constructed from soils present in the overburden at the tailings disposal site. The embankments would vary in height from approximately 7.6 m (25 ft) for cell 1-E to 13 m (42 ft) for cell 5, where the dikes cross the lowest part of the swale. Each dike would be 6.1 m (20 ft) thick at the crest to allow for an access road and would have side slopes no steeper than 3:1 (horizontal to vertical) (Fig. 3.7). When passing between individual cells, the tailings discharge pipe would be contained in an outer "emergency containment" pipe. The "emergency containment" pipe would be secured in a pipe trench lined with a double layer of synthetic lining which would be built into the crests of embankments. The downstream slope of the final, southernmost dike (cell 5) is the only dike that would ultimately have an exposed face (after final reclamation); therefore, to reduce the potential for excessive erosion of this embankment after cessation of mill operations, a 6:1 sloped layer of rock fill would be used in the construction of the downstream segment of this dike (Fig. 3.8). Additionally, to minimize water and wind erosion during operations, excavated rock would be used to protect drainage channels and to cover the exterior slopes on the perimeter of the impoundment. The entire tailings retention system (including the cell 5 safety dike) would cover approximately 135 ha (333 acres) of surface area if the mill were to operate at 1800 MT per day for 15 years; the total affected acreage (includes land needed for stockpiling and borrow areas) would be approximately 195 ha (484 acres). (See Table 4.3.)

To prevent seepage of liquid wastes from the impoundment facilities, the applicant initially will line all interior surfaces of each cell with a state-of-the-art synthetic liner such as PVC reinforced with a nylon scrim (the final liner and liner system specifications and the program for installation, maintenance and inspection of the liner system will be reviewed and approved by the NRC staff prior to use). To prevent puncturing of the synthetic liner, a smooth (projection free) subliner of locally obtained clayey-silt soil would be placed over the excavated rock surfaces of each cell floor. The entire synthetic liner surface (including the liner on the upstream portion of the dikes) would be overlain with 30.5 cm (12 in.) of clayey-silt soil to minimize liner deterioration caused by winds, sunlight, and the tailings materials and also for protection from operating equipment. No slurry discharge will be permitted directly onto the cell lining cover. Because (1) the cell floors would be flat (2% slopes or less) for other than excavation slopes (no steeper than 3H:1V), (2) the cells would be shallow impoundments, and (3) dense, relatively incompressible materials (Dakota Sandstone) would underlay the liner, differential settlement should not be of sufficient severity to compromise the liner integrity.

The expected net evaportion rate at the site is 0.9 m (3 ft) per year, and the total liquid transported with the tailings would be 5.9 x 10^5 m^3 (480 acre-ft) per year. On the slightly sloping impoundment surfaces, the staff expects the tailings to drain and settle to a void fraction approaching 0.34, which would contain pore water at 50% of saturation. This quantity would be effectively bound by capillary forces at 0.17 m^3 (0.17 ft^3) of water for each cubic meter of settled tailings or about 7.0 x 10^4 m^3 (57 acre-ft) per year. With no seepage, equilibrium between input and evaporation would be achieved with about 56 ha (139 acres) of ponded liquid. Because the surface areas of the evaporation cells would be only 40 ha, (98 acres), the staff has concluded that corrective measures, such as recycling tailings solutions to the mill, may have to be instituted to satisfy water balance requirements. However, this should not be required because the moist tailings surface and the ponded slimes will provide at least an additional 24 ha (60 acres) of evaporation surface in addition to the 40 ha (98 acres) of evaporation pond.

During operations, a freeboard of 1.5-m (5 ft) minimum would be maintained in the evaporation and tailings cells. In addition, interceptor ditches would be constructed to divert surface drainage away from the operations and impoundment areas. These ditches, sized to pass the probable maximum flood, would be constructed north, east, and west of the tailings and operating areas. Riprap, consisting of excavated rock, would be placed in the ditches to aid in preventing erosion. Over the long term, the interceptor ditches would fill with silt and become revegetated. The small drainage area upgradient from the reclaimed tailings impoundment [upgradient drainage area is 0.065 km^2 (0.025 sq mile)] obviates concerns over dispersion of the cover from flooding.

Reclamation would be implemented sequentially for the tailings cells as each cell is inactivated and as soon as an individual cell has dried sufficiently to allow the movement of equipment over the pile. To reduce radon gas emanation and gamma radiation from the tailings to acceptable levels, the applicant proposes to cover the tailings with a 0.6-m (2-ft) layer of compacted clay obtained from offsite deposits, 1.2 m (4 ft) of onsite clayey-silt material, 1.8 m (6 ft) of rock, and 15 cm (6 in.) of topsoil. Slopes on the perimeter of the cover would be no steeper than 6H:1V and would be constructed of riprap. The compacted clay would be designed and constructed to prevent damage by differential settlement. To revegetate the tailings area, the applicant has proposed to seed the tailings cover with a mixture of grasses, forbs, and shrubs.

Because the cap would be almost 4 m (13 ft) thick, the staff has concluded that root penetration into the tailings is not likely, reducing the possiblity of adverse impacts associated with the upward migration of radionuclides and toxic elements through plant root systems. Although the disposal area would be located in a relatively arid region, the proposed cover is not expected to develop significant shrinkage cracks because the clay content of the soils to be utilized is low (except for the imported, remolded clay).

The reduction of the gamma radiation that results from capping a tailings pile is dependent on the degree of compaction and mass stopping power of the cover material. As shown in Appendix G, similar cover was calculated by the staff to reduce the gamma radiation from the tailings to approximately 1×10^{-7} milliroentgens per year, thus meeting the performance objective for reduction of gamma radiation.

The radon flux at the surface of uncovered tailings was calculated by the staff to be approximately 439 $pCi/m^2 \cdot sec$. The covering scheme proposed by the applicant [0.6 m (2 ft) of clay overlain with 1.2 m (4 ft) of clayey-silt material, 1.8 m (6 ft) of rock, and 15 cm (6 in.) of topsoil] was estimated by the staff to reduce the radon emanation rate from the reclaimed tailings area to approximately 1.16 pCi/m^2 sec and meets the intent of the performance objective for reduction of radon exhalation. These calculations will be experimentally confirmed.

Discounting and deflating the expected costs to 1978 dollars (10% discount rate and 8% rate of inflation per annum), the total estimated costs for this alternative is approximately $20.7 million. (The costs for a synthetic liner for the entire impoundment and for the clay component of the cover are estimated at $5.5 and $2.0 million, respectively.)

The major benefits that could accrue with implementation of this tailings disposal alternative are the following:

1. The tailings would be stored in the head end of a natural basin and below the ridges bounding that basin on all but the southern (open) end. Although the tailings cover is only partially below these ridges [at least 1.5 m (5 ft)], the slight grade ($<2\%$ overall) on the cover and small upgradient drainage area [0.065 km^2 (0.025 mi^2)] should provide a high degree of protection from wind and water erosion. Slopes on the perimenter of the impoundment cover would be no steeper than 6H:1V and would be constructed of riprap. The entire area would be revegetated; and a layer of riprap would be placed on all exposed slopes around the impoundment, further minimizing potential erosion problems. Although the downstream side of the last dike (on cell 5) has an exposed face, it will have a 6:1 slope and will be constructed of rock overburden.

2. The cellular design allows staged reclamation, minimizing the quantity of tailings exposed at any one time. Overburden storage and handling requirements are also reduced, that is, overburden removed during excavation of later cells can be transported directly to cells being reclaimed.

3. The low dikes and the shallow depth of the cells increase dike stability.

Alternative 2: Below-grade burial in a specially excavated pit

This alternative involves the excavation of a basin of sufficient size and depth to store all of the tailings and tailings cover completely below grade. The impoundment would be lined with a synthetic liner to minimize seepage from the disposal area. After completion of fill operations and as the tailings reach sufficient dryness to allow the movement of equipment over the pile, the tailings would be covered with compacted clay, locally obtained rock and soil, and topsoil in the same configuration as proposed for Alternative 1. Therefore, the radon gas and gamma attenuation estimates would be the same as for Alternative 1.

In the version of this alternative proposed by the applicant, the tailings would be stored below grade; but the tailings cover would protrude above grade. However, a true below-grade disposal system would have to include the cover below grade, which would require modifications in the applicant's proposed plan. Further excavation downward would significantly increase costs and would require extensive blasting to remove unweathered Dakota Sandstone. Implementing either version of this alternative would be advantageous as no retention embankment would be required; thus the probability of release and dispersion of tailings would be minimized.

The estimated cost of Alternative 2 is $32.6 million (discounted to 1978 dollars). This does not include the cost of the additional excavation of bedrock that would be required to make the system "below grade". The benefits that this alternative might have over Alternative 1 do not justify the additional costs.

Alternative 3: Filtered tailings disposal

This alternative features partially below-grade burial of dewatered tailings in unlined basins or trenches. Dewatering would be accomplished by either horizontal belt-type or disc-type vacuum filters. The filtration circuits would not replace the proposed "thickener" liquid-solid separation process but would accept the tailings from the thickener circuit and segregate the liquids and solids for separate disposal (see Fig. 10.3). The dewatered tailings would be transported to the disposal area either by truck or by a portable conveyor system. The liquid filtrate would be discharged to three 28-ha (70-acre) lined evaporation ponds. After completion of milling operations, the ponds would dry out. Soluble residue and contaminated clays and underlying materials would be removed from the pond areas and buried in the tailings disposal area. The evaporation ponds would be constructed above grade, would vary from 1.8 m (6 ft) to 2.4 m (8 ft) in depth, and would be lined with a clayey-silt material available onsite.

The total volume of tailings produced over the 15 years of project operation would approach 6.88×10^6 m^3. This volume would cover an area of 160 ha (400 acres), 4.6 m (15 ft) deep. To balance excavation quantity (4.74×10^6 m^3) and cover requirements, the applicant proposes to construct a 160-ha (400-acre) impoundment, 3 m (10 ft) deep. This design would result in a tailings projecting 1.5 m (5 ft) above grade and the tailings cover completely above grade. The same cover scheme proposed in Alternative 1 would be utilized.

The major disadvantages associated with the implementation of this alternative are as follows:

1. The tailings would be partially above grade, and the long-term stability of the reclaimed tailings impoundment would be questionable.

2. The absence of an impermeable liner under the evaporation pond increases the possibility of long-term leaching of toxic elements from the tailings. (The impermeability of the compacted clayey-silt material has not been proven.)

3. The reliability of the filter system would be questionable due to the wide variety of ores to be processed by the proposed mill.

The total cost of this alternative is a function of the dewatering system and tailings transport system chosen. With haulage of dewatered tailings by truck or by conveyor belt and filtration by horizontal belt or disc filters, the costs range from approximately $24.7 to $25.0 million. (The cost of the clay cap would be approximately $2.4 million.)

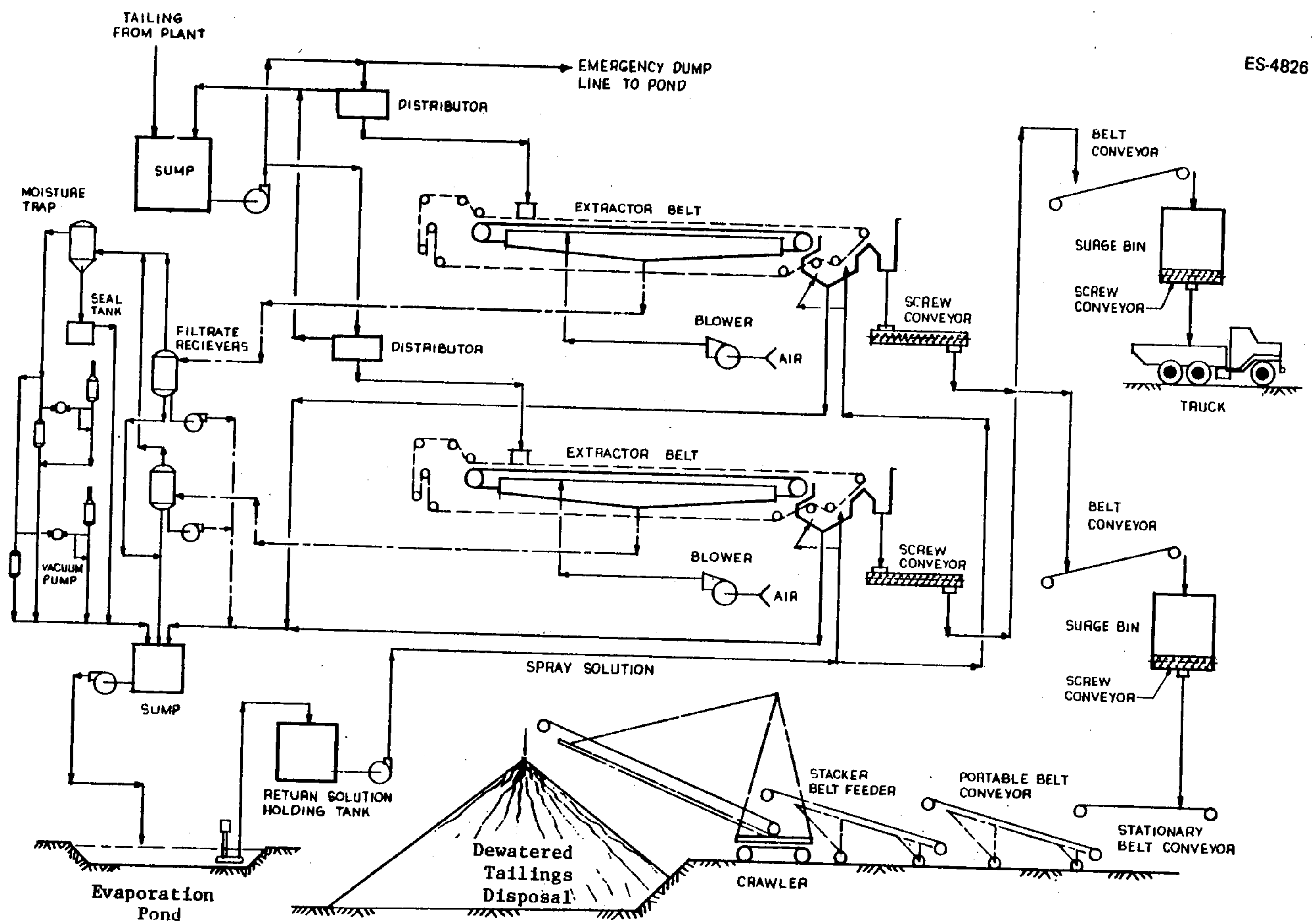

Fig. 10.3. Filtered tailings disposal belt extractor flow diagram. Source: Energy Fuels Nuclear, Inc., adopted from Fig. 3-14 in "Investigations of Alternative Tailings Disposal Systems, White Mesa Uranium Project, Blanding, Utah," April 1978.

Alternative 4: Solidification of tailings utilizing cement, asphalt, or other chemical fixants

In this option, mill tailings would be fixed with cement, asphalt, or other chemicals to form a solid, less leachable product for disposal. The solidified tailings could then be stored in an impoundment. The disposal area would be reclaimed by covering the material with layers of overburden and topsoil and revegetating it to minimize water and wind erosion.

Portland cement could be utilized to fix either the entire tailings solids or the slimes only. In either case, the tailings would be neutralized (probably by the addition of lime), and the waste slurry would be dewatered to a minimum of 60% solids before being mixed with the cement. A minimum of 1 part cement to 20 parts tailings would be required for solidification; strength, leaching resistance, and cost increase as the ratio of cement to tailings increases (ref. 11, p. 43). The 1:20 cement to tailings mixture could be pumped, if necessary, via a slurry pipeline to a disposal site.

Neutralized, dewatered (dried) slimes and waste solutions could be fixed with asphalt, and the final product would contain approximately 60% slimes solids (ref. 11, p. 42). When first mixed, the product would be fluid and could be shipped via a pipeline to a disposal site. The major advantages of solidifying tailings in asphalt are (1) leaching resistance is high and (2) radon exhalation is reduced because asphalt is an effective radon diffusion barrier.

Commercially available chemical fixants could also be used to solidify the tailings. If this waste stabilization method were to be implemented, the chemicals would be blended into the tailings slurry and the resultant mixture pumped to an impoundment where solidification would occur within a few days to a few weeks. The waste material would either be entirely entrapped or the pollutants (primarily heavy metals) would be chemically bound in insoluble complexes.[4]

Although theoretically feasible and environmentally desirable, solidification of tailings is expensive. The applicant investigated the costs of utilizing chemical fixants to solidify the tailings, finding the costs to range from $7 to $36 per ton of treated tailings.[4] If a nominal cost of $10 per ton of tailings is assumed, chemically fixing the waste material produced by 15 years of mill operation would cost approximately $91.3 million (discounted to 1978 dollars). The staff estimates that the costs of asphalt or cement fixation would range from $90 million to $105 million.

Alternative 5: Conventional above-grade tailings disposal using an engineered embankment to retain the tailings

This alternative consists of creating a tailings impoundment by constructing a dike to enclose the lower end of the natural basin south of the proposed mill site (Fig. 10.4). A full-height engineered embankment constructed of borrow material would be used to retain 15 years of mill tailings. Because the basin created by the embankment would be filled with tailings by distribution from the top of the dam, construction of the embankment would have to be completed before the system could be used. The downstream segment of the embankment would be constructed of permeable sand. To minimize seepage, the upstream section would be constructed of compacted clayey-silt and silty-sand and would be tied into the soil liner on the bottom of the impoundment. The dam would be approximately 20.7 m (68 ft) high, with a freeboard allowance of about 1.5 m (5 ft) for wave protection. The tailings reservoir would cover approximately 103 ha (250 acres). To prevent erosion of the downstream dam slope, 15 cm (6 in) of gravel, overlain with 30.4 cm (1 ft) of riprap or a 10 cm-thick (4 in-thick) concrete cap reinforced with wire mesh, would be placed over the downstream segment. The floor of the impoundment would be lined with 0.6 m (2 ft) of compacted, locally obtained clayey-silt material to limit seepage from the impoundment.

After the completion of mill operations and as the tailings reach sufficient dryness to allow the movement of equipment over the pile, the tailings would be covered with layers of compacted clay, clayey-silt material, and topsoil of the same configuration as proposed for Alternative 1, and the area would be revegetated with appropriate plant species.

The total estimated cost for this alternative is $9.6 million (discounted to 1978 dollars) if riprap is used for slope protection. The cost of the clay cap is roughly $1.5 million.

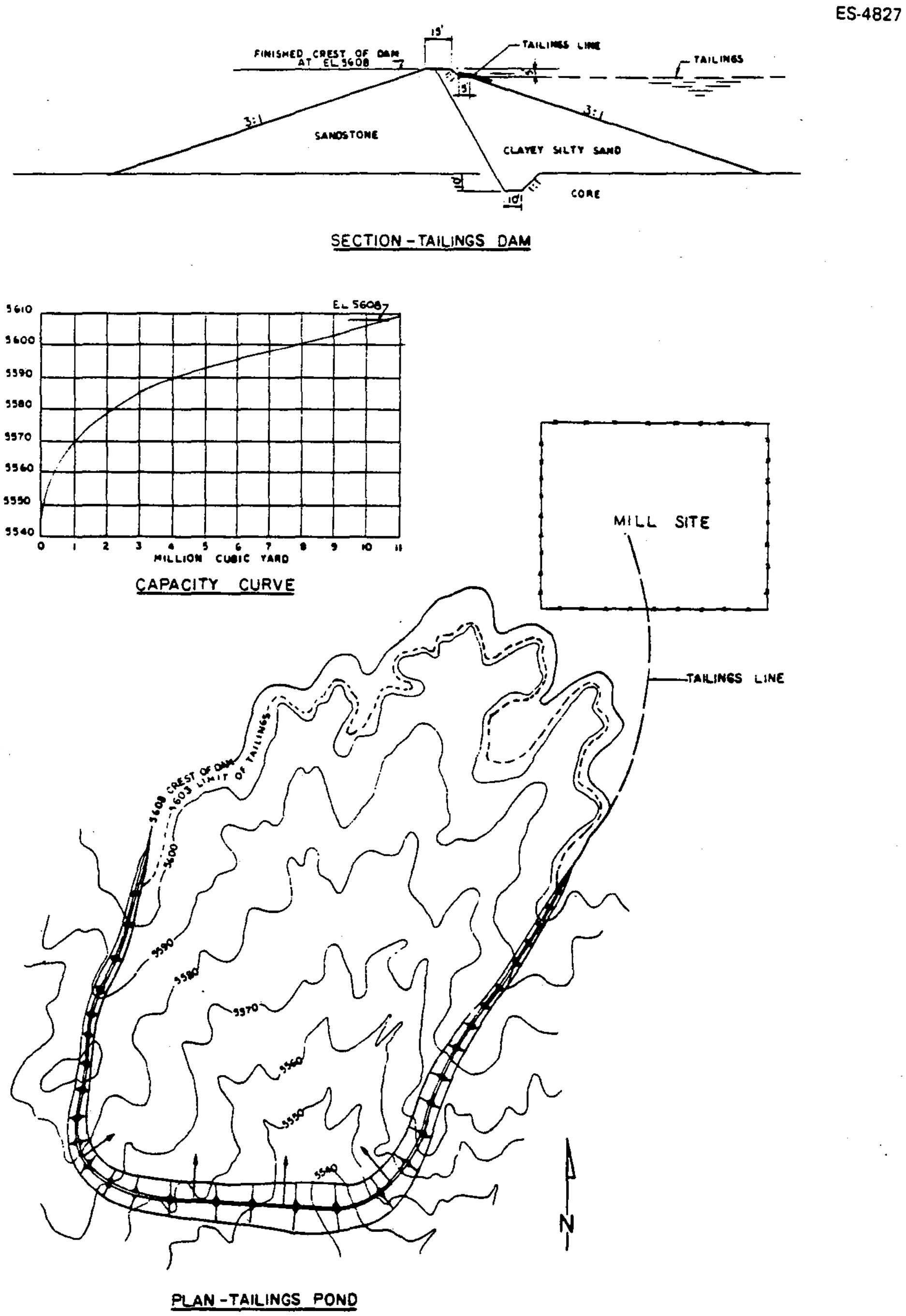

Fig. 10.4. Conventional disposal, engineered embankment — full height. Source: Energy Fuels Nuclear, Inc., Fig. 3-3 in "Investigations of Alternative Tailings Disposal Systems, White Mesa Uranium Project, Blanding, Utah," April 1978.

The applicant also investigated the construction of an engineered embankment in stages, with each stage being sized to retain the tailings from five years of mill operation. With the exception that the dam would be exposed to erosion during the operational period (because no riprap could be adequately placed until the final stage is completed), the impacts of staged dam construction would be about the same as would occur if a full-height engineered embankment were to be used. The cost would be approximately $9.4 million (discounted to 1978 dollars). This estimate does not include the cost described above for the clay cap.

Alternative 6: Conventional above-grade tailings disposal utilizing an evaporation pond for storage of liquid wastes

This alternative consists of discharging the tailings slurry into a segmented settling pond, with liquid wastes being decanted into an evaporation pond. The settling basin and the evaporation pond would be enclosed by engineered embankments (Fig. 10.5). The evaporation pond would be 1200 m (4000 ft) by 165 m (540 ft), or 20.3 ha (49.5 acres). The main basin would cover approximately 103.7 ha (253 acres). The maximum height of the settling pond embankments would be 12 m (40 ft); the dam around the evaporation pond would be about 9 m (30 ft) high. Small embankments constructed of tailings sands would be constructed in the main basin to create five segments. Tailings would be delivered to the tops of these dikes, with the excess liquids being decanted into the pond area outside the tailings impoundment. As each divided segment is filled to design capacity, it would be allowed to dry and then covered with a layer of compacted clay, soil material, and topsoil of the same configuration as proposed for Alternative 1. The main basin and the evaporation ponds would be lined to limit seepage with a 0.6 m (2 ft) liner of clayey-silt materials. The lengths of the embankments required to surround the impoundments would be approximately 4180 m (13,700 ft) for the settling basin and approximately 1550 m (5080 ft) for the evaporation pond. The total cost of this alternative would be approximately $10.7 million (discounted to 1978 dollars). The cost of the clay cap is $1.8 million.

Alternative 7: Segregated disposal

In this alternative, tailings sands would be separated from slimes and liquids. The dewatered sands would be placed in unlined trenches, and the slimes and liquids would be discharged to clay- or synthetic-lined evaporation ponds (Figure 10.6).

The sands disposal area would cover approximately 126 ha (310 acres) and would consist of a series of parallel, unlined trenches. The total excavation requirements for the area would approach 4.18×10^6 m^3. Sands would be placed in the trenches by a "Mobile Disposal Unit," which would (1) receive the total slurry, (2) remove the sands from the slurry by means of either standard hydrometallurgical cyclones (hydrocyclones) with or without a dewatering screen, and (3) would deposit the moist sands (20 to 25% moisture) in the unlined trenches. The deposited sands would drain to 15 to 20% moisture, and all drainage would be recycled to the mill. Use of the hydrocyclone-dewatering screen option would result in drier sands being deposited, thus minimizing the seepage from the trenches. Each individual trench would be reclaimed after it is filled. The sands would be leveled to the natural grade and a 2.7-m (9-ft) layer of compacted clayey-silt material would be placed over the sands to limit radon emanation and to protect the sands against erosion.

Slimes and liquids would be directed to a 36-ha (90-acre) evaporation pond. The applicant has examined four alternate pond configurations: two above grade (lined with onsite soils), one partially below grade (synthetic-lined), and one below grade (synthetic-lined). Engineered embankments would be constructed for the above-grade and partially above-grade options, and the below-grade option would not require embankments.

The major differences in the costs of the alternative configurations are related to the amount of excavation necessary in construction of the ponds. Dike construction for the above-grade option would require 1.13×10^6 m^3 of fill materials from onsite borrow areas. The partially above-grade option would result in the excavation of 1.53×10^6 m^3, with 305,800 m^3 being used in embankment construction. The below-grade option would result in the excavation of 5.35×10^6 m^3 of material, of which 2.78×10^6 m^3 would be solid rock.

Reclamation would be achieved by covering the area with a suitable radon diffusion barrier over the dry slimes. Given the high radium content of the slimes, the staff feels that the cover configuration proposed in Alternative 1 could be inadequate for the slimes area.

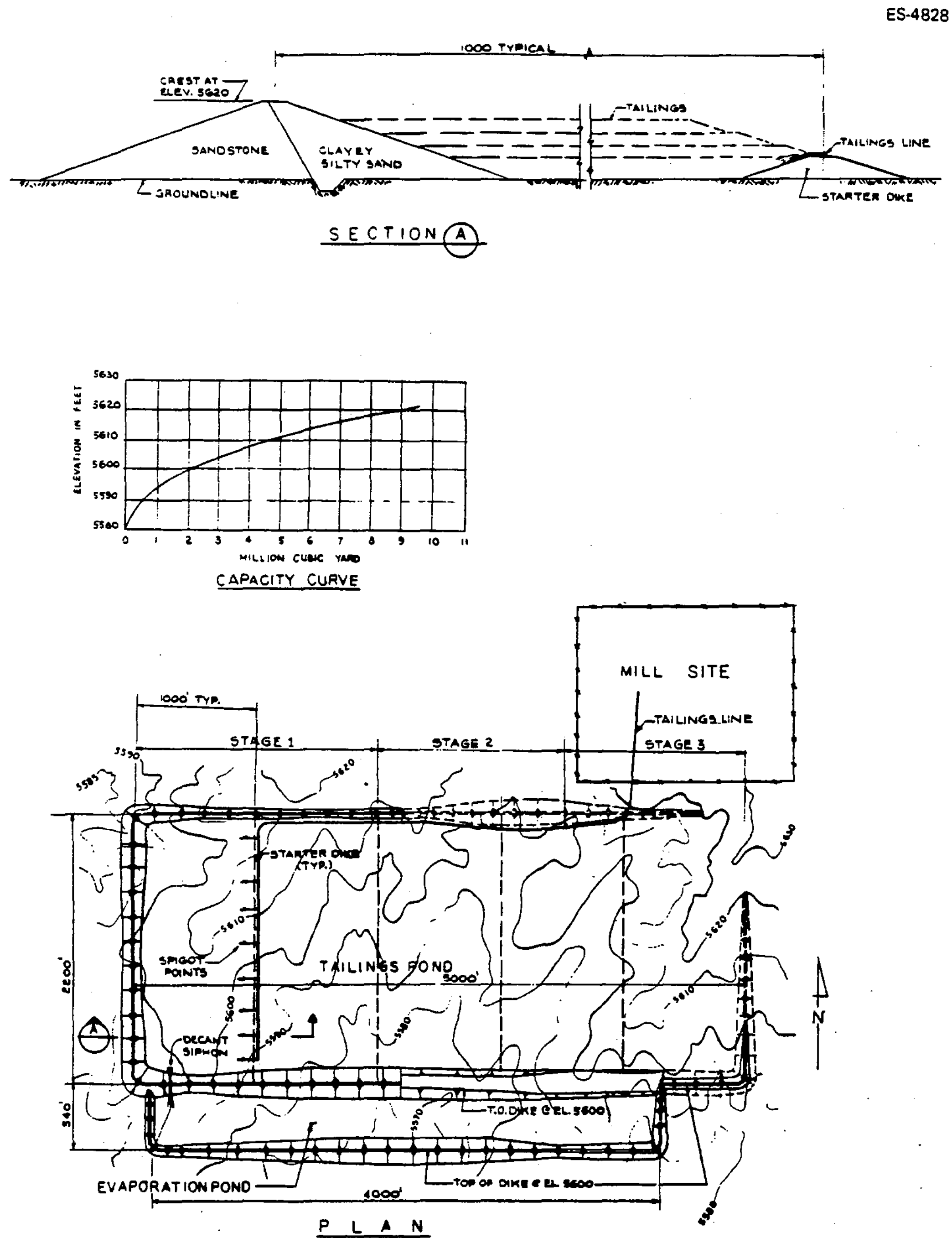

Fig. 10.5. Conventional disposal, segmented settling pond and evaporation pond. Source: Energy Fuels Nuclear, Inc., Fig. 3-6 in "Investigations of Alternative Tailings Disposal Systems, White Mesa Uranium Project, Blanding, Utah," April 1978.

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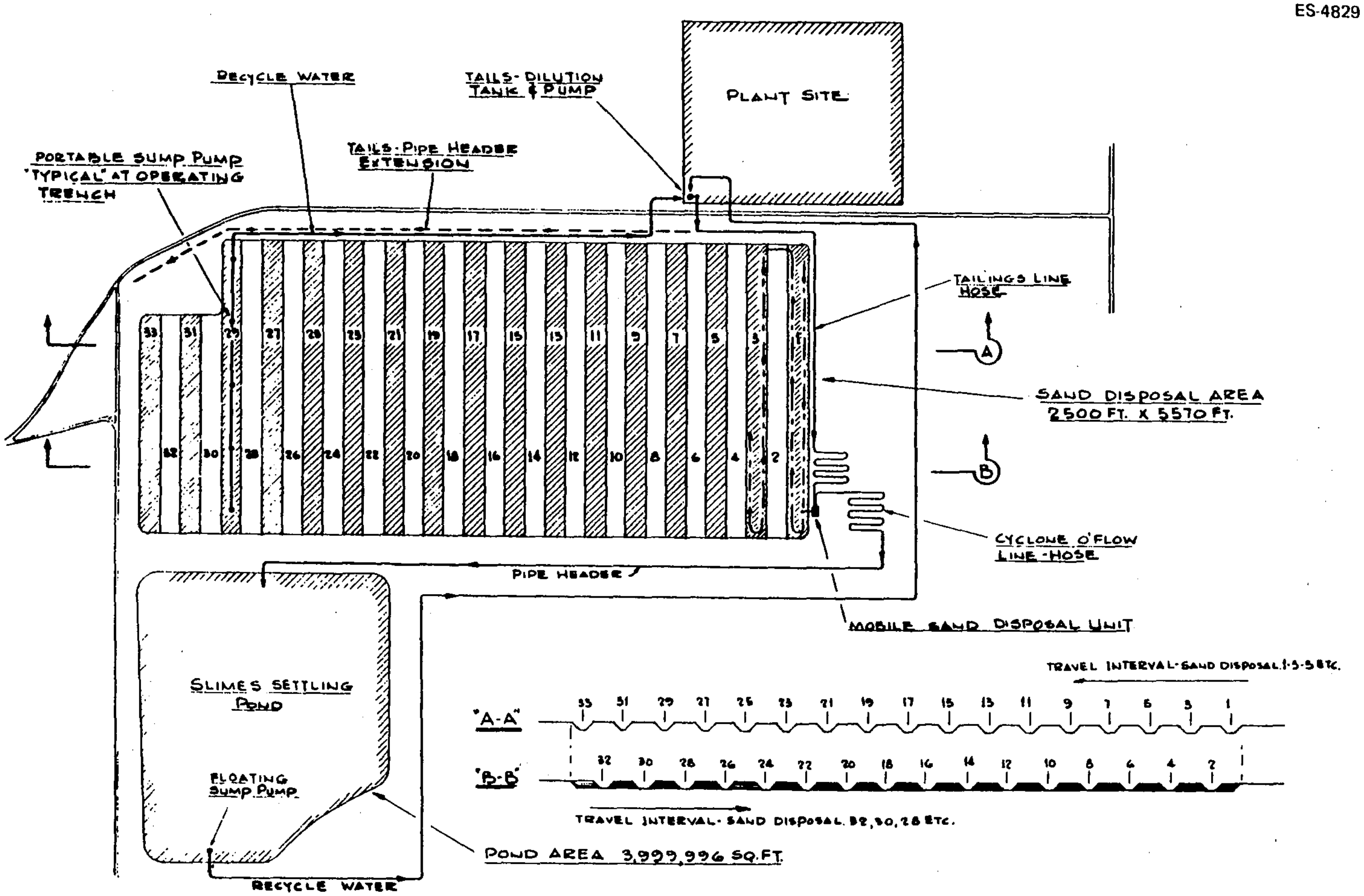

Fig. 10.6. Segregated disposal area — general layout. Source: Energy Fuels Nuclear, Inc., Fig. 3-8 in "Investigations of Alternative Tailings Disposal Systems, White Mesa Uranium Project, Blanding, Utah," April 1978.

The cost of this alternative as estimated by the applicant is a function of the slime-sand separation method and of the slime pond configuration chosen (the increase in costs due to increases in cover material thickness over the dried slimes is not included):

Hydrocyclones only	Hydrocyclones and dewatering screens	Evaporation pond
\$16,720,000	\$16,924,000	Above-grade slimes
\$25,147,000	\$25,350,000	Partially below-grade slimes
\$31,368,000	\$31,571,000	Below-grade slimes
\$16,720,000	\$16,924,000	Above-grade disposal with several small ponds

Alternative 8: Neutralization of tailings

This alternative consists of treating the acidic tailings with various bases to yield a neutral solution. According to ref. 11, pp. 132 and 133, neutralization ". . . causes the precipitation of 90% of the radium, almost all the thorium, and much of the iron, copper, cobalt, arsenic, uranium, vanadium, and other heavy metal ions as insoluble oxides or hydroxides. . . Seepage from neturalized, compacted tailings covered by a pond, or runoff from neutralized tailings, carries very little radium, in contrast to seepage or runoff from unneutralized tailings which may carry dissolved radium."

In Canada, liquid wastes from acid-leach uranium mills are routinely neutralized prior to discharge to natural waterways. Neutralization reportedly requires about 7.3 kg (16 lb) of limestone ($CaCO_3$) and 4.5 to 22 kg (10 to 48 lb) of lime ($Ca[OH]_2$) per ton of ore.[12] A theoretical value of 15.6 MT (34.4 tons) per day of lime for an 1800 MT (2000 tons) per day mill has been reported.[11] The White Mesa Uranium Project would be processing approximately 1800 MT (2000 tons) of ore per day for 340 days per year; therefore, neutralization could require approximately 11,000 MT (12,000 tons) per year of lime [assuming 32 MT (35 tons) per day].

The applicant investigated the possibility of introducing milk of lime into the tailings stream to neutralize the tailings effluent. Neutralization could be applied to any of the tailings disposal alternatives discussed in this section. For alternatives 1, 2, and 6, the applicant estimated that neutralization of the tailings would precipitate about 91 kg (200 lb) of salts (including water of hydration) per ton of tailings. The precipitate would be gelatinous and of low density, and the total volume of tailings would increase slightly. The total capital and operating costs for neutralizing 15 years of mill tailings was estimated to be approximately \$18.55 million (discounted to 1978 dollars) for these alternatives.

The applicant also evaluated the consequences of neutralizing the slimes portion of the tailings produced by segregating the slimes and sands (see Alternative 7). The applicant estimated that approximately 82 kg (180 lb) of salts would be precipitated per ton of tailings, increasing the weight of the slimes and reducing the resulting mixture to approximately 40% solids. The applicant also estimated that to maintain an adequate evaporative rate, the evaporation pond would have to be doubled in size to approximately 73 ha (180 acres). (About 36 ha (90 acres) would be needed for unneutralized slimes.) The total capital and operating costs for neutralization of only the slimes portion of the tailings were estimated to be \$16.34 million, assuming 15 years of mill operation and discounted to 1978 dollars.

10.3.3 Evaluation of alternatives

Alternative 1 is the preferred alternative of the applicant and the staff. The tailings would be stored in the head end of a natural basin and below the ridges bounding that basin on all but the southern (open) end. Although the cover is only partially below these ridges (approximately 5 of the 12.5 ft of cover), the final grade on the reclaimed impoundment is slight (<2%), and the slopes on the perimeter of the cover would be no greater than 6H:1V and would be constructed of riprap. Revegetation of the area and the placement of containment material (riprap or concrete) on all downstream slopes would minimize wind and water erosion. In addition, the small drainage area above the reclaimed tailings area [0.065 km^2 (0.025 mi^2)] obviates concerns over dispersion of cover from flooding which can be a severe problem over the long term. Therefore, the proposed cover meets the performance objectives for reduction of radon exhalation and gamma radiation and should eliminate the need for an ongoing monitoring and maintenance program. The segmented impoundment design, which allows for staged reclamation, would minimize tailings exposure during operations. Theliners on cell interiors would essentially eliminate seepage.

Storing the tailings below grade (Alternative 2) in a specially dug pit would minimize long-term wind and water erosion of the reclaimed tailings impoundment. In addition, the proposed cover (same as for Alternative 1) would meet the radon exhalation and gamma radiation criteria. However, to provide sufficient pit capacity to contain both the tailings and cover completely below grade, significant amounts of bedrock would have to be excavated by blasting, which could fracture the bedrock increasing its permeability substantially. Because the water table is only 15 to 23 m (50 to 75 ft) below the surface and the pit would be deep (7.6 to 9.2 m (25 to 30 ft)), any failure of a liner could result in liquid wastes reaching the water table through these fractures. In addition, the cost of this excavation could be prohibitive.

Alternative 3 involves dewatering the tailings. The major disadvantages for this dewatering alternative as proposed by the applicant are that the tailings themselves would be partially above grade and susceptible to long-term wind and water erosion following reclamation and that the success of filtration, which depends greatly upon the amenability of the ores to the method chosen for filtration, would be questionable because of the variability of the ores. Also, the clayey-silt liner proposed for the evaporation pond has not been shown to be capable of reducing seepage to the maximum extent reasonably achievable.

Alternative 4 involves solidification of tailings. Although this could be environmentally attractive, the technology is not well established, and at present, the costs far outweigh any benefits that might accrue.

Alternative 5 consists of conventional above-grade dam and pond systems. The reclaimed impoundment area would be highly susceptible to wind and water erosion and would not eliminate the need for ongoing monitoring and maintenance over the long term. In addition, the proposed clayey-silt liner has not been shown to be capable of reducing seepage to the maximum extent reasonably achievable.

Alternative 6 consists of discharging the tailings slurry into a segmented, above-grade settling pond and transferring the tailings liquids to an enclosed, above-grade evaporation pond. The reclaimed impoundment would be susceptible to erosion over the long term. Also the proposed liner has not been shown to be capable of reducing seepage to the maximum extent reasonably achievable.

Alternative 7 involves the segregation of tailings sands from the slimes and liquids and disposal of the sands in unlined trenches and storage of the slimes/liquids in clay- or synthetic-lined impoundments. The slimes ponds would be either above grade, partially below grade, or below grade. The proposed alternative would result in above-grade systems that would be highly susceptible to erosion. Also, the cover over the slimes might not reduce radon exhalation to two times background.

Neutralization of the entire tailings (Alternative 8) might partially eliminate the need for a liner which is needed to prevent seepage, however, it has not been shown capable of retarding the movement of anions in the tailings. Neutralization of the slimes produced after segregation of sands from slimes (Alternative 7) or neutralization of dewatered tailings (Alternatives 3 or 6) would appear to be the most effective programs. However, the supplemental costs for neutralization would be high, and are not considered to be justified at the present time by the benefits gained at the White Mesa site.

For all of the alternatives considered, the applicant would be required to implement an interim stabilization program to minimize the blowing of tailings to the maximum extent reasonably achievable.

Based on the above discussion and evaluation of alternatives, the staff believes that the tailings management plan described under Alternative 1 is the best plan for the White Mesa site when considered in terms of both the staff's performance objectives (Sect. 10.3.1) and economic factors. This alternative represents the most environmentally sound, reliable, and reasonable method of tailings management for the proposed White Mesa site using existing commercial technology. It should be noted that the choice of the preferred alternative is based on present standards and existing technologies. However, if the final Generic Environmental Impact Statement on Uranium Milling and associated regulations show that modification of the chosen alternative is necessary, the plan will be changed accordingly.

10.3.4 Alternatives considered and rejected

Table 10.1 lists some of the additional alternatives considered and rejected.

Table 10.1. Alternatives considered and rejected

Alternative	Reason for rejection
Precipitate radioactive and toxic elements to bottom of the tailings pond and consider top of tailings as cover	Technology is not developed (would require a selectively permeable bottom liner)
Install drains below pond to collect and discharge to a local waterway	Technology is not available to allow seepage water treatment sufficient to attain water that is environmentally and legally acceptable for release
Offsite disposal in mines	Control of transportation, unloading, storage, and placement of the wastes in the many small mines as well as monitoring and control of radon gas emissions, particulate emissions, groundwater contamination, and other detrimental impacts would be very difficult (Sect. 10.1.1)
Covering of the tailings with a synthetic liner material such as concrete, asphalt, or PVC plastic to reduce radon emanation	Additional overburden and topsoil would be required to reduce gamma radiation to the natural background level, to prevent plant root penetration into the tailings, and to minimize erosion problems. The cost of the cap would be excessive, compared to cost of the soil the liner would replace. The integrity of the liner could not be guaranteed over the long-term due to the effects of freezing and thawing cycles, settlement of the tailings, and possible chemical attack by the tailings
Transport of tailings to currently active tailings impoundments	The environmental hazards and the costs of mitigating the adverse impacts associated with tailings disposal would only be shifted from the Blanding area to another location. The closest active disposal areas are located in Moab and LaSal. Neither impoundment is capable of holding the design output of the proposed mill. Additionally, transport of tailings would incur risks of accidents, dispersal of tailings, and exposure to workers and others along the transport route

10.4 ALTERNATIVE OF USING AN EXISTING MILL

The option of utilizing existing ore processing mills requires the evaluation of numerous factors, including (1) the method and distance of mine-to-mill transport, (2) variations in ore grade, (3) quality of haul roads, (4) total tonnage to be transported, (5) haulage schedules, (6) traffic and weather conditions, (7) possible interim transfer and storage costs, (8) handling and milling costs, and (9) environmental costs and benefits.

The nearest currently operating uranium ore processing facilities (in relationship to the applicant's Hanksville and Blanding ore buying stations) are located in Moab, Utah; La Sal, Utah; and Uravan, Colorado. The approximate highway distances of these mills from the Hanksville and Blanding stations are, respectively, Moab, 189 km (118 miles) and 134 km (84 miles); La Sal, 243 km (152 miles) and 74 km (46 miles); and Uravan, 339 km (212 miles) and 170 km (106 miles).

Although the mill located in La Sal (Humeca) is reasonably close to the Blanding ore buying station, it would have drawbacks as an ore processing alternative for the following reasons:

1. The Humeca mill utilizes an alkaline leach process. Although tests conducted by the applicant indicated that some of the ores bought by its ore buying stations could be successfully treated by alkaline leaching, higher recovery rates could be obtained with acid for the majority of the ores. Because most of the ores are low grade (about 0.125%), any significant lowering of recovery rates would decrease the economic feasibility of ore shipment from the scattered, small mining operations.

2. Currently, only ore from a company-owned and company-operated mine is being processed; therefore, it is questionable whether the mill has the capacity, processing capability or the willingness to accept additional ore.

The mills at Moab and Uravan utilize acid leaching (the Moab mill also has an alkaline leach circuit); therefore, with process adjustments, acceptable recovery rates could be obtained. However, primarily because of high haulage costs and the limited capabilities of the mills to process additional ore, the staff has concluded that processing the ores at either or at both of these mills is not feasible. Assuming that (1) transportation costs are 10¢ per ton-mile[6] and (2) the average grade of the ore bought at the applicant's Hanksville and Blanding ore-buying stations will be 0.125%, the staff estimates that, if the ore is shipped to these currently operating mills, costs of producing each pound of U_3O_8 would increase by the following amounts for additional transportation costs alone (i.e., does not include incremental cost for toll milling):

1. Moab mill – $3.20 per pound.

2. Humeca mill (La Sal) – $3.04 per pound.

3. Uravan mill – $7.84 per pound.

Transporting the ores to existing mills could reduce the total land requirements for processing the ores. However, the environmental costs associated with uranium ore processing and tailings disposal would not be decreased and would only be shifted away from the Blanding area to the area of the mill receiving the ore. If the proposed mill is not constructed, there is a high probability that other mills (or expansions in capacity of existing mills) will be proposed in the area to process the ore now programmed for the applicant's mill. If no mills (or expansions) are constructed, a substantial economic base for the Hanksville-Blanding area will be removed because many of the small independent mines would not be economically viable.

10.5 ALTERNATIVE ENERGY SOURCES

10.5.1 Fossil and nuclear fuels

10.5.1.1 Introduction

The use of uranium to fuel reactors for generating electric power is relatively new historically. Coal was the first fuel used in quantity for electrical power generation. Coal use was reduced because of the ready availability and low price of oil and natural gas, which are cleaner burning than coal and easier to use. Uranium fuel is even cleaner (chemically) than oil or gas and at present is less expensive, on a thermal basis, than any other fuel used to generate electric power. The following discussion concerns the relative availability of fuels for power generation over the next 10 to 15 years and a comparison of the health effects of utilizing coal and/or nuclear fuels as energy sources.

10.5.1.2 Overview of U.S. energy usage and availability

According to the *National Energy Plan*, published by the Carter Administration in April 1977, the United States uses more energy to produce goods and services than any other nation and consumes twice as much energy per capita as does West Germany, which has a similar standard of living.[13] In 1975, the United States consumed approximately 71 quadrillion Btu's (71×10^{15}), or 71 quads (q), of energy, with about 93% of this energy being supplied by three fossil fuels: oil, natural gas, and coal.[14] Approximately 75% of our energy needs are suppled by natural gas and oil; however, because domestic supplies of these valuable resources are limited (about 7% of proved reserves are oil and gas), the amount of oil imported from foreign sources has increased, undermining our military and economic security.[14] Table 10.2 illustrates the disparity between availability and usage of energy sources in the United States.

Table 10.2. Reserves and current consumption of energy sources

	Percentage of proven U.S. energy reserves economically recoverable with existing (1975) technology	Percentage of total U.S. energy consumption contributed by each energy resource
Coal	90	18
Oil	3	46
Gas	4	28
Nuclear	3	3
Other	0	5

Source: Tetra Tech, Inc., *Energy Fact Book – 1977*, prepared under the direction of the Director, Navy Energy and National Resources Research and Development Office, April 1977.

Despite concentrated efforts to slow down our consumption of oil and natural gas, increase the usage of coal-burning facilities, and further the utilization of nonconventional energy sources, energy demand forecasts indicate that by the year 2000, approximately 43% of our energy will still be supplied by oil and gas, 21% by coal, and only a small percentage (7%) by solar, geothermal, and oil shale (Table 10.3).[15]

Table 10.3. Forecast of gross energy consumption for 1980, 1985, and 2000

Fuel	1980		1985		2000	
	10^{12} Btu	Percentage of gross	10^{12} Btu	Percentage of gross	10^{12} Btu	Percentage of gross
Coal	17,150	19.7	21,250	20.6	34,750	21.3
Petroleum	41,040	47.1	45,630	44.1	51,200	31.3
Natural gas	20,600	23.6	20,100	19.4	19,600	12.0
Oil shale			870	0.8	5,730	3.5
Nuclear power	4,550	5.2	11,840	11.4	46,080	28.2
Hydropower and geothermal	3,800	4.4	3,850	3.7	6,070	3.7
Totals	87,140	100.0	103,540	100.0	163,430	100.0

Source: U.S. Bureau of Mines, *United States Energy through the Year 2000*, December 1975.

Of the 71 q of energy consumed in the United States in 1975, 20 q consisted of electric energy. An estimated 8.6% of this electric energy was generated using nuclear fuels, but within ten years this percentage is expected to increase to 26%. Coal was used for producing 59% of the electric energy generated by combustion of fossil fuels in 1975; oil and gas produced 20 and 21% respectively. Use of oil and gas to generate electric power has decreased about 10% over the last three years, a reflection of high oil prices and gas unavailability.[16]

Current and projected requirements for electric energy (1970-1985) and relative changes in resources used for generation, as estimated in the *Project Independence* report,[17] are shown in Table 10.4. The evidence available at this time indicates that, of the resources currently used in electric-power generation (coal, uranium, oil, gas, and hydro), coal and uranium must be used to generate an increasing share of U.S. energy needs. The supplies of oil and gas available for electric power generation are decreasing, and the United States does not have sufficient oil and gas reserves to ensure a long-run supply.

Table 10.4. Estimated relative changes in resources to be used for generation of projected electric energy requirements

Fuel resource used	Thermal energy required by years, %			
	1970[a]	1974[b]	1980[b]	1985[c]
Coal	45	45	45	46[c]
Oil and gas	38	34	25	16
Nuclear	2	4[d]	17	26
Hydro, waste, etc.	15	17	13	12
Total quads of energy required	15.6	20	25.5	34

[a] Actual.

[b] Estimated from Federal Energy Administration, *National Energy Outlook*, U.S. Government Printing Office, Washington, D.C., February 1976.

[c] Coal usage must increase 77% by 1985 to attain this level.

[d] Uranium-fueled reactors furnished 9.9% of the total U.S. production in January 1976.

Source: Federal Energy Administration, *Project Independence*, U.S. Government Printing Office, Washington, D.C., November 1974.

With increasing energy demands, both foreign and domestic, expectations are that in the next few decades the prices of oil and and gas will increase rapidly as reserves of these two resources become severely depleted. Because of the time lag between initial extraction and consumption of the resource for energy production (three to five years from mine to generation plant for uranium and coal, five to seven years for construction of a coal generating plant, and seven to ten years for construction of a nuclear generating plant), the exploitation of both coal and uranium resources must be integrated with contemporary energy needs. Although coal and uranium resources are adequate for foreseeable energy needs, major expansion of both uranium- and coal-producing industries will be required, as neither of these industries is considered capable of singly supplying future energy requirements.

The determination of availability of uranium in large enough quantities to fuel the projected nuclear generating capacity (for 1985 and beyond) is currently a matter of study.[18] Results of those studies are given in Appendix B, which includes an estimate of reactor installation through the year 2000 and the relative percentage of total electricity-generating capacity these new installations would represent.

10.5.1.3 Coal production

Congress and the Carter administration have stressed, via passed and proposed legislation, the necessity of future decreases in oil and gas demand to alleviate our dependence on foreign energy sources and to reorient our energy consumption patterns. The *Project Independence* report of November 1974 and the *National Energy Outlook* of February 1976 both proposed that coal production be increased from present levels (approximately 650 million tons per year) to approximately 1.2 billion tons by 1985.[16,17] The major expansion of coal production will likely be in the west (from approximately 92 million tons in 1974 to about 380 million tons in 1985), because of the low sulfur (low air pollutant) content of most western coals. The potential for environmental damage (due to disturbance of generally fragile ecosystems) in the western United States will be increased. Because the major markets for the coal produced will be located hundreds of miles from the western mines, transportation costs will be high, as will the environmental impacts associated with transportation systems. Currently, transportation costs for bringing western coal to the eastern United States account for the major portion of the market price. Also, for a given thermal content, transport facilities for U_3O_8 per year are minimal compared to those for coal because of the much higher energy content of uranium fuel. Approximately 250 tons of U_3O_8 per year are required for a 1000-MW nuclear plant operating at a plant factor of 0.8. Annual western coal requirements for an equivalent 1000-MW coal plant would be more than 3×10^6 tons, or the load capacity of at least one unit-train (100 cars of 100 tons each), per day of plant operation.

10.5.1.4 Uranium fuel production

Estimates presented in the *National Energy Outlook*[16] indicate that 140,000 to 150,000 MWe of nuclear generating capacity will be needed to supply 26% of the total electrical energy used in 1985. The first *Project Independence* report[17] indicated that nuclear capacity could increase to more than 200,000 MWe by 1985. A more recent and lower estimate resulted from lower projections of electricity demand, financial problems experienced by utilities, uncertainty about government policy, and continued siting and licensing problems. The more recent projections of uranium requirements are given in Table 10.5.

Table 10.5. Uranium requirements

MWe operating by 1985	Lifetime U_3O_8 requirements (tons) for specified plant factor	
	0.8	0.6
142,000	960,000	704,000

Source: Federal Energy Administration, *National Energy Outlook*, U.S. Government Printing Office, Washington, D.C., February 1976.

Table 10.6 presents estimates of quantities of uranium available at different recovery cost levels. Assuming reserves recoverable at a forward cost of production up to \$30/lb of U_3O_8, the Department of Energy (DOE) estimated that in January 1978 the total of all variously known categories of uranium resources was approximately 3.48×10^6 tons.[19] An estimated 6.9×10^5 tons of these resources consisted of known reserves; that is, drilling and sampling have established the existence of these deposits beyond reasonable doubt.[19] Approximately 5.2×10^5 tons of U_3O_8 could be recovered from very low grade ore and Chattanooga shale for about \$100/lb and approximately 4×10^9 tons of U_3O_8 from seawater for an estimated cost of between \$300/lb and \$750/lb.[20,21]

Table 10.6. U.S. uranium (U_3O_8) resources

Cost category[a] (\$/lb)	Reserves[b] (tons)	Potential resources (tons)		
		Probable[c]	Possible[d]	Speculative[d]
15	370,000	540,000	490,000	165,000
30	690,000	1,015,000	1,135,000	415,000
50	890,000	1,395,000	1,515,000	565,000

[a] Each cost category includes all lower cost reserves and resources.

[b] Reserves are in known deposits.

[c] Probable resources have not been drilled and sampled as extensively as reserves.

[d] Possible and speculative resources have been estimated by inference from geologic evidence and limited sampling.

Source: Department of Energy, *Statistical Data of the Uranium Industry*, Report GJO-100(78), Jan. 1, 1978.

Historically, resources of uncertain potential have become established at an average rate of 7% per year since 1955.[17] If this rate were to persist over the next decade, total reserves would exceed requirements (1,340,000 tons of reserves vs a maximum 960,000 tons required for lifetime nuclear generating capacity rated at 142,000 MWe) by about 380,000 tons. Assuming no transfer of possible resources into the "probable" category, probable resources would still contain 430,000 tons.

Mill capacity in the United States as of January 1978 was 39,210 tons of ore per day. These mills operated at 79% of capacity in 1977. Uranium oxide output was approximately 14,946 tons, equivalent to about 2.5 lb of U_3O_8 per ton of ore.

A survey of U.S. uranium marketing activity completed by ERDA in May 1977[22] indicated that annual contracted deliveries of U_3O_8 for nuclear-powered electric generation plants (assuming no recycle of plutonium and uranium and 0.20% uranium-235 enrichment plant tails assay until October 1, 1980, 0.25% thereafter) will exceed annual requirements until 1979 (see Fig. 10.8). Contracted imports of U_3O_8 will exceed contracted exports by a considerable margin over the next few years. Through 1990, cumulative contracted imports of U_3O_8 are 47,200 tons (approximately 50% of future contracted imports will come from Canadian sources), compared to 13,500 tons to be exported. Figure 10.7 illustrates total U_3O_8 requirements, domestic deliveries, imports, and exports through 1990.

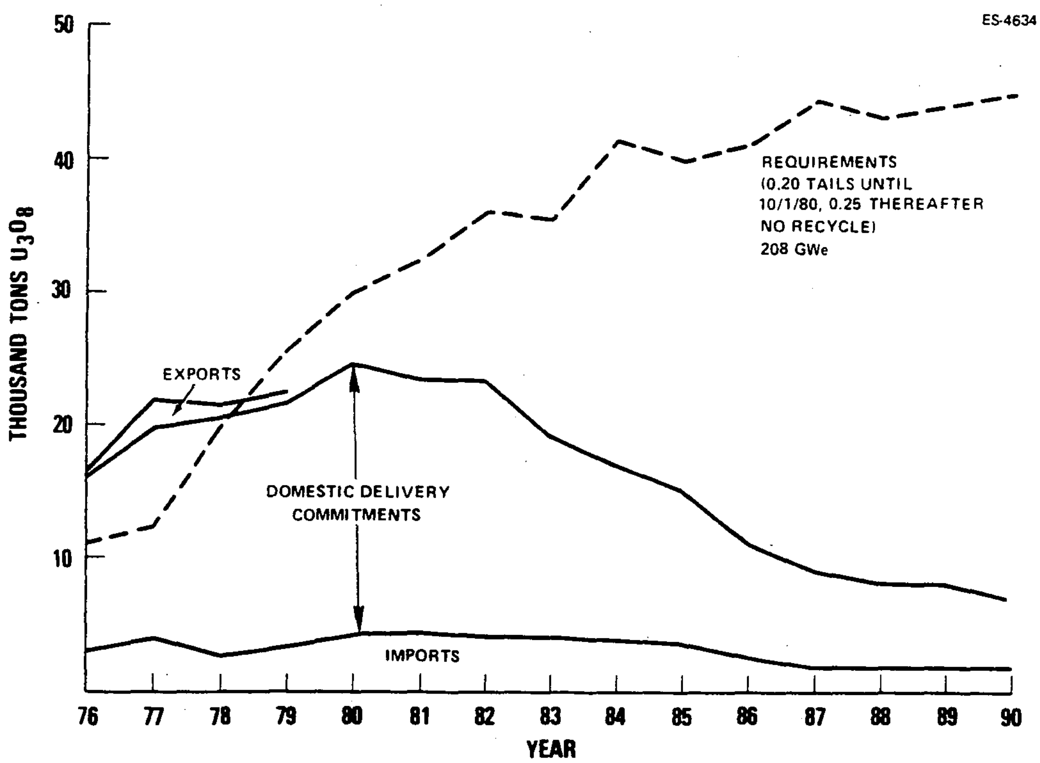

Fig. 10.7. Summary of uranium requirements and delivery commitments as of January 1, 1977. Source: Energy Research and Development Administration, *Survey of United States Uranium Marketing Activity*, Division of Uranium Resources and Enrichment, Office of Assistant Director of Raw Materials, May 1977.

Cumulative U.S. supplies of U_3O_8 (including domestic and foreign inventories and contract commitments) will exceed DOE enrichment feed requirements until 1983. The gap between cumulative supply and cumulative requirements is expected to be approximately 58,000 tons by 1985 and widen to approximately 233,000 tons by 1990 (see Fig. 10.8).

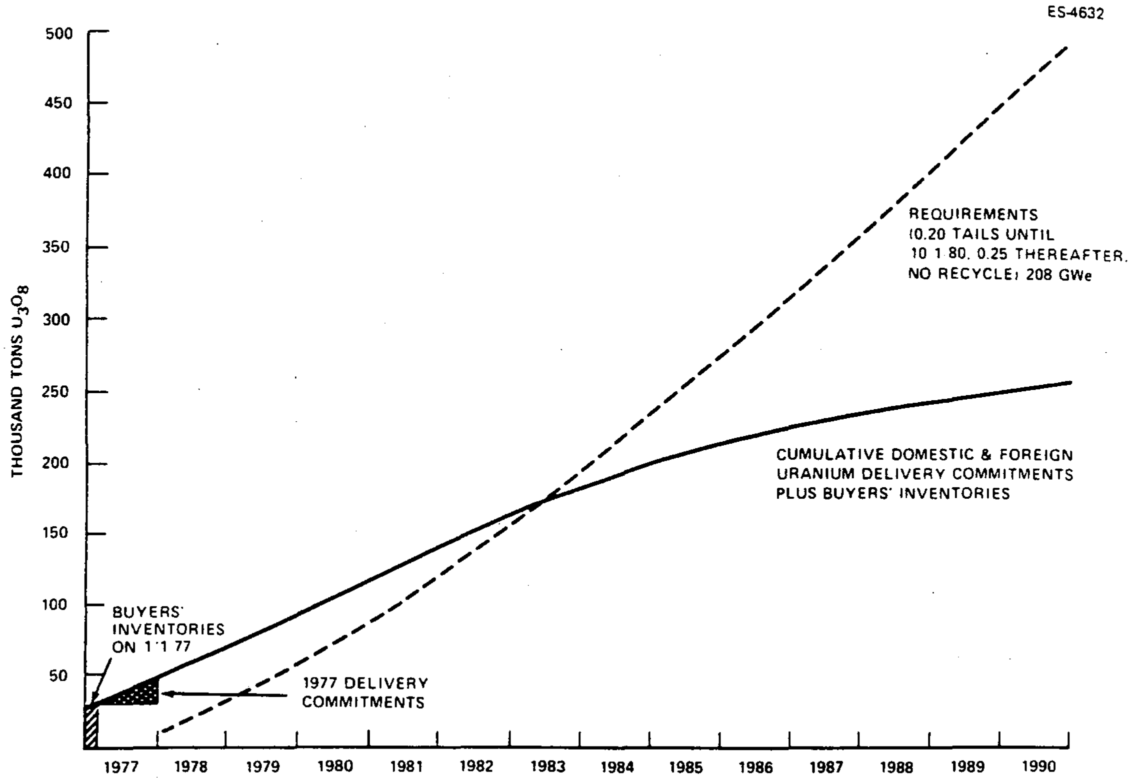

Fig. 10.8. Comparison of U_3O_8 requirements and contracted deliveries plus inventories. Source: Energy Research and Development Administration, *Survey of United States Uranium Marketing Activity*, Division of Uranium Resources and Enrichment, Office of Assistant Director of Raw Materials, May 1977.

10.5.1.5 Comparison of health effects of the uranium fuel cycle and the coal fuel cycle

Research conducted by the U.S. Nuclear Regulatory Commission[23] comparing the health effects associated with the coal fuel cycle (mining, processing, fuel transportation, power generation, and waste disposal) and the uranium fuel cycle (mining, milling, uranium enrichment, fuel preparation, fuel transportation, power generation, irradiated fuel transportation, and waste disposal) indicated that increases in the use of coal for power generation may cause the adverse health impacts related to electric energy production to increase. As defined by the study, health effects are stated in terms of "excess" mortality, morbidity (disease and illness), and injury among occupational workers and the general public, where "excess" implies illness and injury rates higher than normal and premature deaths. The estimated excess deaths per 0.8 gigawatt-year electric [GWyr(e)] (i.e., per 1000 MWe power plant operating at 80% of capacity for one year) were 0.47 for an all-nuclear economy (assumes that all of the electricity used within the nuclear fuel cycle is generated by nuclear power) and 1.1 to 5.4 if all the electricity used in the uranium fuel cycle (primarily for uranium enrichment and reactor operation) came from coal-fired plants. Excess deaths for the entire coal cycle varied from 15 to 120 per 0.8 GWyr(e). Mortality estimates are shown in Table 10.7.

Excess morbidity and injury rates for workers and the general public resulting from normal operations and accidents in an all-nuclear cycle were estimated to be about 14 per 0.8 GWyr(e), with injuries to miners from accidents (falls, cave-ins, and explosions) accounting for ten of these occurrences. If all the electrical power used in the uranium fuel cycle originated from coal-fired plants, these rates would increase to approximately 17-24 per 0.8 GWyr(e). The estimated excess disease and injury rate for the coal cycle was 57-210 per 0.8 GWyr(e). Coal-related illnesses among coal miners and the general public and injuries to miners account for the majority of nonfatal cases. Table 10.8 illustrates these comparative illness and injury rates.

Table 10.7. Current energy source excess mortality summary per year per 0.8-GWyr(e) power plant

	Occupational		General public		Totals
	Accident	Disease	Accident	Disease	
	Nuclear fuel cycle				
All nuclear	0.22[a]	0.14[b]	0.05[c]	0.06[b]	0.47
With 100% of the electricity used in the fuel cycle produced by coal power[d]	0.24–0.25[a,e]	0.14–0.46[b,f]	0.10[c,g]	0.64–4.6[h]	1.1–5.4
	Coal fuel cycle				
Regional population	0.35–0.65[e]	0–7[f]	1.2[g]	13–110[h]	15–120
Ratio of coal to nuclear: 32:260 (all nuclear); 14:22 (with coal power)[i]					

[a]Primarily fatal nonradiological accidents, such as falls, explosions, etc.

[b]Primarily fatal radiogenic cancers and leukemias from normal operations at mines, mills, power plants and reprocessing plants.

[c]Primarily fatal transportation accidents (Table S-4, 10 CFR Part 51) and serious nuclear accidents.

[d]U.S. population for nuclear effects; regional population for coal effects.

[e]Primarily fatal mining accidents, such as cave-ins, fires, explosions, etc.

[f]Primarily coal workers pneumoconiosis and related respiratory diseases leading to respiratory failure.

[g]Primarily members of the general public killed at rail crossings by coal trains.

[h]Primarily respiratory failure among the sick and elderly from combustion products from power plants but includes deaths from waste coal bank fires.

[i]100% of all electricity consumed by the nuclear fuel cycle produced by coal power; amounts to 45 MWe per 0.8 GWyr(e).

Source: R. L. Gotchy, *Health Effects Attributable to Coal and Nuclear Fuel Cycle Alternatives,* Report NUREG-0332, Division of Site Safety and Environmental Analysis, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, September 1977.

Although the adverse health effects related to either the uranium fuel cycle or the coal fuel cycle represent small additional risks to the general public, the study concluded that ". . . the coal fuel cycle may be more harmful to man by factors of 4 to 260 depending on the effect being considered, for an all-nuclear economy, or factors of 3 to 22 with the assumption that all of the electricity used by the uranium fuel cycle comes from coal-powered plants . . ." (ref. 23, p. 13). Additionally, ". . . the impact of transportation of coal is based on firm statistics; this impact alone is greater than the conservative estimates of health effects for the entire uranium fuel cycle (all nuclear economy) and can reasonably be expected to worsen as more coal is shipped over greater distance . . ." (ref. 23, p. 13).

10.5.2 Solar, geothermal, and synthetic fuels

Estimates reported in the *National Energy Outlook*[16] indicate that solar and geothermal sources will each supply about 1% of U.S. energy requirements by 1985 and about 2% by 1990. Supplies of synthetic gas and oil derived from coal will probably not exceed 1% of U.S. energy requirements as of the year 1990. These projections are based on many considerations. The technology exists in all cases but not in a proven, commercially viable manner. The potential for proving these technologies on a commercial scale is great, but timely development will require a favorable market as well as governmental incentives. A maximum of 6% of projected 1990 energy requirements is expected to be derived from solar, geothermal, and synthetic fuel resources combined.

The *National Energy Plan*[13] does not set specific goals for increased use of synthetic fuels or geothermal energy, but does state that, as a possible goal, solar energy will be used in 2.5 million homes by 1985.

Table 10.8. Current energy source summary of excess morbidity and injury per 0.8 GWyr(e) power plant

	Occupational		General public		Totals
	Morbidity	Injury	Morbidity	Injury	
Nuclear fuel cycle					
All nuclear	0.84[a]	12[b]	0.78[c]	0.1[d]	14
With 100% of electricity used by the fuel cycle produced by coal power[e]	1.7–4.1[f]	13–14[b]	1.3–5.3[g]	0.55[h]	17–24
Coal fuel cycle					
Regional population	20–70[f]	17–34[i]	10–100[g]	10[h]	57–210
Ratio of coal to nuclear: 4.1:15 (all nuclear); 3.4:8.8 (with coal power)[j]					

[a]Primarily nonfatal cancers and thyroid nodules.

[b]Primarily nonfatal injuries associated with accidents in uranium mines, such as rock falls, explosions, etc.

[c]Primarily nonfatal cancers, thyroid nodules, genetically related diseases, and nonfatal illnesses following high radiation doses, such as radiation thyroiditis, prodromal vomiting, and temporary sterility.

[d]Transportation-related injuries from Table S-4, 10 CFR Part 51.

[e]U.S. population for nuclear effects; regional population for coal effects.

[f]Primarily nonfatal diseases associated with coal mining, such as coal workers pneumoconiosis, bronchitis, emphysema, etc.

[g]Primarily respiratory diseases among adults and children from sulfur emissions from coal-fired power plants but includes waste coal bank fires.

[h]Primarily injuries to coal miners from cave-ins, fires, explosions, etc.

[i]Primarily nonfatal injuries among members of the general public from collisions with coal trains at railroad crossings.

[j]100% of all electricity consumed by the nuclear fuel cycle produced by coal power; amounts to 45 MWe per 0.8 GWyr(e).

Source: R. L. Gotchy, *Health Effects Attributable to Coal and Nuclear Fuel Cycle Alternatives*, Report NUREG-0332, Division of Site Safety and Environmental Analysis, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, September 1977.

10.5.3 By-product uranium

Uranium recoverable as a by-product of phosphate fertilizer and copper production is estimated to be 140,000 tons through the year 2000.[19] These reserves are in addition to the 690,000 tons of $30 uranium available from conventional mining and milling sources.

The following is noted in a report by the National Academy of Sciences:[24]

> Like all by-product commodities, by-product uranium is entirely dependent upon production of the primary commodity, is limited in amount by the level of production of the primary commodity, and is unresponsive to the demand for uranium. By-product uranium could be obtained from the mining of phosphate, copper, and lignite.
>
> Much phosphate is treated with sulfuric acid to produce fertilizer and goes through a phosphoric acid step. Uranium in the phosphate can be recovered from the phosphoric acid. . . . It has been estimated that about 2500 ST U_3O_8 per year could be recovered from Florida phosphate mined for fertilizer.
>
> The Bureau of Mines studied the sulfuric acid leaching of low-grade dumps at 14 porphyry copper mines and concluded that about 750 ST U_3O_8 per year could be recovered. This would be recovered from rocks whose uranium content ranges from 1 to 12 ppm.

The Bureau of Mines thought that other porphyry copper deposits might also be possible sources of by-product uranium.

The staff has studied available data on the potential of uranium production from phosphate fertilizer production[25] and from copper dump leaching, and estimates that production could reach 3000 to 5000 MT (4000-6000 tons) per year from phosphoric acid extraction and 400 to 900 MT (500-1000 tons) per year from copper dump leaching.[25,26] Much effort has been expended to determine the amounts of uranium that might be recovered from coal and lignite. Some uranium was recovered from lignite ash in the early 1960s, but the lignite itself was not a suitable fuel for the process; supplementary fuel was needed for the necessary conversion to ash. No uranium has been recovered as a by-product from the ash of coal- or lignite-fired power plants. Ash samples continue to be analyzed for uranium, but to date no ash containing more than 20 ppm U_3O_8 has been found, and most ash samples contain from 1 to 10 ppm U_3O_8.[26]

10.5.4 Energy conservation

The cornerstone of the *National Energy Plan* is conservation, the cleanest and cheapest source of new energy supply.

> If vigorous conservation measures are not undertaken and present trends continue, energy demand is projected to increase by more than 30% between now [1977] and 1985.[13]

The *National Energy Plan* lists the following consuming segments as being prime targets for energy conservation:

1. transportation,
2. buildings, including residences,
3. appliances,
4. industrial fuel use, and
5. industries and utilities using cogeneration of electricity and low-grade heat.

Part of the *National Energy Plan* will be the utilization of all possible governmental means (tax reduction, incentives, direct subsidy, and legislation and regulation) to change the past relationship between energy production and use of energy requirements in the United States where energy usage is two times higher per capita than in other industrial countries for energy consumption and production and energy use.

The *National Energy Plan* clearly states that both coal and nuclear electrical generation facilities will be needed to meet estimates of U.S. energy requirements through the year 2000, even if the conservation goals of the *Plan* are met. The relative amounts of each energy source used will depend on economic and regional environmental considerations.

10.6 ALTERNATIVE OF NO LICENSING ACTION

Among the alternative actions available to the NRC is the denial of a Source Material License to the applicant. Classifications of source materials are discussed in 10 CFR Part 40.13(b); these classifications are based on Section 62 of the Atomic Energy Act of 1954, which specifically exempts "unbeneficiated ore" from control. Under these regulations Energy Fuels could mine the ore but could not process it, should the NRC deny the Source Material License.

Exercise by the NRC of this option would thus leave the applicant with three possible courses of action: (a) mine the ore and have it processed at an existing mill possessing a Source Material License; (b) postpone the project while attempting to remove the objections that led to the denial of the license; or (c) abandon the project. Alternative (a) has been discussed in Sect. 10.4. Alternative (b) is essentially the applicant's proposal (merely shifted in time), which is the subject of this Statement. Alternative (c), therefore, is the only alternative discussed herein.

If the applicant were not awarded a Source Material License, the uranium concentrate it intends to produce would not become available for use as fuel in nuclear reactors in as timely a manner. The relationship of electrical energy produced by nuclear reactors to the total U.S. energy requirements has been discussed in Sect. 10.5.

The yellow cake produced by the White Mesa mill will contribute to the worldwide supply of uranium which will be used as fuel in nuclear reactors that are either operating or under construction in the United States or abroad. As was stated in Section 10.5.1.4, contracted imports of U_3O_8 will exceed contracted exports over the next few years. Lack of fuel would require those reactors short of fuel to reduce their output and could conceivably result in the shutdown of some of them.

The applicant has indicated the effects of losses of local and regional economic benefits that would occur if the White Mesa mill were not licensed and has also pointed out the environmental costs that would not be incurred should no license be issued. Overall, the benefits accruing from the mill outweigh the costs.

REFERENCES FOR SECTION 10

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2. R. C. Merritt, *The Extractive Metallurgy of Uranium*, Colorado School of Mines Research Institute, Golden, Colo., 1971.

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23. R. L. Gotchy, *Health Effects Attributable to Coal and Nuclear Fuel Cycle Alternatives*, Report NUREG-0332, Division of Site Safety and Environmental Analysis, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, September 1977.

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11. NRC BENEFIT-COST SUMMARY FOR THE WHITE MESA URANIUM PROJECT

11.1 GENERAL

Implicit in the decision of a utility to construct a nuclear power plant is that the uranium needed to fuel the reactor is available (Appendix B). For each application to the NRC for a permit to construct a nuclear power plant, an Environmental Statement is prepared which includes a review of the availability of uranium resources. The uranium to be produced by the White Mesa mill is among the total U.S. resources considered to be available to the commercial market for reactor fuel; thus, the uranium from this mill is needed to meet the demands of the nuclear power industry. In the Environmental Statement, the benefits (the electrical energy produced) of the nuclear plant are weighed against the economic and environmental costs, including a prorated share of the environmental costs of the uranium fuel cycle. These incremental impacts in the fuel cycle are justified in terms of the benefits of energy generation. However, because these costs and benefits are not localized, it is appropriate to review the specific site-related benefits and costs for an individual fuel cycle facility such as the White Mesa mill.

11.2 QUANTIFIABLE ECONOMIC IMPACTS

Section 4 of this Environmental Statement treats the quantifiable economic impacts for the White Mesa Uranium Project. On the one hand, many monetary benefits accrue to the community from the presence of the mill — for example, local expenditures of construction and operating funds and payments of State and local taxes. Against these monetary benefits are the monetary costs to the different communities involved — for example, costs for new or expanded schools and other community services. It is not possible to arrive at an exact numerical balance between the benefits and costs for any one community unit or for the mill because the distribution of revenues to support services may not be timely or completely consistent with those geographical locations where impacts occur.

11.3 THE BENEFIT-COST SUMMARY

As stated in Sect. 11.1, the benefit-cost summary for a fuel cycle facility such as the White Mesa Uranium Project rests on a comparison between the societal benefit of an assured U_3O_8 supply (ultimately providing electrical energy) and local environmental costs for which there are no directly related compensations. For the White Mesa mill, these uncompensated environmental costs are basically two: radiological impact and disturbance of the land. As shown in Sect. 4.7, the radiological impact of the White Mesa mill is acceptable by current standards. The disturbance of the land, as shown in Sect. 4.2, is a long-term impact that is judged to be small in comparison to alternative uses the land may support in the future.

11.4 STAFF ASSESSMENT

The staff has concluded that the adverse environmental impacts and costs are such that use of the mitigative measures suggested by the applicant and the regulatory agencies involved would reduce to acceptable levels the short- and long-term adverse environmental impacts and costs associated with the project.

The White Mesa Uranium Project, along with other energy-related projects in the area, will create a short-term stress on the political and social systems (including housing and schools) of the area. The quantity of total tax money appears to the staff to be adequate but the distribution may not be (see Sect. 11.2). This aspect of the project is currently receiving attention by the institutions directly concerned, and mitigation appears possible.

As was shown in section 10.5.1.4, U.S. requirements for U_3O_8 will exceed production capability for the next few years. Although the applicant may export the uranium derived from the U_3O_8 produced at the White Mesa Mill, the United States is a net importer of uranium and failure to license the proposed project would only result in the foreign demand being filled by other domestic/foreign mills that could be producing uranium for consumption in the United States.

In considering the energy value of the U_3O_8 produced, minimal radiological impacts, minimal long-term disturbance of land, and mitigable nature of the impacts of growth on the local communities, the staff has concluded that the overall benefit-cost balance for the White Mesa Uranium Project is favorable, and the indicated action is that of licensing.

Appendix A

COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT AND NRC STAFF RESPONSES

Appendix A

COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT AND NRC STAFF RESPONSES

In this appendix, the letters of comment on the Draft Environmental Statement pertaining to the White Mesa Uranium Project are reproduced in full. The staff responses are printed conveniently close to each comment. Specific comments and responses are keyed by numbers in the margins of the letters and at the beginnings of the corresponding responses. In addition, changes in the text have been made where needed.

Letters of comment were received from the following:

U.S. Department of the Interior
U.S. Environmental Protection Agency, Region VIII
Advisory Council on Historic Preservation
U.S. Department of Health, Education, and Welfare
Department of the Army, Corps of Engineers
U.S. Department of Agriculture, Soil Conservation Service
Federal Energy Regulatory Commission
U.S. Department of Agriculture, Science and Education Administration
U.S. Department of Transportation, U.S. Coast Guard
State of Utah, Department of Social Services
State of Utah, Department of Development Services
Utah Department of Employment Security
William A. Lochstet
R. W. Berg
City of Blanding
City of Monticello
San Juan School District
San Juan Center for Higher Education
College of Eastern Utah
Church of Jesus Christ of Latter Day Saints
Jim Dandy, Navajo Indian Tribe
Councilman, White Mesa Ute Tribe
Chamber of Commerce of Monticello, Utah
A. W. Egbert
John Mitchell, Wasatch Financial Corp.
Tom Redd, Wasatch Financial Corp.
E. A. Black
Zelma Acton
Calisbee Black
Earl E. Stevens
Phil B. Acton
E. Brent Redd, Abajo Petroleum, Inc.
Jim H. Acton
City Council of Monticello, Utah
Kay R. Johnson, JTN Insurance, Inc.
Robert E. and Joan Hosler, Thin Bear Indian Arts, Inc.

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

In Reply Refer To:
EGS-ER-78/1222
Mail Stop 760

FEB 14 1979

Mr. Ross A. Scarano
Uranium Mill Licensing Section
Division of Fuel Cycle and
Material Safety
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Scarano:

This is in response to your letter of December 15 requesting the Department of the Interior's comments on the draft environmental statement for operation of the White Mesa Uranium Project, San Juan County, Utah.

We find that the draft statement is incomplete in its treatment of cultural and recreational resources, and that a fuller discussion of the infrastructure of the local communities together with the potential impacts, including financial burdens, on these communities is warranted. Further discussion of the impact of the project on recoverability of mineral resources other than uranium is also desirable.

The statement should deal more adequately with the availability of ground water and with potential contamination of water resources, especially with regard to the long-term stability of mill tailings.

GENERAL COMMENTS

The draft statement does not adequately discuss project impacts to archeological resources, and the compliance with historic preservation laws and regulations is incomplete.

RESPONSES

A. Sections 2.5.2 and 4.2.2 have been revised and Appendix E has been included concerning the currently identified cultural resources and the mitigatory actions that will be taken.

Although at least 78 archeological sites have been identified in the project area by field survey and preliminary testing, there is no indication that the eligibility of the sites for the National Register of Historic Places, either individually or as a district, has been determined pursuant to 36 CFR 63, nor that consultation with the Advisory Council on Historic Preservation required by 36 CFR 800 has taken place. These steps should be completed prior to preparation of the final environmental statement. As the statement recognizes (p. 4-4), "a precise statement of impacts is not possible," since further consultations are needed to prepare an appropriate avoidance/mitigation plan and conclude the Memorandum of Agreement. When this is done, the statement should be revised to discuss both the specific mitigation measures that have been agreed to and the extent and severity of remaining unavoidable adverse impacts to archeological resources.

B The discussion of alternative mill sites concludes that on the basis of socioeconomic and transportation impacts there are "no better" alternative sites in southeastern Utah (p. 10-2, par. 2). It appears, however, that alternative sites have not been evaluated on the basis of impacts to environmental and cultural resources. In view of the density of archeological sites on and in the vicinity of the project area, as well as the amount of land disturbance required to construct the mill and tailings ponds, we recommend further study to identify alternative locations with lower densities of archeological sites and thus lesser impacts to these resources. Any analysis of such sites should be included in the final statement.

C We are concerned that the statement does not adequately recognize the effect of population increases on recreation resources and facilities in the project area, particularly in the community of Blanding. There is no discussion of the facilities in or capacity of the four public parks in Blanding, but simply the statement that the facilities are "adequate" (p. 4-7). Although these may be adequate for the present population, it is not clear whether the facilities could accommodate a population increase of nearly 50 percent. Moreover, in view of the projected $1.5 to $2 million increase in local government costs and the apparent shortfall in tax revenues (pp. 4-19 and 20), the conclusion that "the impacted communities will be able to provide services for the expected population influx without long-range fiscal difficulties" appears unwarranted.

B. Modifications to the applicant's proposed tailings impoundment plan (Sect. 3.2.4.7) will result in impacts to a smaller land area. The staff also agrees with the Utah State Historic Preservation Officer (SHPO), Appendix A, p. A-35, that archaeological resources would not result in the choice of another of the alternative sites in this case.

C. A detailed listing of present and proposed recreational facilities in the communities of Blanding, Monticello, and Bluff has been added to Sect. 2.4.2.1. In light of the planned expansion of local facilities in Blanding and Monticello, where the bulk of plant-induced in-migration is expected, and the abundance of nearby Federal and State recreation areas (Table 2.7), the staff judgment that current and projected populations can be adequately served appears to be justified.

Regarding the provision of other public services and their associated costs, Sect. 4.8.2.2 discusses the capability of present and planned facilities to accommodate anticipated growth in the communities surrounding the proposed White Mesa mill. As stated there, Blanding is planning to expand water and sewer facilities to accommodate expected plant-induced population growth, and Monticello is working on improvements to their water supply, sewage treatment, and electricity distribution systems, an effort also aimed at accommodating growth. The capital for these improvements is expected to come from a variety of sources, with Federal and State funds significantly bolstering the local contribution.

The $1.5 to $2 million annual operating costs cited earlier will be met by a variety of sources; the combination of property and sales taxes with the utility's operating income and other revenues is expected to balance needed expenditures, supporting the staff's original contention that the provision of services should not entail long-range financial difficulties.

D The final statement should analyze the capacity of existing facilities to accommodate projected population increases, recognize the adverse effects resulting from any inadequacy of capacity, and discuss what action will be taken by the Nuclear Regulatory Commission and the project sponsor to assure the provision of adequate recreation facilities. In particular, we urge that the project sponsor explore with local officials and the Utah Outdoor Recreation Agency various means of providing aid for the development of needed recreation facilities.

E Known mineral resources in the millsite vicinity include uranium-vanadium, coal, copper, and sand and gravel. These resources are discussed in general and it is pointed out that seven petroleum test wells drilled about 4 miles west of the site were dry. We believe, however, that more might be said about the possible commitment of mineral resources under the tailings area because commitment of the 450 or so acres required for this use is virtually permanent. Thus, in addition to the general statement in section 2.7.2.1 (p. 2-36), something should be said as to whether or not any exploration or evaluation has been done to determine the possible loss of resources under the proposed tailings areas. A map showing proposed or existing mining operations that would supply this mill would be helpful in identifying the need for the project.

SPECIFIC COMMENTS

1 Page 2-5, fig. 2.1: The map indicates that the highway that would receive much of the heavy truck traffic provides access to the Natural Bridge National Monument. The impact on access to the Monument should be assessed in section 4.8.5 (p. 4-21).

2 Pages 2-7 to 14, sec. 2.4.2: Under social economic profile it is difficult to grasp the current situation. Existing capacities for water, sewer, and other components of the infrastructure should be described.

RESPONSES

D. The response to the previous comment outlined the capacity of existing and planned recreational facilities to accommodate projected local population growth. Continuing company cooperation with local communities as evidenced by housing planning (Sect. 4.8.6) is expected in the future.

E. Potentially commercial coal occurs locally only in the Dakota Formation. No coal is evident in the local [0.8 to 2.4 km (0.5 to 1.5 miles)] outcrops or has been observed during well drilling on the site. Uranium-vanadium deposits could occur in the Morrison Formation at depths of 70 to 280 m (230 to 920 ft) at the site. If deposits are present, underground mining would be required and the tailings area would not preclude this. Oil exploration and possible production would not be affected because top casing would be set below the tailings or offset drilling techniques could be used.

1. A discussion of the impact of heavy truck traffic along Utah Highway 95 on the Natural Bridges National Monument has been added to Sect. 4.8.6.

2. Section 2.4.2 provides a profile of the social, economic, and transportation systems of the mill impact area, including a description of the various public services provided in the communities of Blanding, Monticello, and Bluff. It is the staff's judgment that the treatment given therein to water, sewer, power, waste disposal, public safety, health, and educational systems provides a clear and accurate picture of the local infrastructure.

3. Pages 2-16 to 17, sec. 2.5.1.2: The discussion of farmlands should indicate that no unique or prime farmlands exist in the area.

4. Page 2-17, sec. 2.5.2.2: In the discussion of scenic areas Visual Resource Management ratings should be included.

5. Page 2-32, sec. 2.6.2: Two of the onsite wells are located in the area of the proposed tailings impoundment and it is stated that these wells would be capped. We suggest that to protect the aquifer(s) properly and to avoid the possibility of future problems in monitoring and contamination control, the wells in the tailings impoundment area should be thoroughly plugged both in and below the uppermost impermeable layer below the base of the tailings and above the aquifer(s). Otherwise, deterioration of the abandoned wells surrounded by tailings could furnish ready avenues for the movement of pollutants into the aquifer(s). If, on the other hand, plans include future use of the wells--for example, for monitoring--the statement should describe precautions to ensure the continued integrity of the casings.

6. Page 3-12, par. 2: Despite the assertion that the "tailings would be stored completely below grade" (p. 10-19, par. 1), this is not clear from the description of the dike construction in chapter 3. Embankment height at the lowest point in the swale is given as 30 feet and from the description and figure 3.7 it appears that this would be 30 feet above the natural ground. A better description of the tailings grade in relation to natural grade and the dike farthest downstream would be helpful.

7. Page 3-14, sec. 3.3.2: The source of cover material for the tailings area should be described. As this area will probably need extensive reclamation, we recommend a discussion of this topic.

8. Page 4-1: The project area is close to major recreation areas where visual impacts are of great concern. A discussion of impacts on visibility from emissions would be appropriate.

9. Page 4-3, sec. 4.2.1.1: How long will the 1,480 acres be disturbed?

10. Page 4-5, sec. 4.3.2.2: What is the permeability or estimated life of the liner for the tailings ponds?

RESPONSES

3. A discussion of this issue has been added to Sect. 2.5.1.2.

4. The U.S. Bureau of Land Management's Visual Resource Inventory evaluates an area's scenic quality based on land form, vegetation, water, color, influence, scarcity, and cultural modification. According to these criteria, the proposed mill site itself does not rank as an outstanding scenic area, receiving a "Class C" rating, as shown below.

Score (Circle Appropriate Level)

		High	Medium	Low	Rationale or Explanation
1	Landform	5	3	1	flat topography
2	Vegetation	5	3	1	little diversity
3	Water	5	3	0	none
4	Color	5	3	1	relatively uniform
5	Influence	5	3	0	unaffected
6	Scarcity	6	2	1	common
7	Cultural Modification	2	0	-4	modified for grazing

Scenic Quality Classification

Class A	19-33
Class B	12-18
Class C	11 or Less

SQRU Final Rating

Subtotal ____ + ____ + 0 = Total 0 = C (A, B, or C)

5. The section has been revised to state that the two wells will be completely plugged.

6. Sections 3.2.4.7 and 10.3 (Alternative 1) have been revised to clarify the description of the proposed system. The tailings area will be constructed in a natural swale with each cell being excavated to provide additional depth. Each retention embankment will be constructed across the excavated cell with the final embankment matching the level of the adjacent natural ground that creates the ridges along the edges of the swale. Therefore, the embankments will only be as high as the undisturbed ground adjacent to the tailings cell. The maximum embankment heights will vary from 7.6 to 13.0 m (25 to 42 ft), depending on the individual cell. The last embankment will be constructed with a 6:1 downstream slope and will be constructed of riprap for long-term stability.

Each tailings cell will be filled to a level 1.5 m (5 ft) below the top of the embankment and the adjacent ground and will be covered with a sufficient amount of cover to reduce the radon emanation to twice background. This cover will create a slight rise where the swale formerly existed to gently drain waters away from the reclaimed tailings area while minimizing erosion of the cover material.

7. The silt-sand, rock, and topsoil are available from cell excavation and the onsite borrow area shown in Fig. 3.4. Clay for cell linings and cover will probably be removed from Brushy Basin outcrops on Westwater Creek Canyon. These barren, heavily dissected outcrops will lose no potential use from clay removal. No reclamation is required because they presently support no vegetation.

8. A discussion of impacts of visibility from emissions has been added to the text.

9. The total project site [599 ha (1480 acres)] will not be disturbed by project activities. As stated in Sects. 4.2.1.1 and 4.2.1.2, about 196 ha (484 acres) will be disturbed by construction and operation of the mill facility. A realistic estimate of the minimum amount of time the land will be disturbed is about 20 years. Note that the reclaimed tailings area will not be available for unrestricted use.

(11) Page 4-6, sec. 4.6.1: Which deer herd is affected?

(12) Page 4-7, par. 3: This paragraph does not adequately describe the impacts of the project on mule deer use of the project site as discussed on page 2-42 (par. 6). Deer use of the area will be influenced by factors other than just noise. Approximately 358 ha occupied by the mill, mill facilities, tailings area, and roads will not be available for use by deer. How much of the total project site, or specific facilities within the site, will be fenced and what are the patterns of human use of the facilities that will influence the daily movement and use of the area by deer? We recommend that the applicant fence as little of the total area as possible by limiting fencing to areas where required for specific safety or other operational requirements. We also recommend that the applicant, during construction and operation of the project, coordinate with the Utah Division of Wildlife Resources concerning ways to mitigate any impacts to deer that may develop during this time.

(13) Page 4-7, par. 4: The discussion concerning the quantity of tailings water (28 ha) that may impact wildlife is in conflict with the discussions of the proposed tailings system on page 3-13. There, figures concerning the surface acreage of tailings water that may be present at one time range from 33.2 ha to 100 ha. What is the maximum surface acreage of tailings liquid that would be present at any one time that might serve as an attraction to waterfowl or shorebirds?

(14) Page 4-13, sec. 4.7.6: The paragraphs on occupational health are somewhat limited. Discussion of followup on employee health might be included, both here and in section 6.6.

(15) Page 4-17, sec. 4.8.2.2, par. 1: It is mentioned that the town of Blanding has adequate water and sewer facilities for 300 new residents. However, even in a good year, water must be watched very carefully. During a drought season their water supply has been down to less than a two-week supply. Monticello has similar problems.

(16) Page 4-18, sec. 4.8.2.3: What is meant by "a large portion of the population"? Figures are available to determine the percentage of various groups.

RESPONSES

10. No long-term data on service life is available. No deterioration during the mill operating lifetime is expected, and because final reclamation is under drained conditions, no long-term problems should occur. If properly installed, permeabilities less that 10^{-9} cm per second are expected.

11. The deer herd under consideration is part of Utah's Division of Wildlife Resources herd unit 31-A (San Juan-Blue Mountain). As discussed in Sect. 2.9.1.2, deer migrate through the vicinity of the site to Murphy Point (Fig. 2.5) to winter. Daily movement during winter periods by deer inhabiting the area has also been observed between Westwater Creek and Murphy Point (Fig. 2.5).

12. Although about 154 ha (383 acres) for the mill facility and tailings impoundment will be fenced, an additional 40 ha (98 acres) will be disturbed as a result of stockpiles and borrow areas. As stated in Sect. 4.2.1.2, a total of about 195 ha (484 acres) would be disturbed. In addition to these direct impacts as a result of habitat disturbance and human activities at the site, the deer may be further impacted as discussed in paragraph 5, page 4-7. Greater human population associated with construction and operation of the mill can result in greater hunting pressure (both legally and illegally) and destruction of habitat by off-road recreational vehicles. Although the staff does not expect the movements of deer across Highway 163 to be influenced, increased wildlife losses are expected to occur as a result of greater vehicular travel. The applicant will be required by license condition to consult and coordinate with the Utah Division of Wildlife Resources regarding extent of fencing and other ways to mitigate any adverse impacts to deer that may occur.

13. The staff estimates that the 40-ha (98-acre) area of the evaporation cells may be required. Because the moist tailings also provide evaporation surface, the total area of the evaporation ponds may not be required.

14. The section has been modified slightly to clarify that maximum radiation exposures for both mine and mill workers have been set by regulatory agencies to protect the workers from undue risks and that protection measures to reduce occupational dose are reviewed and revised to keep radiation exposures as low as reasonably achievable.

Because doses to occupational workers are measured and maintained below occupational dose limits, no increase in discussion is warranted in the FES.

15. Although water scarcity is indeed a reality in southeastern Utah, information supplied by the Blanding city manager indicates the ability of existing facilities to accommodate 300 additional residents. Growth of a greater magnitude, however, is contingent upon planned improvements in the water supply system (Sect. 4.8.2.2).

16. A quantification of Mormon and Native American populations in San Juan County has been added to Sect. 4.8.2.3.

(17) Page 4-21, par. 1: It is concluded that the project can be accomplished "without long-range financial difficulties" for the local communities. Actual experience in similar situations, particularly Carbon and Emery Counties, indicates that there have been substantial lags between needed tax revenues and demand for housing and public services. Since these lags have resulted in significant impacts on the affected communities, we suggest further analysis of this issue.

(18) Page 6-3, par. 3: Further explanation should be provided in this paragraph as to how "potentially harmful amounts of radionuclides and other contaminants in the tailings impoundment" amount to insignificant impacts to wildlife (waterfowl and shorebirds). We fully support the need for a monitoring program to detect any adverse impacts of the tailings impoundment on waterfowl and shorebirds. Of particular importance would be to note the behavior of the birds using the impoundment. Is there any indication of sluggish flight or difficulty in taking off once birds have landed on the pond(s)? Does there seem to be an increase in preening activity? We recommend that at the first sign of any problems (behavioral changes or mortalities) the applicant should immediately notify the Utah Division of Wildlife and the Fish and Wildlife Service so appropriate mitigative measures can be pursued.

(19) Also, the possibility of any impact to public health as a result of radionuclides or other contaminates entering the human food chain (waterfowl) should be discussed in this paragraph. This would be a function of the length of use of the ponds by the birds, the mechanism of their contamination, and the probability of their being harvested. These items should be discussed in this paragraph and in section 4.6.1 (p. 4-6).

(20) Page 9-1: The statement should give a better concept of the characteristics and water-bearing properties of the Navajo Sandstone aquifer. Yield and drawdown or specific capacity information for the Blanding site well in the Navajo Sandstone aquifer should be given, if no aquifer test has been made; such information would permit at least quantitative assessment of ground-water impacts. The basis for the assertion in section 9.2.1 concerning the large amount of water available in the Navajo Sandstone aquifer of the project area should be indicated. The environmental report

RESPONSES

17. Sections 4.8.2.1 and 4.8.2.2 describe planned expansions of the housing stock and various public services designed to accommodate projected growth in the impact area. This apparent readiness for mill-induced population growth indicates a likelihood that the adverse impacts experienced in Emery and Carbon counties will be avoided here. As stated in Sect. 4.8.6, a strong defense against such impacts lies in making sure that planned improvements are made before growth occurs. An explanation of how needed expenditures are expected to be balanced by future revenues, thus avoiding long-range financial difficulties, is found in the response to general comment "C" above.

18. Although no data exist on the use of uranium mill tailings ponds by migratory waterfowl, the staff does not anticipate that contact with the tailings will result in increased mortality. The salinity of the tailings liquid (mostly sulfate) is in excess of 100,000 ppm, which makes it unpalatable for drinking by any species. The effective acid concentration (0.016 molar) is too low to cause physical damage but is expected to result in sufficient irritation to the skin of the feet and legs of waterfowl that they will not spend extensive periods of time on the tailings pond. Consequently, exposure time is not expected to be sufficient for waterfowl to contract high body burdens of radionuclides and toxic chemicals from the tailings. In addition, the acidic nature of the tailings will preclude the growth of aquatic plants and invertebrates used as food by most waterfowl, making it unlikely that other consumer organisms (including man) will be exposed to significant levels of radionuclides through the ingestion of waterfowl exposed to tailings. The staff is unaware of data that document the impacts to waterfowl from exposure to uranium mill tailings. The staff does not expect that anything but an occasional landing will be observed but requires that the applicant observe any use by waterfowl and maintain a record of such observations to confirm that this is true.

19. No potential effects on human health are expected because no sustained ingestion of the saline water by birds is credible. See response to comment 18.

20. The staff contacted the USGS, Water Resources Division, Utah District. For the Four Corners area, the range of Navajo characteristics were as follow:

Coefficient of transmissivity (gpd/ft^2)	450-3800
Coefficient of storage	~0.005
Specific capacity (gpm/ft drawdown)	0.74-3.24

The city of Blanding has completed one well in the Navajo about 11 km (7 miles) north of the site. Static water level was 152 m (500 ft); the well produces 200 gpm (309 acre-ft per year) with 122 m (400 ft) of drawdown. Other Blanding wells are completed in the Entrada.

The staff estimates that, at the site, both the Entrada and Navajo aquifers contain about 25,000 acre-ft/sq mile (formation thickness times 0.25 effective porosity). Most usage in the area is from the Entrada. Even without recharge, the staff considers the impacts minimal in the low population density region.

for the project asserts (p. 2-120) that in 1977 development of the deeper aquifers of the Entrada Sandstone and the Navajo Sandstone was progressing near Blanding and Monticello, Utah. Because of the proximity of the town of Blanding, the aquifer(s) utilized by the municipal wells should be identified. The statement should also indicate whether wells on the Ute Indian Reservation tap the Navajo Sandstone aquifer. The following references may be useful in considering the properties of the aquifer in the general area.

(1) Irwin, James H., 1966, Geology and availability of ground water on the Ute Mountain Indian Reservation, Colorado and New Mexico: U.S. Geological Survey Water-Supply Paper 1576-G.

(2) Cooley, M. E., Harshbarger, J. W., Akers, J. P., and Hardt, W. F.1969, Regional geohydrology of the Navajo and Hopi Indian Reservations, Arizona, New Mexico and Utah: U.S. Geological Survey Professional Paper 529-A.

Thank you for the opportunity to comment.

Sincerely,

Larry E. Meierotto
Deputy Assistant SECRETARY

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VIII
1860 LINCOLN STREET
DENVER COLORADO 80295

MAR 16 1979
REF: 8AH-WM

Leland C. Rouse, Chief
Fuel Processing & Fabrication Branch
Division of Fuel Cycle and Material Safety
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Rouse:

We have completed reviewing your Agency's recently-issued Draft Environmental Statement (DES) on the White Mesa Uranium Project (NUREG-0494). The enclosed final comments do not differ from those previously submitted to you in draft form.

In general, there are no major problems with this document. Overall, EPA's reviewing staff found the DES to be a well-prepared statement which supports the construction and operation of a uranium mill at the proposed location. We are pleased to note that this DES incorporates many of our comments on previous DES's developed by the Commission for other uranium milling projects.

The most positive feature of the proposed project is the plan for the disposal and long-term stabilization of the radioactive residuals. By disposing of these tailings in below ground and lined cells which are to be filled and reclaimed sequentially, any environmental impacts should be minimized.

We are concerned with the proposed sizing of the tailings impoundment cells. This may create situations where insufficient storage volume is available for total evaporation, or there is a lack of reserve volume in the event that a rupture of one cell's dike would breach the next cell's dike. This concern is compounded by our doubt that the filled cells will dry as quickly as indicated due to the minimized seepage through the proposed impoundment lining. Expansion of the tailings disposal area with shallower cells appears more desirable than increasing the individual cell volumes through raised dam height increments.

We concur with your Agency's policy of evaluating the justification for licensing uranium milling projects, in part, with the need for uranium to fuel nuclear power plants that will produce electric power for sale to U.S. consumers. In this regard, we were surprised to learn that the NRC licensed Bear Creek Uranium Mill, owned by the Rocky Mountain Energy Co., has negotiated a large sale of uranium to a Swedish utility. The NRC FES for Bear Creek did not acknowledge such an eventuality nor does the DES for the White Mesa Project describe any foreign sales of its product. To maintain federal credibility we feel that the NRC should strive to give a more accurate account of the marketing of uranium by its licensees. This is particularly important when the question of environmental costs versus the gain of certain benefits are used to justify a given project.

According to the procedures EPA has adopted to rate environmental statements, NUREG-0494 will be listed in the Federal Register as ER-2. This means that EPA has reservations concerning the environmental effects of certain aspects of the proposed action and needs additional data as indicated by the enclosed comments.

We will be glad to discuss these comments if you need further clarification or desire additional guidance on how these can be dealt with in the Final Environmental Statement.

Sincerely,

Alan Merson

Alan Merson
Regional Administrator

EPA REGION VIII

SPECIFIC COMMENTS ON

DRAFT ENVIRONMENTAL STATEMENT (DES)

(NUREG - 0494)

WHITE MESA URANIUM PROJECT

1. Page 1-3, Section 1.5: The DES does not appear to reference NRC's responsibility under the recently enacted "Uranium Mill Tailings Radiation Control Act of 1978". What additional requirements will be stipulated? What changes, if any, in tailings management will result?

2. Page 2-17, Section 2.5.2.3: The Final Environmental Statment (FES) should contain more detailed information on the significance and location of all archaelogical sites. The staff mentions (p. 2-19) that a surface survey was conducted in the Fall, 1978, yet the results of the survey are not presented. Further field investigations and analysis (as suggested by the staff) are needed in order to determine the potential importance of the sites as well as any adverse impacts which may occur from the proposed mill. These results should be presented in the FES.

3. Pages 2-26 thru 29, Table 2.22: The radiological analyses look somewhat suspect. Results for the two replicate samples are not in good agreement. Gross alpha results seem to generally be less than the uranium activity. At location SIR, it is difficult to see how the creek could have enough water for one sample but not enough for the replicate sample. Some of the samples also seem high for background samples.

4. Page 2-30, Figure 2.5: This figure is too cluttered for ease of interpretation. It should only be a schematic showing the intermittent drainages, project boundaries, and sampling locations. The contour lines and other markings should be eliminated.

RESPONSES

1. The last paragraph in Sect. 1.3 has been revised to include a statement that Title II of that act gives the NRC direct licensing authority over uranium mill tailings. (Sect. 1.5 does not appear to be affected.) The proposed tailings management plan for this project is currently considered state of the art, and the act itself should not result in the stipulation of additional technical requirements. The act does require that "reclaimed" land used for tailings storage be deeded to the Federal government and this requirement shall be complied with. The proposed tailings impoundment would be located on lands owned by Energy Fuels Nuclear, Inc., except for small portions which are federally owned.

2. The results of the survey conducted in the fall of 1978 were not reported until January 1979. Additional information has been included in this FES.

3. Admittedly, the replicate samples do not show good agreement, but this is understandable as the samples are replicates with respect to location and not with respect to time. Activity levels and other parameters can vary widely as a function of flow conditions.

   It is true that the gross alpha results are generally less than the uranium activity. However, this is evidently not unique to this work alone. An EPA publication (EPA 906/9-75-002) entitled *Water Quality Impacts of Uranium Mining and Milling Activities in the Grants Mineral Belt, New Mexico*, September 1975, stated the following as two of its study results:

   - The uranium isotopes (uranium-234, -235, and -238) are the main contribution to the gross alpha result; however, in several determinations, gross alpha underestimated the activity present from natural uranium.
   - It is doubtful that the gross alpha determination can even be used as an indicator of the presence of other alpha emitters (e.g., uranium-natural and polonium-210), and because the gross alpha results generally have such large error terms, no meaningful determination of percentage of radionuclide to gross alpha can be implied.

   The adequacy of SIR's sample size to permit a replicate is not known, but because all of the other samples are without replicate, at least one sample was analyzed (although an index of reproducibility was possible).

   Some of the activities do seem high for background values (e.g., radium-226 averages equal 0.03 pCi/liter in North American streams — less than stated values), but statistical fluctuations and local environmental conditions must be considered.

4. The staff considers the level of detail in this figure to be appropriate.

5. Page 2-32, Section 2.6.2: This Section is not very specific on the recharge characteristics of the aquifer underlying the site (Dakota SS).
There should be more detail on possible recharge in the immediate vicinity of the mill. This should include some detail as to the prevalence of fractures and points which would provide avenues of recharge. It would be helpful to also have site specific infiltration data for the soils and underlying bedrock in the vicinity of the proposed tailings ponds. A discussion on the possibility that joints may be open enough to provide a direct path to the ground water would be appropriate.

6. Page 2-33, Figure 2.6: A vertical scale range would be helpful in finding the depth to various units.

7. Page 2-38, Figure 2.9: Since the DES states that uranium deposits are also found in the Chinle, and Cutler formations and they are shown in the stratigraphic section in Figure 2-6, why aren't they represented in Figure 2-9? In addition to describing the lithography of the Chinle and Cutler formations in Figure 2.9, it should show which members of the Morrison formation are potentially uranium bearing.

8. Page 3-1, Section 3.2.2.1: Since the ore will be purchased from diverse sources and will consist of a mixture of differing chararteristics, it is difficult to determine if the proposed milling method is the most environmentally acceptable without additional information about the ore. It is not clear that the sulfuric acid leach circuit is the most acceptable due to the apparent alkalinity of some of the ore.

9. Page 3-6, Section 3.2.3.2.: We concur with the staff that the drainage design should be altered to isolate mill site runoff into a retention pond.

10. Page 3-7, Figure 3.4: The proposed land acquisition shown in Figure 3.4., appears to be much too small. Even with the precautions taken that are described in the text, deposition of airborne contaminants from stacks or resuspension will probably contaminate land beyond the boundaries shown. The size of the buffer zone should be increased.

11. Page 3-11, Section 3.2.4.7: This Section presents data on the composition of the tailings that will be going into the ponds, but there is no estimate on the amount of selenium or arsenic that might be in the material. It is hard to envision that the ore being milled will not contain these two elements. Data on these elements should be included.

RESPONSES

5. The Dakota sandstone on White Mesa has been completely isolated by erosion; consequently, all recharge to this formation comes from precipitation and irrigation on the mesa. No irrigation occurs close to the mill site, and normal annual precipitation is only 30 cm (12 in.) per year, most of which reenters the atmosphere as evapotranspiration (i.e., does not penetrate the soils over the Dakota). The Dakota is the underlying bedrock under the proposed tailings impoundment and has a permeability coefficient from 1.5 to 3 m (5 to 10 ft) pee year (ER, Sect. 2.4.2.1 and Appendix H). Jointing occurs in the formation but is probably not fully penetrating. An aquiclude, the Brushy Basin member of the Morrison Formation, underlies the Dakota sandstone, which accounts for the groundwater retained in the lower portion of the Dakota.

6. Thicknesses of stratigraphic units in the vicinity are shown in Fig. 2.9.

7. Some formations shown in Fig. 2.6 are not shown in Fig. 2.9 because the former is a generalized stratigraphic section showing the freshwater-bearing units of southeast Utah, and Fig. 2.9 is a stratigraphic section showing the rocks exposed in the project vicinity. The oldest unit shown in Fig. 2.9 is the Carmel Formation because this is the oldest rock exposed in the vicinity. The Chinle Formation occurs at an estimated depth of 518 m (1700 ft) and the Cutler Formation at over 975 m (3200 ft) at the project site. If uranium is present in these formations, underground mining would be required.

See DOI comment E regarding the Morrison Formation.

8. Ore samples from the Hanksville and Blanding area were obtained by the applicant from approximately 50 mines that will be shipping ore to the White Mesa mill. Samples from each of the mines were composited on a weighted basis (percentage of mine production) for laboratory testing, which included alkaline and acid-leach studies for comparisons. These studies showed that uranium recoveries were higher by approximately 2% and vanadium recoveries by approximately 50% when acid-leach was used compared to alkaline leaching. This discovery was the basis for the applicant's choice. The staff considers both acid and alkaline milling acceptable. (See Sect. 10.2.1.)

9. All surface runoff from the mill and ore storage sites be impounded onsite in a sedimentation pond.

10. The NRC staff recognizes that operation of the White Mesa Uranium Mill and its tailings impoundment system may result in some offsite low-level contamination of ground surfaces. The levels and impacts of such contamination have been considered in detail in the preparation of the radiological impact evaluation of the proposed project. The results of this evaluation are presented in Sect. 4 7 and include an assessment of compliance with relevant Federal regulations governing offsite contamination. Staff analysis indicates that the project will, if operated in accordance with planned license conditions, fully comply with these regulations. The monitoring program outlined in Section 6 is designed to provide the data necessary to confirm this conclusion.

11. The concentration of ten minor constituents, including arsenic and selenium, have been added to Table 3.1.

12. Page 3-12, Section 3.2.4.7: The thinness of the cover over the synthetic liner raises concern about assuring the integrity of the liner over the life of the project. There is no data as to whether the inflow structures will be designed to insure that the liner is not damaged by the inflow of tailings. Also there is no information on the long term effect of the chemical in the tailings on the liner. There should be some discussion as to the feasibility of implacing a natural clay liner with a permeability of less than 10^{-6} cm/sec. This would be vastly superior to a synthetic liner because it would have integrity for a longer period of time. A clay liner should be required, but if a synthetic liner is used, there should be a thicker cover over the liner (4-6 inches of silt) in the areas where inflow will be occuring.

13. Page 3-12, Section 3.2.4.7: Even if it is believed that the dikes will not saturate, good practice calls for installation of piezometers or soil moisture tubes to monitor dike moisture.

14. Page 3-13, Section 3.2.4.7.: The assumption is made that if a pipeline failure occurs in one cell any tailings loss would be contained. It would seem that this would depend on the scenario selected. A pipeline break such as the United Nuclear-Homestake Partners break, which took out the dike, could conceivably breach all of the completed dikes for the White Mesa system if it occurred on an upstream dike. This presumes that at least one pond is full, that the next pond is partially full, and that the break occurs in the first dike. Since the NRC staff analysis concludes that water evaporation may not proceed as rapidly as the applicant proposes, this problem should be carefully considered in pipeline routing.

15. Page 3-14, Section 3.3.2.: The San Juan River area is a water short area. The arid climate will make revegetation of mill tailings areas difficult, without frequent use of irrigation during the growing season. On page 2-39, the last paragraph, the staff states..."light irrigation may be required to establish native vegetation during reclamation." We do not believe this statement adequately reflects the reclamation effort that would be needed in this area.

16. Page 3-14, Section 3.3.2.: Is the revegetation plan for reclamation of the mill tailings area necessary for long term stability? If so, have revegetation tests been performed that demonstrate successful revegetation?

17. Page 4-3, Section 4.2.2.: The first paragraph is misleading to the reader when considering other information presented in Section 2.5.2.2. The results of the historical survey and recommendations of the Council on Historic Preservation and the State Historic Preservation Officer should be included in the FES.

RESPONSES

12. With the procedures and controls proposed for the installation of the liner in cells 1-I, 1-E, and 2, the staff believes that the impermeable synthetic liner will limit seepage to a very minor quantity, if any.

This statement has not attempted to detail the procedures by which the impoundment will be constructed or the liner placed. However, the applicant has proposed installing a smooth, rut-free surface without protrusions as a liner base to offer protection to the membrane during placement and subsequent use. Following the installation of the liner, a protective soil cover would be placed over the liner, and a maintenance and inspection program for the liner system will be a condition of the license. Note that discharge of tailings directly onto the liner cover will not be permitted. A 2-ft liner of compacted clay has been proposed for cells 3, 4, and 5. A review of tests results for the proposed clay material will be completed prior to system approval to ensure that a permeability of 1×10^{-7} cm/sec can be achieved under the conditions anticipated.

13. Piezometers will be required in the dikes.

14. Section 3.2.4.7 has been revised and should eliminate these concerns. In addition, the slurry and decant lines will pass through a safety containment pipe in the dikes between cells. No failure by erosion is credible under these conditions. Finally, the tailings impoundment system will be monitored at 4-hr intervals.

15. Plummer, Christensen, and Monsen* (1968) have stated that stand establishment in areas with less than 23 cm (9 in.) annual precipitation will not generally succeed without irrigation. The Blanding site, however, receives an average annual precipitation of about 29.7 cm (11.7 in.). In addition, crested wheatgrass pastures already established in this area without irrigation are good evidence that the species suggested for reclamation can be established in the reclaimed areas without irrigation. The statement "light irrigation may be required to establish native vegetation" refers to the germination and initial establishment of the plants. Areas that are irrigated for several years following seeding will undoubtedly produce an excellent plant cover, but it is likely that these plants would be far less able to survive an interruption or cessation of irrigation than those whose growth characteristics reflect the arid characteristics of the site.

The applicant recognizes that complete success should not be expected in nonirrigated plantings. Therefore, light irrigation may be required in the initial establishment stages. Further, the applicant is committed to monitoring and maintaining the reclaimed areas until stand establishment and perpetuation is assured in accordance with the State of Utah Division of Oil, Gas, and Mining, Reclamation Regulation Rule M-10 (Sect. 6.2.2).

16. The revegetation plan for reclamation of the mill tailings area is necessary for long-term stability for several reasons. The roots of the plants help stabilize the soil to reduce wind erosion, and the cover helps break the ground-level wind to reduce wind erosion, reduces raindrop splash and downslope movement of runoff, and adds a yearly increment of organic matter to aid in rebuilding the soil profile.

*A. P. Plummer, D. R. Christensen, and S. B. Monsen, *Restoring Big-Game Range in Utah*. Publication 68-3, Utah Division of Fish and Game, Salt Lake City, 1968.

18. Page 4-5, Section 4.3.2.2: With regard to seepage into ground water after liner deterioration, the recently published ORP/LV-78-8 (Water Movement in Uranium Mill Tailings Profiles) suggests that seepage may continue for the lifetime of the pile. ORP/LV-78-5 (Study of Engineering and Water Management Practices that will Minimize the Infiltration of Precipitation into Trenches Containing Radioactive Waste) also notes that clay liners (and caps) are extremely susceptible to biological damage and should be protected from freezing. Native clay contains substantial portions of non-clay material which diminishes its sealant value.

19. Page 4-5, Section 4.3.2.2: Although the amount of ground water in the White Mesa area (5 mile radius from project site) that is used for domestic, livestock, or agricultural purposes is small, and careful monitoring of this ground water supply will be required (during construction and operation), we believe that NRC should consider additional monitoring requirements of the runoff water from retention ponds. Since the ground water supply is located very close to the surface, there is a potential for ground water contamination in this area. Cultivated crops are located as close as 1 mile north of the project site.

20. Page 4-5, Section 4.3.2.2.: The description of the retention ponds (and catchment basin for potential ruptures of piped tailings) is not adequate as presented in the DES. Mention is made of rock being placed along the dikes of the retention ponds, but what kind of soil or liner will be placed underneath the rock?

21. Page 4-9, Figure 4.1: The ingestion pathway should include wildlife, such as deer.

22. Page 4-12, Table 4.8: The NRC regulation (10 CFR 20) applicable dose limit for the bronchial epithelium is reported in working levels (WL) in this table, but was reported in cumulative working level months (CWLM) in Table 4.6 of Moab DES. This inconsistency is confusing to the reader and make comparisons difficult. The estimated radiation doses to the bronchial epithelium as reported in mrem/yr in this table appear to be too low.

23. Page 4-13, Section 4.7.7.: While probably not of great significance, it seems unlikely that there would be no adverse radiological impact on resident burrowing animals in the tailings areas.

RESPONSES

Revegetation can occur in the project area as evidenced by the past treatments of the land to improve range condition. These treatments have included chaining of sagebrush, plowing the surface, and reseeding with crested wheatgrass (Sect. 2.9.1.1). Covering the disturbed areas with previously stockpiled topsoil and reseeding with "Luna" pubescent wheatgrass, crested wheatgrass, forbs, and shrubs (Table 3.4) will closely replicate these past treatments of the land and should result in successful revegetation, assuming that proper planting time, the addition of appropriate soil amendments (such as nitrogen and possibly irrigation for initial stand establishment), and protection from grazing and other disturbances are provided.

Please note that the staged reclamation plan should provide an opportunity to verify the viability of the proposed cover.

17. Sections 2.5.2 and 4.2.2 have been revised and Appendix E has been included concerning the currently identified cultural resources and the mitigatory actions that will be taken.

18. ORP/LV-78-8 clearly states "under limited rainfall conditions . . . any significant vegetation cover on the tailings pile would use all available precipitation, leaving little or no water to flow below the root zone to greater depths." Because revegetation will occur and because a 3.2-m (10.5-ft) cover (minimum) is proposed over the clay cap to protect it from biological damage and freezing, the staff does not expect significant seepage from the tailings impoundment.

19. Please refer to Fig. 3.4 and Sect. 3.2.3.2. Runoff from the mill site will be impounded on the site. No monitoring of runoff water appears necessary under these conditions.

20. See responses to comments 14 and 19. Tailings impoundment construction and operation are discussed in revised Sects. 3.2.4.7 and 10.3 Alternative 1. Dike construction is shown in Figs. 3.7 and 3.8.

21. The meat ingestion pathway considered as part of the overall radiological impact evaluation implicitly accounts for ingestion of wildlife, although the models and parameter values used are specifically applicable for beef cattle. This is accomplished through the use of conservative occupancy factors, environmental transfer factors, and ingestion rates. With specific regard to the inclusion of deer as part of the ingestion pathway for meat, numerical values in all three of these categories would be reduced, causing a net decrease in the estimated doses from the meat ingestion pathway.

22. The noted change was made to more accurately represent the actual limitation on radon-222 daughter concentrations expressed in 10 CFR Part 20. Similarly, the presentation made in this Statement will continue to be made in future Statements until refinements are considered justifiable. The estimated bronchial epithelium doses were calculated using the models and data provided in Appendix D and have been found to be numerically accurate.

23. The staff agrees that during project operation such animals could receive doses in rems per year, but not sufficient to cause observable effects. After reclamation, considering the cover to be placed over the tailings, the staff considers potential exposures to be extremely small.

24. Page 5-5, Section 5.3.1.: The major toxicity of yellow cake appears to be heavy metal poisoning to the kidney, not radiation damage. A chemical toxicity evaluation of accidental dispersal to the public should be made.

25. Page 5-6, Section 5.3.1.: Yellow cake shipments in congested urban areas appear to be neglected in the accident models. A population density of 160 people per square mile is not an accurate representation of an urban area, where larger traffic volumes and busy intersections increase the likelihood of an accident with a higher population dose potential. An accident model, utilizing specific data for a metropolitan area such as Denver, would be useful in evaluating the most severe accident consequences.

26. Page 5-7, Section 5.3.2.: When considering the likelihood of 7.6 ore truck accidents per year from the Hanksville ore buying station and the economics of hauling low grade ore 163 miles to the White Mesa Project site, it seems appropriate to consider the alternative of hauling the Hanksville ore to the proposed Shooting Canyon Project to be located south of Hanksville.

27. Page 5-8, Section 5.3.3.: Truck shipments of amines and sulfuric acid should be discussed.

28. Page 6-2, Section 6.3.2.: This Section indicates that monitoring wells will be installed near the tailings ponds to detect contaminants if they reach the ground water. By the time any contaminants reach the ground water in a detectable level there would be a fairly large amount of material moving through the unsaturated zone. If the applicant installed one vacuum lysimeters below each pond in the unsaturated zone (5-15 feet below the bottom of the pond), it would be possible to detect leachate movement well before it reached the ground water. If such a device was installed, it would not endanger the integrity of the liner and would allow the applicant to use fewer monitoring wells. The best monitoring well scheme would have one to three wells on the up gradient side of the pond area and three to five wells on the down gradient side. The wells should not penetrate more than 15-30 feet of the formation to minimize the dilution effect caused by sampling a large perforated interval.

RESPONSES

24. The staff recognizes that inhalation of yellow cake dust can cause health effects due to the chemical toxicity of uranium. However, no clinical effects were observed among the individuals who were involved in a recent (September 1977) yellow cake truck accident or in the subsequent clean-up. Also, uranium bioassays of 27 persons who were in the vicinity of the spill (including the law-enforcement and rescue personnel) indicated that physically damaging uranium intake did not occur. The highest reported bioassay being 18.1 μg of uranium/liter of urine.

With respect to radiotoxicity, the critical organ and impact for yellow-cake-uranium inhalation is dependent on the solubility category assumed. If yellow-cake-uranium solubility in human lung fluid is assumed to be Class Y (years), then radiation exposure to lung tissue is critical. That assumption has been made for this analysis following ICRP recommendations. However, recent contractor data indicate varying solubilities for uranium in yellow cake depending on the specific chemical compounds constituting the yellow cake and the calcining temperature. This issue is presently under NRC staff review.

25. The population density used by the staff is considered conservative. Denver has a population density of 5418 people per square mile, and a potential similar accident would calculate to 440 man-rems and 30 man-rems for Models I and II respectively. Effects on exposed individuals would not be more severe than the accident discussed in Sect. 5.3.1.

26. Beside the fact that there is no regulatory basis upon which transfers of ore between competing operators could be required, there is no overwhelming reason from an environmental standpoint why this would be advantageous.

27. This information has been added to the text.

28. For the initial groundwater monitoring program, the applicant plans to install five deep wells completed in and cased down to the Dakota Sandstone aquifer, as well as five shallow wells with monitoring zones in (a) the soil and residuum and (b) fresh rock above the saturated zone. Of these wells, one will be upgradient and four generally downgradient; the remainder will be cross-gradient. The two deep downgradient wells will be operated as pumping wells. The monitoring program will be expanded with the construction of additional tailings cells. The downgradient pumping wells are planned to draw flow from along the edges of the cells to the wells and to decrease flow and contaminant detection times by increasing the hydraulic gradient. A program of mitigation will be initiated if leakage is detected. The monitoring program appears adequate as proposed.

29. Page 6-5, Table 6.1: The following additions to the proposed preoperational monitoring program are recommended:

a) Air Particulate
Expand analytical protocol to include polonium - 210, particulates (weight on filter), and significant trace metals present in the ore (e.g., arsenic and molybdenum).

b) Ground water
The monitoring requirements set forth on page 6-2 implies a greater number of wells for monitoring the tailings disposal area than the six indicated in Table 6.1. This apparent inconsistency should be explained. Due to the confusing parenthetic remark-"from each well", it is not clear how many wells are within 2 kilometers of the tailings disposal area and what the sampling frequency is.

c) Surface Soil
Samples analyzed for lead-210 should also be analyzed for polonium-210 and significant trace metals found in the ore.

d) Stream Sediment
Same comment as for surface soil samples.

30. Page 6-7, Table 6.2: The following additions to the proposed operational monitoring program are recommended:

a) Air Particulate
Consistent with the recommendation for the preoperational monitoring program, analysis of filter samples for polonium -210 (at least semi-annually), particulates (weight on filters), and significant trace metals. Air particulate samplers should be located on the periphery of the active tailings disposal area (one upwind and several downwind) monitor the effectiveness of the interim stabilization program. Sampling should be continuous with filters replaced weekly. Each sample should be analyzed weekly for gross alpha and monthly composition for radium-226.

b) Radon Gas
Samplers should be located on the periphery of the tailings disposal area to quantify emissions from this source. These stations will have to be operated in the post-reclamation period to ensure the effectiveness of the reclamation program.

29. (a) Because of the quarterly compositing of air filters, the value of analyzing for polonium-210 is essentially eliminated because of the relatively high decay of collected polonium over several months. Any polonium-210 present would be due to decay of lead-210. Trace metals are not expected to be transported in significant or accurately measurable amounts in the small quantities of particulates anticipated.

(b) See above response to 28 for a description of the proposed ground water monitoring program. Table 6.1 has been changed appropriately.

(c) and (d) Using reasoning similar to that presented in (a), neither polonium-210 nor trace metals should be sampled in surface soil or sediment.

30. (a) As in the above response to 29(a), analyses of filter samples for polonium-210, particulates (weight on filters), and trace metals are not considered necessary. The monitoring of the interim stabilization program will be closely controlled in accordance with written operation procedures and is considered adequate.

(a) & (b) Monitoring at the periphery of the tailings disposal area is not considered necessary and the use of site boundary air sampling stations should permit the assessment of the radiological effluents to the general population. This is expecially true since the sampling locations will be chosen using the following factors:

- average meteorological conditions (windspeed, wind direction, atmospheric stability);
- prevailing wind direction;
- site boundaries nearest to the mill, ore piles, and tailings piles;
- direction of nearest residence; and
- location of estimated maximum concentration of radioactive material.

c) Ground water
The monitoring requirement set forth on page 6-2 implies a much larger number of wells for monitoring the potential impact of seepage from the tailings disposal area than the four indicated in table 6-2.

(c) See above response to 27(b). Table 6.2 has been changed appropriately.

d) Surface Water
To provide a meaningful comparison with pre-operational data, analysis for total and dissolved concentarations of specific radionuclides should be conducted, not only total concentrations.

(d) This is not considered necessary as comparison of pre- and operational total concentrations is as informative.

e) Stream Sediment
Consistent in the preoperational monitoring program, annual or semi-annual sampling of sediment at the surface water stations should be continued during the operational period.

(e) The staff does not require sediment sampling in the operational monitoring program. Surface-water analysis is as informative.

f) Surface Soil
In addition to the proposed 5 stations, soil collection stations should be established on the periphery of the ore storage pad and the tailings disposal area. Collection should be annually with routine analyses for radium-226 and uranium. Selected samples (10 to 20%) should be analyzed for lead-210, polonium -210, and significant trace metals.

(f) Soil sampling at the periphery of the ore piles or the tailings piles is not considered necessary. With an annual collection frequency and considering the integrative collecting function of soil, the results would probably be inconclusive as to the origin of a radionuclide (e.g., whether or not the radium-226 in a sample from the ore pile periphery includes contributions from the grinding and crushing stack, tailings pile, etc.).

g) Vegetation
For a totally comprehensive monitoring program, on site as well as off site, vegetation should be monitored for radionuclides concentrations. Perhaps, three to five on-site stations with analyses for radium-226 and uranium on all samples, and lead -210, polonium-210, and significant trace metals on selected samples.

(g) The staff does not feel these suggested changes are necessary.

31. Page 10-9, Section 10.3.2.: We concur with the staff that Alternative 1 is the most environmentally sound long term tailings management plan. We are however, concerned with the potential of a sequential cell dike failure causing an uncontrolled tailings release (indicated in earlier comment) and the likelihood of the predicted tailings drying time due to the synthetic liner. The recent EPA publication "Water Movement in Uranium Mill Tailings Profiles" (ORP/LV-78-8) indicates that the tailings may never dry adequately for final stabilization and reclamation action without considerable additional materials and effort. We suggest that a tailings dewatering plan be added to this alternative.

31\. Modifications in the tailings management program proposed by the applicant should obviate these concerns. Tailings deposited in lined cells will be gravity-drained, and the liquids will be pumped back to the evaporation cells (cell 1, Initial and cell 1, Enlargement). The probability of a sequential failure of embankments becomes very small after cell 2 has been filled and reclaimed. In addition, the embankment that forms the final barrier for containment of tailings (at any point in the operating sequence) will be constructed only after review and approval in accordance with Regulatory Guide 3.11.

32. Page 10-24, Section 10.6: This Section states (as in previous DES's) that the uranium production is needed to fuel reactors that produce electric power to U.S. consumers. If this is an important consideration in NRC licensing action, and we feel it should be, it deserves further evaluation. We are becoming increasingly aware of foreign sale of yellow cake that the NRC stated in the specific FES was destined for U.S. energy needs. Since much criticism is being generated by the general public concerning the hazards associated with nuclear power and the unpopular radioactive waste disposal issues (including tailings), misstatements such as the above will further erode public confidence in Federal actions related to nuclear energy.

32\. As was shown in section 10.5.1.4, U.S. requirements for U_3O_8 will exceed production capability for the next few years. Although the applicant may export the uranium derived from the U_3O_8 produced at the White Mesa Mill, the United States is a net importer of uranium and failure to license the proposed project would only result in the foreign demand being filled by other domestic/foreign mills that could be producing uranium for consumption in the United States. Sections 10.5, 10.6 and 11.4 and Appendix B have been modified to better reflect this current situation.

33. Page D-6, Section D.4.1.: In the first paragraph, the reference should be task Group Lung Model.

This section is much to abbreviated for proper evaluation and needs expansion. The rationale for assuming that indoor radon daughter concentration would be 50% of the outdoor radon cloud concentration, should be explained. Since a WLM is based on 170 hours exposure, it should be explained how continuous exposure to 1 WL is equal to 25 WLM per year. We feel that the bronchial epithelium dose conversion factor of 0.625 mrem/yr is not appropriate. A more conservative estimate between this value and the 4 mrem/yr per pci/m^3 estimate in EPA-520/1-76-001 would be more appropriate for NRC licensing action.

34. Page F-2, Section F.2.: Again, the radon emission flux estimates should be more conservative. More conservative (higher) estimates for dry, moist, and saturated tails seems appropriate for NRC licensing action.

35. No specific page: We are increasingly becoming aware of reports of stolen quantities of uranium yellow cake. One such report describes 7,000 lbs. of yellow cake valued at $280,000 which was stolen from a New Mexico mill. Previously it was felt that 55 gallon drums weighing 800 lbs. and valued at $8/lb. (but for which there were no unauthorized buyers) would not be readily stolen. However, in light of the dramatic rise in the price of uranium and availability of further processing plants around the world, it is time to consider increased plant security measures.

RESPONSES

33. This typographical error has been corrected.

The basis for the staff's dose conversion factor for bronchial epithelium exposure due to inhalation of short-lived radon-222 daughters is now detailed in Appendix I.

34. The staff considers the treatment of radon exhalation sufficiently conservative in Appendix F. The conclusion is the result of the following considerations:

- The estimates for radon emissions were based on 100 ha (250 acres) of tailings exposed to radon exhalation. The maximum area of the impoundment (operational tailings and evaporation cells) subject to radon exhalation at any point in the mill lifetime should be no more than 90 ha (222 acres). However, cells 1-I and 1-E are evaporation ponds (p. 3-12) and hence contribute an insignificant amount of radon exhalation. Thus, there would only be a maximum of 50 ha (124 acres) of tailings subject to radon exhalation at any point during the lifetime of the mill. The consideration of the area subject to radon exhalation introduces conservativism into the final radon emission estimates of 5500 Ci/year, 2480 Ci/year, and 30 Ci/year for dry, moist, and saturated tailings respectively.
- The parameter values for the calculation of the radon flux are considered to be reasonable choices in the literature.*,†
- The staff has stipulated additional controls to dusting such as water spray or similar means, which would in turn reduce radon exhalation by increasing the moisture content of the tailings surface.

35. The applicant has provided a description of security measures to prevent theft as follows:

Each barrel of yellow cake produced will be weighed and an identification number stenciled on the side and top of the drum. These weights and numbers will be recorded and filed. Lids will be bolted onto the drum and "sealed." The seal number will also be recorded and filed. The yellow cake packaging room will be locked unless authorized shipments are being made from the room.

Yellow cake that is stored inside the plant area will be in a fenced area (6-ft chain link) that will be within the mill area 6-ft fence with the gate locked unless authorized deliveries or shipments are being made.

The entire mill area will be fenced with a 6-ft chain-link-type fence as indicated above. All gates and entrances to the mill will be kept locked with the exception of the main gate by the administrative office. This latter gate will be under surveillance or locked at all times. Employees will be required to park outside the fence and pass through the main gate on foot.

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*A. B. Tanner, "Radon Migration in the Ground: A Review," in *The Natural Radiation Environment*, J. A. S. Adams and W. M. Lowder, Eds., University of Chicago Press, Chicago, 1965.

†M. B. Sears et al., *Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "as Low as Practicable" Guides – Milling of Uranium Ores*, Report ORNL/TM-4903, vol. 1, Oak Ridge National Laboratory, Oak Ridge, Tenn., May 1975.

Advisory Council On Historic Preservation

1522 K Street NW.
Washington D.C.
20005

RESPONSES

January 17, 1979

Mr. Ross A. Scarano, Section Leader
Uranium Mill Licensing Section
Fuel Processing & Fabrication Branch
Division of Fuel Cycle & Material Safety
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Scarano:

This is in response to your request of December 15, 1978, for comments on the draft environmental statement (DES) for the White Mesa Uranium Project, Utah. We have reviewed the DES and note that the undertaking will affect numerous archeological properties that may be eligible for inclusion in the National Register of Historic Places.

Pursuant to Section 106 of the National Historic Preservation Act of 1966 (16 U.S.C. 470f, as amended, 90 Stat. 1320) Federal agencies must, prior to the approval of the expenditure of any Federal funds or prior to the granting of any license, permit, or other approval for an undertaking, afford the Council an opportunity to comment on the effect of the undertaking upon properties included in or eligible for inclusion in the National Register.

A While we note that the Nuclear Regulatory Commission appears to be implementing steps which will result in compliance with Section 106, until the requirements of Section 106 are met, the Council must consider the DES incomplete in its treatment of historical, archeological, architectural and cultural resources. To remedy this deficiency, the Council will provide, in accordance with its "Procedures for the Protection of Historic and Cultural Properties" (36 CFR Part 800), substantive comments on the effect of the undertaking on these properties.

A. Sections 2.5.2 and 4.2.2 have been revised and Appendix E has been included concerning the currently identified cultural resources and the mitigatory actions that will be taken.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE HFV-2
FOOD AND DRUG ADMINISTRATION
ROCKVILLE, MARYLAND 20857

January 19, 1979

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Director, Division of Fuel Cycle and Material Safety

Dear Sir:

Attached are comments on DEIS (NUREG-0494) related to the operation of White Mesa Uranium Project. These comments pertain to sections not covered by the review of FDA's Bureau of Radiological Health, who submitted their comments in a letter dated January 10, 1979. As the coordinating office, I normally would have asked the Bureau of Radiological Health to incorporate substantive comments of other PHS agencies and/or HEW regional offices into a single set of comments. Having received the Center for Disease Control comments after the Bureau of Radiological Health forwarded their comments, I am attaching CDC's separately for your Department's consideration in dealing with comments received by February 5, 1979, the DEIS comment deadline.

Sincerely yours,

K. E. Taylor

Kenneth E. Taylor, D.V.M.
FDA Environmental Coordinator

Attachment

MEMORANDUM

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL

RESPONSES

TO : Dr. Kenneth E. Taylor
Food & Drug Administration

DATE January 15, 1979

FROM : Chief, Environmental Affairs Group
Environmental Health Services Division/BSS

SUBJECT: USNRC, DES Related to Operation of White Mesa Uranium Project (San Juan County, Utah)

1 Section 3.2.3.2 states: "Storm run-off from the mill, ore storage piles, and ore buying stations will be directed to the interceptor drainage ditch along the eastern margin of the tailings impoundment. The staff recommends that the drainage design be altered to isolate mill site runoff into a retention pond." We agree with the staff recommendation; mill site runoff should be ponded and evaporated if feasible. Sections 4.3.1 and 7.3.1 should incorporate this idea.

Frank S. Lisella, Ph.D.

1. Section 3.2.3.2 has been revised and should clarify that this runoff will be impounded. Sections 4.3.1 and 7.3.1 have also been appropriately modified.

GPO 1977-744-000/8814 REGION NO 4

Please call Brit Allan Storey at (303) 234-4946, an FTS number, to assist you in completing this process.

Sincerely,

Louis S. Wall, Chief
Western Office
Review and Compliance

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
FOOD AND DRUG ADMINISTRATION
ROCKVILLE, MARYLAND 20857

January 10, 1979

DOCKETED
USNRC
JAN 16 1979
NMSS
MAIL SECTION
DOCKET CLERK

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Director, Division of Fuel Cycle and Material Safety

Dear Sir:

Following are comments on the DEIS (NUREG-0494) related to the operation of White Mesa Uranium Project. These comments are related only to the radiological impacts described in the document.

1. Page 4-10 indicates that bone dose (Table 4.8) from ingestion of meat would exceed 40 CFR 190. Reference in document to negotiations to restrict access by grazing cattle would not, in my opinion, constitute a definitive action to allay concerns concerning this potential impact.

2. Occupational doses are discussed for normal operating conditions (p. 4-13). There is no discussion of potential occupational doses under accidental conditions.

3. From calculations in sec.4, bone appears to be the critical organ. However, in discussing the impact of accidents, dose commitments are calculated for the lung, rather than for bone. While it is recognized that bone doses are most likely to occur through the ingestion pathway, I believe that doses to this organ merits discussion under accidental circumstances.

Sincerely yours,

Bernard Shleien

Bernard Shleien, Pharm.D.
Assistant Director for Scientific Affairs
Bureau of Radiological Health

RESPONSES

RESPONSES TO HEW COMMENTS

1. Staff analysis indicates that ingestion of meat grazed in the area immediately south of the site would result in doses in excess of those allowable under 40 CFR Part 190, which becomes enforceable for uranium mills as of December 1980. Should the subject area remain available for grazing as of that date and should further NRC evaluation continue to result in dose estimates above compliance levels, the mill operator would be required to undertake mitigating actions that could conceivably include mill shutdown. However, the primary sources of potentially excessive meat ingestion doses are radium-226 and lead-210 transported in airborne tailings dusts. Due to the progressive nature of the tailings cell construction-fill-reclamation scheme, the available dusting area of dry tailings would be minimal. Thus, actual releases during this time would not be expected to amount to the quantities assumed for this licensing evaluation, and noncompliance with 40 CFR Part 190 would not be anticipated. The NRC staff intends to remain fully cognizant of this particular situation and to fully enforce the limitations on offsite exposure embodied in 40 CFR Part 190.

2. No attempt has been made to quantify the potential occupational doses under accidential conditions because there is no evidence that this information would add to that already provided in Section 4.7.6. That section includes a brief summary of mill exposure data which are required to be reported to the NRC and notes that the combined exposure of an average worker to the radioactive components present (under all conditions) does not exceed 25% of that permitted. That section also notes that protection measures to reduce occupational exposures are periodically reviewed and revised in accordance with the requirement to make such exposures as low as is reasonably achievable.

3. For ingestion pathways, bone doses are critical. However, following an accident situation, food ingestion exposure would be controlled through monitoring and condemnation procedures, if necessary. Therefore, only inhalation exposures are routinely evaluated for accidents.

RESPONSES

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
650 CAPITOL MALL
SACRAMENTO, CALIFORNIA 95814

REPLY TO
ATTENTION OF
SPKED-W

11 January 1979

Mr. Ross A. Scarano
Uranium Mill Licensing Section
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Scarano:

This is in reply to your letter of 15 December 1978 requesting review of the draft environmental statement for the White Mesa Uranium Project near Blanding, Utah. The proposed project is within the area under jurisdiction of Sacramento District, Corps of Engineers, and accordingly, Los Angeles District referred the correspondence to our office for reply.

Corps of Engineers interest in the project is primarily the effect the project would have on flood problems in the area, the relationship of the project to Corps projects and studies, and compliance with Corps regulatory permit programs. We have no comments since the project does not appear to contribute to, or affect, flood problems in the area, does not conflict with Corps flood control projects or plans, and it appears that the project would not require a Section 404 permit under the Clean Water Act (33 USC 1344).

Thank you for the opportunity to review and comment on the proposed project.

Sincerely yours,

for GEORGE C. WEDDELL
Chief, Engineering Division

No response is required.

United States Department of Agriculture | Soil Conservation Service | 4012 Federal Building
125 South State Street
Salt Lake City, UT 84138

RESPONSES

January 19, 1979

Director
Division of Fuel Cycle and Material Safety
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

We have reviewed the December 1978, Draft Environmental Statement, related to the operation of White Mesa Uranium Project by Energy Fuels Nuclear, Inc. This document was identified as Docket No. 40-8681 and was transmitted to us by your December 15, 1978 letter.

The points of consideration where the SCS has interest or expertise have been adquately addressed. We have no specific comments.

John H Schmidt acting
George D. McMillan
State Conservationist

No response is required.

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D.C. 20426

IN REPLY REFER TO:

February 22, 1979

Mr. Ross A. Scarano
Section Leader, Uranium Mill
Licensing Section
Division of Fuel Cycle and
Material Safety
Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Scarano:

I am replying to your request of December 15, 1978 to the Federal Energy Regulatory Commission for comments on the Draft Environmental Impact Statement for the White Mesa Uranium Project. This Draft EIS has been reviewed by appropriate FERC Staff components upon whose independent evaluation this response is based.

The staff concentrates its review of other agencies' environmental impact statements basically on those areas of the electric power, natural gas, and oil pipeline industries for which the Commission has jurisdiction by law, or where staff has special expertise in evaluating environmental impacts involved with the proposed action. It does not appear that there would be any significant impacts in these areas of concern nor serious conflicts with this agency's responsibilities should this action be undertaken.

Thank you for the opportunity to review this statement.

Sincerely,

Jack M. Heinemann
Advisor on Environmental Quality

RESPONSES

No response is required.

RESPONSE:

Section 3.5.1 has been changed.

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:
U.S. COAST GUARD (G-WS/73)
WASHINGTON, D.C. 20590
PHONE: (202) 426-2262

12 April 1979

Mr. Ross A. Scarano
Fuel Processing & Fabrication Branch
Division of Fuel Cycle and Material Safety
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Scarano:

This is in response to your letter of 15 December 1978 forwarding the draft environmental impact statement on the White Mesa Uranium Project for comment.

The concerned operating administrations and staff of the Department of Transportation have reviewed the material, and the Office of Hazardous Materials Regulation has the following comment:

"Section 5.3.1 - First sentence: The Department of Transportation does not classify containers as Type A. This is done by the shipper."

The opportunity to review this draft statement is appreciated.

Sincerely,

W. R. RIEDEL
DOT Coordinator for Water Resources

Social Services

Scott M. Matheson, Governor, State of Utah
Anthony W. Mitchell, Ph.D., Executive Director

January 31, 1979

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: White Mesa Uranium Project
Environmental Impact Statement

Gentlemen:

A review of the above referenced report reveals that questions remain concerning air pollution.

This is explained by the enclosed copies of memoranda from our Bureau of Air Quality.

We will appreciate receiving clarification of these matters.

Sincerely,

Richard C. Hansen

Richard C. Hansen
Associate Deputy Director of Health
Environmental Health Services Branch

RCH:mkh

Enclosure

Division of Health
Environmental Health Services Branch
James D. Close
Deputy Director of Health

150 West North Temple Suite 426
P.O. Box 2500, Salt Lake City, Utah 84110
801 533 6121

An Equal Opportunity Employer

Social Services 533-6108 **Memorandum**

To: File

Date: December 7, 1978

From: Casper A. Nelson

Subject: White Mesa Uranium Mill - Energy Fuels Nuclear, Inc.

EFN, Inc. proposes to construct and operate an acid leach uranium mill and associated facilities for producing yellow cake uranium concentrate and a more limited quantity of vanadium concentrate in San Juan County approximately six miles south of Blanding. San Juan County is classified as Class II area.

The project site is adjacent to an existing buying station which includes a stockpiling area and sampling mill. It is estimated that 250,000 tons of ore will be stockpiled prior to start-up of the mill.

The mill will have a design capacity of 2000 TPD. Operations would be continuous, 340 days per year. Conventional milling methods will be practiced, which includes grinding, two stage leaching, solvent extraction, precipitation and thickening, drying and packaging. Because vanadium is not present in all ore receipts, the vanadium circuit will operate approximately 120 days per year. Vanadium precipitate will be dried and fuzed before packaging.

Ores are being blended and will continue to be blended according to chemical and metallurgical characteristics. Crushed ore will be wet-ground (SAG - semiantogenous grinding) prior to the H_2SO_4 leach. Acid leaching will produce SO_2 and acid mist in sufficient quantity to require covered tanks and demister exhaust fans venting directly to the atmosphere. The leach solution containing the uranium (and vanadium) will go to the solvent extraction section. The barren waste will be pumped to the tailings rejection cells.

An amine-type compound carried in kerosene (organic) is used to absorb the dissolved uranyl ions from the aqueous leach solution. Kerosene (hydrocarbon) vapor is emitted to a limited extent during this solvent extraction and stripping process. It is proposed to vent this vapor to the atmosphere by forced air building ventilation at 6 changes per hour.

Yellow cake (ammonium diurante) is precipitated from the strip solution with ammonia. Yellow cake slurry is to be dewatered in a centrifuge and pumped to a 6' diameter oil fired multiple-hearth dryer (calciner). The dried concentrate is reduced to minus 1/4" size through a hammer mill and packaged in 55 gallon drums for shipment. It is proposed to conduct the drying, crushing and packaging of yellow cake in an isolated, enclosed building with negative pressure to contain and collect (by wet scrubbing) all air borne particles.

The White Mesa Project is currently being evaluated by the appropriate regulatory authorities to ascertain if PSD regulations apply. The applicant must comply with all applicable regulations under the PSD rules, including any required sampling methods to demonstrate performance.

By-product vanadium, when present, will report with the aqueous phase of the solvent extraction process. An amine-type compound carried in kerosene will be used to selectively absorb the vanadium ions from this equeous (raffinate) solution. The organic will be stripped of vanadium with soda ash as an ammonium metavandate precipitate. The slurry is to be filtered, dried in a multiple-hearth furnace,and fuzed to produce black flake (V_2O_5), which is also to be packaged in 55 gallon drums. This operation is to be conducted under conditions like that for preparing yellow cake for market, including wet scrubbing for collection of particulate matter.

Coal will be used as the major fuel for both process steam and space heating, with oil-fired boiler as standby for 30 days per year. It is estimated that the maximum heat input requirement will be 33 X 10^6 BTU's per hour (40 tons coal per day). Fly ash and bottom ash will be sent to the tailings pond. It is proposed that the coal fired boilers be equipped with a cyclone fly ash collector of 90% control efficiency. Due to the small size of the proposed oil-fired boiler (10 X 10^6 BTU/hr) and limited operating time (30 days/year), there is no intent to apply particulate emissions control to this source. EFN, Inc. environmental report indicates that the sulfur content of the coal to be used will be 0.3%, which is about one-half the average sulfur content of Utah coals.

The White Mesa Uranium project includes construction and use of a laboratory. Gaseous fumes emitted from laboratory operations will be small and considering the dilution in the collection stack should be inconsequential.

There will be fugitive particulate emissions resulting from construction activities; wind erosion of stockpiled ore and coal; front end loader handling of ore and coal; wind erosion of a portion of the tailings area; vehicular traffic on unpaved roads.

See notes and calculations on Appendix A sheets and Table 4.1-1 - Gas-Fume-Dust Generation Areas; Table 4.1-2 - Stack Heights and Emission Data.

See pages 6-13 - Environmental Report. Dames and Moore found that maximum ground level concentrations from the dryer and boiler stack were obtained from stable conditions and low wind speeds. Therefore, diffusion calculations should include use of a stable atmosphere (F Stability) and wind speed of 2 meters per second. Terrain fluctuations are slight within 2000 meters of the proposed mill; therefore, terrain probably need not be considered in diffusion calculations.

David Markley, Environmental Coordinator, was contacted by telephone December 6, 1978, relative to need for additional information and clarification of some statements and data in the Permit Application of November 21, 1978. He will confirm replies by letter.

il

Social Services

Memorandum

To: Richard C. Hansen, Associate Deputy Director of Health

Date: January 25, 1979

From: Alvin E. Rickers, Director, Bureau of Air Quality

Subject: White Mesa Uranium Project

The environmental impact statements for the White Mesa Uranium Project prepared by both Dames & More and the Nuclear Regulatory Commissions have been reviewed.

While both statements address air quality in a very general way, there is concern about both documents. The background ambient air quality data from the proposed plant site which are referenced in both documents were obtained by static sampling. This method is not equivalent to the EPA reference method and therefore, the data are subject to question. It is doubtful that such data would be acceptable particularly if it were proposed for use to fulfill the requirements of the Federal Prevention of Significant Deterioration of Air Quality criteria.

il

DSS-30 12/77

UNITED STATES DEPARTMENT OF AGRICULTURE
SCIENCE AND EDUCATION ADMINISTRATION

OFFICE OF THE DEPUTY DIRECTOR FOR
AGRICULTURAL RESEARCH
WASHINGTON, D.C. 20250

Subject: Draft Environmental Statement-White Mesa Uranium Project

To: Ross A. Scarano, Section Leader
U.S. Nuclear Regulatory Commission
Div. of Fuel Cycle & Material Safety
Washington, D.C. 20555

We have reviewed the draft environmental impact statement related to operation of the proposed White Mesa Uranium Project located in San Juan County, Utah.

We have no comments to add to the staff evaluation and recommendations.

We appreciate having the opportunity to review this document.

H. L. Barrows

H. L. BARROWS
Acting Deputy Assistant Administrator

RESPONSES

No response is required.

RESPONSES

STATE OF UTAH

Scott M. Matheson, Governor

DEPARTMENT OF DEVELOPMENT SERVICES

J. Phillip Keene III
Executive Director
104 State Capitol
Salt Lake City, Utah 84114
Telephone: (801) 533-5961

DOCKETED
USNRC

NMSS

January 12, 1979

Mr. Jack Martin
Assistant Director
Fuels Cycle Safety and Licensing
United State Nuclear
Regulatory Commission
7915 Eastern Avenue
Silver Springs, Maryland 20901

RE: White Mesa, San Juan County

Dear Mr. Martin:

The purpose of this letter is to address some additional concerns that the Nuclear Regulatory Commission and the Advisory Council may have concerning the mitigation of cultural resources that are being impacted by the development of a processing plant on White Mesa by Energy Fuels Nuclear.

1 One issue is alternate site location for the mill and tailings. It is our understanding that alternate sites were not considered because of hydrology problems and that because of this, archeological studies were not done of these areas. It is the opinion of our staff that if studies would have been done of the four alternative sites, that a higher or equal degree of density or archeological sites would have been located and more complicated mitigation may have been required.

1. The staff agrees with the comment.

2 A second issue concerns the possibility that this area could be considered as a possible nomination to the National Register of Historic Places as an archeological district. It is our opinion that this information by itself would be insufficient for nomination as a district, it is felt that the total area of White Mesa would have to be looked at to be nominated. The boundaries of this project would be considered artifical and would not take into consideration the natural barriers that would be necessary for a nomination.

2. This opinion was revised by the Utah State Historic Preservation Officer. The White Mesa Archeological District has since been determined to be eligible for inclusion in the National Register of Historic Places.

In summary; the alternative sites, even if there would have been no hydrological problems, would probably have presented a larger problem in the mitigation of cultural resources and that the nomination of the sections of land around the processing plant would probably be unacceptable as an archeological district.

Mr. Jack Martin
January 12, 1979
Page 2

Should you need assistance or clarification, please call or write Wilson G. Martin, Preservation Development Coordinator, Utah State Historical Society, 307 West 200 South, Salt Lake City, Utah 84101, 533-6017.

Sincerely,

J. Phillip Keene III
Executive Director
and
State Historic Preservation Officer

JLD:jr:B746:SA:J-1

RESPONSES

STATE OF UTAH

Scott M. Matheson, Governor

DEPARTMENT OF
DEVELOPMENT SERVICES

J. Phillip Keene III
Executive Director
104 State Capitol
Salt Lake City, Utah 84114
Telephone: (801) 533-5961

January 15, 1979

Mr. Ross A. Scarano
Fuels Cycle Safety and Licensing
United States Nuclear Regulatory
Commission
7915 Eastern Avenue
Silver Springs, Maryland 20901

RE: Comments on Draft EIS Statement, White Mesa Uranium Project

Dear Mr. Scarano:

In response to your request for review of the draft environmental impact statement on the White Mesa Uranium Project, the staff has one general comment and three specific comments concerning the cultural resources and the potential impact on those resources.

In general, perhaps more space could have been allotted for a discussion of the background of archeological impacts and proposed mitigations of those impacts.

Specific comments about the statement are:

(1) 2.5.2.3, pg. 2-19 - The last paragraph should read 45 archeological sites instead of 25 archeological sites.

(2) 2.5.2.3, pg. 2-20 - Chart 2.18 should reflect all 112 sites located. It is realized that the information on all sites was probably not available at the time of the draft, but the new information should be reflected in the final statement.

(3) 4.2.2, pg. 4-4 - Concerning paragraph 3, it is suggested that there should be monitoring of activities at the Mill Sites for subsequent development activities, which we agree with; however, the use of the term Mill Operation suggests that an archeologist be put on the staff to monitor all Mill Operations for the life of the Mill, and we feel this is unnecessary.

1. The text has been changed to the correct number of sites.

2. Table 2.18 has been updated and a footnote added that affected sites are shown in Fig. 3.4.

3. Appendix E has been included and should resolve this comment. The actual monitoring plan will be developed in consultation with the Utah State Historic Preservation Officer.

Mr. Ross A. Scarano
January 15, 1979
Page 2

If you have any questions or concerns, please contact Wilson G. Martin, (801) 533-6017, or James L. Dykman, (801) 533-6000, Utah State Historical Society, 307 West 200 South, Salt Lake City, Utah 84101.

Sincerely,

J. Phillip Keene III
Executive Director
and
State Historic Preservation Officer

JLD:jr:B746:SA:J-1

RESPONSES

January 23, 1979

STATE OF UTAH

Scott M. Matheson, Governor

DEPARTMENT OF DEVELOPMENT SERVICES

Division of State History

Melvin T. Smith, Director
Crane Building, Suite 1000
307 West 2nd South
Salt Lake City, Utah 84101
Telephone (801) 533-5755

Mr. Jack Martin
Assistant Director
Fuels Cycle Safety and Licensing
United States Regulatory Commission
7915 Eastern Avenue
Silver Springs, MD 20901

Dear Mr. Martin:

Several issues have arisen during our discussion of the White Mesa Mill and Tailings Development. We would like to go over those concerns one at a time.

A First, the selection of sites for the location of the mill and tailings. We understand that alternate sites were not considered because of hydrology problems. However, it is the opinion of our staff that if the four alternative sites had been researched for archeological resources, that areas of an equal or higher degree of density would be found since these alternative sites have similar characteristics and the problem of high archeological densities would remain.

B Second, we did not consider nomination of the site as a district at this time. The portion of the property being developed by Energy Fuels Nuclear would of neccessity have to be the boundaries of the district, since sufficient research has not been done for the whole White Mesa area. Under our rules, this would be considered an artifical boundary and would not be an acceptable perimeter for a historic area. Therefore, we have considered the individual sites on an individual basis of eligibility. This criteria would apply regardless of whether it were a district or not, since the sites they have found not eligible would also not be eligible within a historic district.

If you have any questions or concerns, please contact Wilson G. Martin, Preservation Development Coordinator, Utah State Historical Society, 307 West 200 South, Salt Lake City, Utah 84101, (801) 533-6017.

Sincerely,

J. Phillip Keene III
Executive Director
and
State Historic Preservation Officer

WGM:jr/B746SJ

cc: Energy Fuels Nuclear

A. The staff agrees that a consideration of archeological resources would not result in the choice of another of the alternative sites in this case.

B. Pursuant to 36 CFR Part 63.3, the White Mesa Archeological District has been determined to be eligible for inclusion in the National Register of Historic Places.

RESPONSES

JOB SERVICE

Utah Department of Employment Security

. :ott M. Matheson, Governor

A. Barclay Gardner, Administrator

February 2, 1979

U.S. Nuclear Regulatory Commission
Office of Nuclear Material
Safety and Safeguards
Washington, D.C. 20555

Dear Sir:

The staff of the Blanding Job Service Office has been rather deeply involved with the Energy Fuels Nuclear operation from the time it first started in San Juan County. The past, current and, we believe, the future impact of the Energy Fuels program, has been and will continue to be very positive.

Our business is jobs and this is what Energy Fuels is providing, in an area which needs jobs very badly. The draft environmental statement which was issued in December 1978, does not address some socio-economic conditions which relate to the need for jobs. For instance, the November 1978 report from the Utah Department of Social Services lists 555 families containing 2,084 individuals who are receiving public assistance in San Juan County. This does not include individuals who are on medical assistance only. This means that 14.78% of the total county population is receiving public assistance under AFDC or GA categories. This is by far the highest welfare percentage in the entire State of Utah. It is our feeling that the only way to reduce this financial burden and break the dependency cycle is to provide high quality jobs.

A review of the draft statement indicates that Energy Fuels is prepared to do an excellent job with environmental and other community concerns. On the basis of these and other facts, we support the construction and operation of the White Mesa uranium mill and urge you to issue appropriate licenses as soon as possible.

Very truly yours.

Harold J. Lyman, Manager

No response is required.

104 Davey Laboratory
Penn. State University
University Park, Pa
16802

5 February 1979

Director, Division of
Fuel Cycle and Material Safety
U.S. Nuclear Regulatory Commission
Washington, D.C.
20555

Gentlemen:

Enclosed is my analysis of the White Mesa Uranium Project. Please note that the information is my own and not necessarily the opinion of The Pennsylvania State University, which afiliation is given for identification purposes only.

The analysis in the draft does not seem to satisfy NEPA. I would hope that these matters are addressed in the final ES.

Sincerely,

William A. Lochstet

Wm. A. Lochstet

1-41

An Analysis of the Proposed

White Mesa Uranium Project

by

William A. Lochstet

The Pennsylvania State University*

February 1979

The Nuclear Regulatory Commission has attempted to evaluate the environmental impact of the proposed White Mesa Uranium Project (Ref. 1). The long term radiological effects are dismissed by estimating that the radon emissions from the mill tailings will be twice background. Erosion of the abandoned tailings is to be minimized. These efforts will be examined here.

In 1976, Pohl (Ref. 2) pointed out that the thorium-230 in mill tailings decays to radium-226, which in turn decays to radon-222 with a time scale determined by the 8×10^4 year half life of thorium-230. Recently, Kepford (Ref. 3) has shown that the uranium-238 in the mill tailings and in the uranium enrichment tailings, of the gaseous diffusion plants, decays by several steps thru thorium-230 to radon-222, and should be considered. This process operates on a time scale determined by the 4.5×10^9 year half life of uranium-238. These matters

* The opinions and calculations presented here are my own, and not necessarily those of The Pennsylvania State University. My affiliation is given here for identification purposes only.

RESPONSES

The staff has chosen to limit its radiological assessment to an evaluation of the dose to the population within an 80-km radius of the plant integrated over a 50-year period from one year of exposure for the following reasons:

1. The radon dose commitment becomes a very small fraction of the natural background dose beyond 80 km. Table 4.7 of this document shows that the bronchial epithelium population dose within 80 km (132 man-rems per year) is only ~0.25% of the bronchial epithelium population dose from natural background (23,000 man-rems per year).

2. The calculation of the maximum annual dose from one year of exposure integrated over 50 years provide a realistic estimate than can easily be compared to applicable standards and regulations. The staff does not feel that it is realistic or meaningful to consider effects on a time scale of 4.5×10^9 years as proposed by the commentor. It should be noted that the 3.2×10^8 deaths estimated by the commentor over 4.5 billion years is only 0.026 statistical premature deaths per year.

   Also, because the depleted uranium tails from the enrichment process are not necessarily waste and it is a NEPA goal to attain maximum use of depletable resources, we would consider the enrichment tails as a resource. If, however, they are to be considered as waste, the staff believes the reduction factor for radon of 200 to be unrealistic. In fact, we would assign a zero increase of radon above that naturally occurring if the depleted enrichment tails were buried at a depth and erosional environment similar to that of their former place of natural deposit. Without the enrichment tails, the 5.3×10^7 deaths estimated by the commentor over 4.5 billion years is only 0.018 statistical premature deaths per year.

   The Dakota Sandstone underlying the tailings impoundments is about 70 million years old. The staff considers it unlikely that it will erode away in the foreseeable future.

   Recent public hearings before the Atomic Safety and Licensing Board to consider the question of the proper assessment of the impact of radon releases from the nuclear fuel cycle and health effects that can reasonably be assumed associated therewith have supported the staff's position.

   > We believe that to attempt to fix absolute figures for health impacts over hundereds of thousands of years, as Dr. Pohl did, represents pure speculation . . . Our "rule of reason" then, would be to look at absolute figures only for those periods for which reasonable estimates can be made . . . and to accept the notion that effects beyond that time can be adequately quantified by noting that they are "immeasurably small" compared to natural backgrounds.*

*The July 24, 1978, Partial Initial Decision of the Atomic Safety and Licensing Board Authorizing Limited Work Authorization, Black Fox Station, Units 1 and 2.

have been addressed by Dr. R.L. Gotchy of the NRC Staff (Ref. 4). These arguements will be considered in the case of the White Mesa Uranium Project.

The White Mesa mill is expedted to produce 7.3×10^5kg of U_3O_8 per year which for 15 years of operation would yield a total of 1.1×10^7kg (Ref. 1, P. 3-1). Of this total, 9.3×10^6kg would be uranium metal. This is the material shipped away from the mill for isotopic enrichment. The mill is expected to operate at a 94% recovery rate for uranium (Ref.1, P. 3-1). In this case a total of 9.9×10^6kg of uranium will be contained in the ore supplied to the mill. Of this, 5.9×10^5kg of uranium will remain in the mill tailings. With an extraction efficiency of 95% for thorium, (Ref. 1, P. 3-11) these mill tailings will also contain 161 kg of thorium-230, which remains from the total that was in secular equilibrium with the uranium-238 in the ore. Of the uranium shipped away, 7.4×10^6kg will remain as tailings (depleted uranium) from the enrichment process.

The ultimate decay of the 5.9×10^5kg of uranium in the mill tails will produce a total of 8.5×10^{13}curies of radon-222. The decay of the 161 kg of thorium-230 will yield 2.4×10^{10} curies of ~~x~~ radon-222. The decay of the 7.4×10^6kg of depleted uranium from the enrichment process will result in 1.1×10^{15}curies of radon-222.

The NRC goal is to reduce radon emissions to twice background. The actual calculation (Ref. 1, P. 9-) results in an emission rate of 1.4 pCi/m^2sec in an area where the background rate is

RESPONSES

. . . we believe that we have an obligation to assess the effects of today's actions on future generations. We certainly must consider any known effects on our immediate successors as of importance comparable to effects on those now living. When it comes to balancing adverse impacts to those descendants who may follow a million years from now against the benefits to the present generation, we would weight benefits to the present population. The benefits are certain — the impacts hypothetical. The action presently proposed is not one that presents a serious risk to any future generation.*

This evaluation is supported by the draft Generic Environmental Impact Statement on Uranium Milling, NUREG-0511, April 1979. Specifically, refer to Table 5 in the Summary of that document, entitled "Comparison of Continuous Releases of Radon from Uranium Mill Tailings with Other Continuous Radon Releases."

*The July 14, 1978, Partial Initial Decision of the Atomic Safety and Licensing Board, Perkins Nuclear Station, Units 1, 2, and 3.

0.64 pCi/m^2sec. The difference of 0.76 pCi/m^2sec is the excess expected due to the tailings. The area is taken as that of 6 cells of 28 ha each (Ref. 1, P. 10-9) with a total area of 1.68 x $10^6 m^2$. This results in an emission rate of 1.3 x 10^{-6}Ci/sec, or 40 Ci/year. Considering the ratio of thorium to thorium in the tailings and the half lives involved, this results in a total of 1.6 x 10^{10}Ci of radon released to the air, primarily from the decay of uranium-238. This of course assumes that the soil cover remains intact for a period of time longer than the 4.5 x 10^9 year half life of uranium-238. This is not likely.

At present, some recent dry mill tailings piles have two feet of dirt covering. In this case the EPA estimate is that 1/20 of the radon escapes to the air (Ref. 5). The proposed stabilization will have more than this covering. The downstream slope of the ~~first~~ final, southernmost dike is proposed to be 6:1(Ref. 1, P. 10-9). This will not stop erosion. The only question is how long it will be before erosion cuts into the tailings volume. The effects of erosion must be considered over a time span measured by the half life of uranium-238. On this geologic time ~~x~~ scale it is clear that the entire mesa will erode away. The proposed site is bounded on the west by westwater creek where the surface drops away as much as 240 feet in 1/4 mile. Directly east of the site, the surface drops away into corral creek as much as 120 feet in 1/4 to 1/8 of a mile. The difference in releif with Cottonwood Canyon is up to 750 feet (Ref. 1, P. 2-36). The question is how long will it before the entire mesa erodes away. To average over the effects of erosion over long periods of time and possible re-burial it will be assumed that 1/20 of the radon produced in the mill tailings escapes to the atmosphere. It should be noted that this figure represents an average over time and locations. Deteriorization of the stabilization of mill tails piles is recognized by the NRC staff (Ref. 4, P.4), but not discussed in the EIS (Ref. 1). It should be noted that this situation could be mitigated if the mill extracted more of the uranium and thorium, or if the tailings were located elsewhere. It should be noted that trucks will be returning from the mill or ore buying station to the mines in an empty state. These trucks could carry tailings with little additional effort.

At present there is no clear plan for the disposal of the depleted uranium from the isotopic enrichment process. At present such material is located in the eastern part of the country. It is assumed that it will be buried near its present location at some shallow depth. A reduction factor of 1/200 is used here to account for the wetter condition of the ~~xx~~ soil. Thus, of the 1.1×10^{15}Ci of Rn produced by the decay of the enrichment tails, it is estimated that 5.3×10^{12}Ci escape to the atmosphere.

To estimate the health consequences of these releases, it is necessary to determine the population at risk. The population considered here is that of the entire U.S., along with some of the rest of the northern hemisphere. Since it is not possible to predict the U.S. population thousands of years into the future, the present population with its present spatial distribution will be used as a first estimate. The NRC Staff has already done this, assuming a U.S. population of 300 million (Ref. 4, P.3), with the result that the release of one curie of radon-222 from a typical pile will result in a total of 0.56 person-rem to the bronchial epithelium, for the total population. The total doses which result are shown in Table 1. It should be noted that 10 CFR Part 50, Appendix I presents a guideline of $ 1000 per total body person-rem. If this were applied to the bronchial epithelium, the NRC estimate of 1.6×10^{10} Ci released would result in 8.7×10^9 person-rem for a cash estimate of $8700 billion.

The NRC estimate of cancer risk is 22.2 deaths per million person-rem to the bronchial epithelium (Ref. 4, P.7), and is taken from WASH-1400 and Gesmo. Even though this estimate is too low, it will be used here. The results, shown in Table 1, are that the thorium in the mill tails will causex about 15,000 deaths, while the uranium therein will result in 53 million deaths. The depleted uranium will result in 66 million dead. Even the NRC estimate of radon releases will result in 194,000 dead.

These deaths will be accumulated over a very longtime period. The estimate is probably incorrect due to an underestimation of population. There certainly will be health consequences for many years into the future. There is no basis for an arbitrary cutoff at any point in time. In fact the long time period used here is required by footnote 12 of NRDC v. USNRC, 547 F. 2nd 633 (D.C. Cir. 1976), which states in part:

> We note at the outset that this standard is misleading because the toxic life of the wastes under discussion far exceeds the life of the plant being licensed. The environmental effects to be considered are those flowing from reprocessing and passive storage for the full detoxification period.

It is felt that this statement takes precident over statments of the Atomic Safety and Licensing Boards in the Perkins and Black Fox cases.

The comparison of these health impacts to background is totally irrelevant, and contrary to the National Environmental Policy Act of 1969 (NEPA). To carry out a proper cost - benefit analysis, the total costs must be considered, regardless of whether or not it might be possible to statistically detect or measure them. NEPA does not require an environmental assessment of background. It does require an assessment of the activity in question. In this way a proper cost - benefit analysis will be performed. In particular, in Calvert Cliffs Coordinating Committee v. USAEC, 449 F. 2nd 1109 (D.C. Cir., 1971) the court stated:

> We conclude, then that Section 102 of NEPA mandates a particular sort of careful and informed decision - making process and creates judicially enforcable duties..... But if the decision was reached procedurally without individualized consideration and balancing of environmental factors--Conducted fully and in good faith-- it is the responsibility of the courts to reverse.

Thus it is required that the analysis be conducted honestly without ruling out costs procedurally. There is no basis for an arbitrary cutoff in time or in distance from the facility. It is hoped that these issues are addressed in the final environmental statement.

Dose Commitments to Humans due to White Mesa Mill
Table 1

Origin of Radon	Radon generated Curies	Reduction Factor	Population Dose Bronchial Epithelium Person-rem	Deaths
Thorium in Mill Tails	2.4×10^{10}	20	6.7×10^{8}	15,000
Uranium in Mill Tails	8.5×10^{13}	20	2.4×10^{12}	5.3×10^{7}
Uranium in Enrichment Tails	1.1×10^{15}	200	3.0×10^{12}	6.6×10^{7}
Mill Tails NRC Estimate	1.6×10^{10}	none	8.7×10^{9}	1.9×10^{5}

References

1 Draft Environmental Statement related to operation of White Mesa Uranium Project, Energy Fuels Nuclear, Inc., NUREG-0494, Docket No. 40-8681, U.S. Nuclear Regulatory Commission, December 1978

2 R.O. Pohl,"Health Effects of Radon-222 from Uranium Mining",Search,7 (5),345 - 350 (August 1976)

3 Testimony of Dr. Chauncey R. Kepford, "Health Effects Comparison for Coal and Nuclear Power" in the matter of Three Mile Island Unit 2 (Docket # 50 - 320) operating license hearings and portions of transcript related, in which the NRC staff supports Kepford's numbers.

4 Affidavit of R.L. Gotchy, NRC Staff, " Appendix", "Radiological Impact of Radon-222 Releases", U.S. NRC, in the matter of Three Mile Island Unit 2 (Docket # 50 - 320), (January 20, 1978).

5 "Environmental Analysis of the Uranium Fuel Cycle, Part I - Fuel Supply" EPA-520/9-73-003-B, U.S. Environmental Protection Agency, (October 1973).

Energy Fuels Nuclear — White Mesa Uranium Mill
Blanding, So. Juan County, Utah
DOCKET # 40-8681

February 5, '79

Dear Gentlemen, Ladies

I am concerned about the proposed uranium mill to be constructed south of Blanding. My main concern is that the prevailing winds (in this country are from the S or SW and that means they would be blowing across the yellow-cake piles towards town for a period of years. After 20 or so years of this exposure wouldn't there be a possibility of a dangerous accumulation of radioactivity in town & adjacent areas ??

I also have concerns for the "disposal" of nuclear power plant "wastes". Why should we be creating such hazards to life itself? The sun, wind, and sea surely offer as promising a source of energy for man at a comparable cost or less (and with minimal risk to the safety of man). But, this latter concern is not the question facing the town residents at present.

DOCKETED
USNRC
FEB 9 1979
MAIL SECTION
DOCKET CLERK

Thank You
E. W. Berg
Box 522
Blanding UT.

RESPONSES

1. The radiological impact evaluation has fully addressed the radioactivity sources constituted by airborne transport of ore, yellow cake, and tailings dusts. These sources are addressed and quantified in Sect. 3.2.4 (see Table 3.3), and their impacts are evaluated in Sect. 4.7. The staff evaluation indicates that the White Mesa Uranium Mill and its tailings impoundment system will not result in offsite radioactivity concentrations or radiation exposures in excess of Federal limitations. Resulting exposures at the city of Blanding have been estimated and are provided in Table 4.6.

   An ongoing radiological environmental monitoring program will be conducted to assure compliance with EPA's "Radiation Protection Standards for Normal Operations of the Uranium Fuel Cycle" (40 CFR Part 190). Those standards limit radiation dose commitments to individuals to no more than 25 millirems per year, which is approximately 16% of natural background radiation (161 millirems per year; see Sect. 2.10).

   The issues of nuclear power plant waste disposal and alternative energy sources are beyond the scope of this document.

Responses were not necessary for the following letters from cities, schools, and other organized groups.

City of Blanding

50 WEST 1ST SOUTH STREET
POST OFFICE BOX 68
BLANDING, UTAH 84511
(801) 678-2791

February 3, 1979

DOCKETED USNRC
FEB 1 4 1979
NMSS MAIL SECTION

United States Nuclear
Regulatory Commission
7915 Eastern Avenue
Silversprings, Maryland

Attention: Mr. Ross Scarano

Gentlemen:

As elected representatives of the citizens of the City of Blanding, Utah, the City Council and I herewith set forth our comments relative to the Draft Environmental Statement on the White Mesa Uranium Project proposed for development by Energy Fuels Nuclear, Inc.

During the past several years, while Energy Fuels has been performing baseline environmental studies and preparing the mill site application, our primary consideration has been the impact the mill operation and increased resource development and production will have on required municipal services. We have developed a cooperative working relationship with Company management, which we feel will assure that the impacts and demands on the City and its services will not be disruptive.

Since the discovery of Uranium-Vanadium bearing ores in the area in the late 1930's, mining has played a significant role in the local economy. When there has been an absence of a market for uranium ore, the economy has been depressed. In recent years such a depression has existed until Energy Fuels revitalized market activity by establishing buying stations at Blanding and Hanksville, Utah. Since that time, many of our citizens have found productive, well-paying jobs developing and mining uranium ore. For the first time, many of our young people who were previously forced to leave the area for satisfactory employment, now have the opportunity to remain and find jobs suitable to their talents.

Direct and indirect growth generated by the plant construction, resource development and production will impact quite heavily on the City

culinary water supply and distribution system. However, the close relationship with Energy Fuels management has enabled us to plan and prepare adequately for that impact. It is our understanding that the plant construction timetable is now largely in the hands of the Nuclear Regulatory Commission. We respectfully urge prompt and favorable action on the mill license so that the implementing of our plans may be expedited consistent with anticipated economic growth.

Sincerely,

DeLamar Gibbons, M.D.
Mayor

FDN:vjn
cc: Governor of Utah
Congressional Representatives

MAYOR
Keith B. Redd

CITY OF MONTICELLO

MONTICELLO, UTAH 84535

February 5, 1979

Director
Division of Fuel Cycle and Material Safety
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: White Mesa Uranium Project - Docket #40-8681

Gentlemen,

After studing the environmental statement and attending a public meeting held by Energy Fuels Nuclear, Inc., we the City of Monticello, would like to go on record giving approval for the above named project.

Sincerely,

CITY OF MONTICELLO

Keith B. Redd
Mayor

COUNCILMEN

San Juan School District

Post Office Box 219
Monticello, Utah 84535

February 7, 1979

U. S. Nuclear Regulatory Commission
7915 Eastern Avenue
Silversprings, Maryland 20910

ATTENTION: Mr. Ross Scaramo

Dear Mr. Scaramo:

The San Juan Board of Education is writing in support of the application of Energy Fuels Nuclear, Inc. for a source materials license with respect to its proposed uranium mill to be located approximately six miles south of Blanding, Utah.

The San Juan School District is concerned about the socio-economic impacts of energy development in our county. The proposed energy development program will add significantly to our county tax base and will create an attractive job market for our high school and college graduates.

The benefits of the proposed energy program are significant.

For the above reasons we respectfully urge that this license be issued in the shortest time possible.

Sincerely,

Dwight Laws, President
San Juan Board of Education

RDL:cc

SJC

SAN JUAN CENTER FOR HIGHER EDUCATION

Lynn Lee, Director

February 5, 1979

Director, Division of Fuel Cycle and Material Safety
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

I have received a draft copy of the Environmental Statement Related to the Operation of White Mesa Uranium Project Energy Fuels Nuclear, Inc., and discussed the proposed mill with personnel from the company and would like to comment.

San Juan County is located in a remote area of the Southwestern United States, is sparsily populated and has very few industries. The southern third of the county, which contains nearly half the residents, has an extremely high unemployment and underemployment rate (52%) with only 15% of the male labor force receiving a salary of $5,000 or more.

The establishment of a uranium processing mill at White Mesa on the very edge of reservation land, represents a potential for employment which has previously been unavailable. Energy Fuels Nuclear has lent its support and has been involved in the development of bilingual training materials which will enable bilingual Navajo adults to qualify for employment in the mining industry. In as much as an estimated 75% of the 85 workers required to operate the mill could come from the local job market as well as a substantial percentage of non-basic sector jobs, the creation of the mill represents a significant contribution to the overall economy of the county.

We appreciate the contribution Energy Fuels has already made to our community and we support their efforts in constructing the White Mesa Uranium Mill.

Respectfully,

Lynn Lee

Lynn Lee, Director
San Juan Center for Higher Education

Jim Kindred

Jim Kindred
Bilingual Vocational Specialist

LL/JK/fb

P.O. BOX 363 • BLANDING, UTAH 84511 • (801) 678-2370
AFFILIATE OF COLLEGE OF EASTERN UTAH • DEAN M. McDONALD, PRESIDENT

DEAN M. McDONALD PRESIDENT

College of Eastern Utah

February 5, 1979

Director, Division of Fuel Cycle and Material Safety
U. S. NUCLEAR REGULATORY COMMISSION
Washington, DC 20555

Re: Energy Fuels Nuclear
White Mesa Project
Docket No. 408681

Dear Sir:

It has been brought to my attention that you are currently receiving public comments on the environmental draft for the White Mesa Uranium Project proposed by Energy Fuels Nuclear, Inc.

The College of Eastern Utah has been involved in the Blanding, San Juan County, Utah, area since 1976. Although most of our efforts have been in the professional preparation of bilingual/bicultural teachers and teacher aides, we have had a chance to observe the development of energy-related industry in the area.

The uranium mill proposed by Energy Fuels Nuclear, in our opinion, can indeed have a marked favorable effect on the residents of San Juan County. Inasmuch as the area is at present virtually devoid of major industry, the establishment of such a mill would be able to stimulate the economy in a positive manner. I personally urge your favorable consideration of their draft statement.

Sincerely yours,

Dean M McDonald

Dean M. McDonald
President

DMM:eg

COLLEGE OF EASTERN UTAH • PRICE, UTAH 84501 • (801) 637-2120

THE CHURCH OF JESUS CHRIST OF LATTER-DAY SAINTS

BLANDING UTAH STAKE
Blanding, Utah 84511

Feb. 7, 1979

United States Nuclear Regulatory Commission
7915 Eastern Avenue
Silversprings, Maryland 20910

Attn: Mr. Ross Scarano

Dear Mr. Scarano,

As representatives of the Church of Jesus Christ of Latter-Day Saints, we are writing in support of the application of Energy Fuels Nuclear, Inc. for a Source Materials License with respect to its proposed uranium mill to be located approximately six miles south of Blanding, Utah.

Our church is a primary influence in the society of the southeastern part of Utah and therefore; is concerned about the socioeconomic impacts of energy development. Many of our members are employed, either directly or indirectly, in the area's mining industry. The industry is comprised of numerous independent miners whose success is dependent upon hard work and a vigorous market for his ore. Energy Fuels has provided such a market during the past two years. The proposed program will provide attractive job market for our high school and college graduates.

We respectfully urge that this license be issued in the shortest time possible.

Sincerely,

Fred E. Halliday

President Fred Halliday

February 7, 1979

Director
Division of Fuel Cycle
and Material Safety
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: Energy Fuels White Mesa Uranium Mill

The undersigned as a representative of the Navaho Indian Tribe in Southeastern Utah wishes to advise you that we support the Energy Fuels White Mesa Uranium Mill project. This project will provide needed jobs to the Navaho Indians and should have a beneficial economic impact on the Tribe as a whole. A number of our Tribe are already employed in the Energy Fuels Buying Station and mines in the area of the Mill. Approval of this project at the earliest possible time will no doubt open jobs during the construction and operation phases of this project.

Navaho Indian Tribe
Off Reservation Chapter President

February 7, 1979

Director
Division of Fuel Cycle
and Material Safety
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: <u>Energy Fuels White Mesa Uranium Mill</u>

The White Mesa Ute Indian Tribe supports the construction and operation of the proposed Energy Fuels Uranium Mill to be located on White Mesa approximately five (5) miles north of the Ute Reservation. The White Mesa project should be a benefit to the Ute Tribe insofar as tribe members will benefit from the jobs created in the immediate area. The Tribe urges your favorable consideration of the issuance of the source material license for the Energy Fuels Mill. Your earliest possible action on the issuance of this license will permit the opening of a substantial number of job opportunities to the Ute tribe members.

Councilman
White Mesa Ute Tribe

Post Office Box 1105
Monticello, Utah 84535

the Chamber of Commerce of MONTICELLO, UTAH

Center of Scenic
San Juan County,
8,000-square-mile
Home of......

Canyonlands

Abajo (Blue) Mountains

Lake Powell

Rainbow Bridge

Navajo Reservation

Natural Bridges

LaSal Mountains

Hovenweep

Goosenecks of the San Juan

Dead Horse Point

Manti-LaSal Forest

Monument Valley

Looking Glass Rock

Valley of the Gods

Trail of the Ancients

DOCKETED USNRC FEB 12 1979 MAIL SECTION DOCKET CLERK

February 5, 1979

Director
Division of Fuel Cycle and Material Safety
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: White Mesa Uranium Project - Docket #40-8681

Gentlemen:

The Monticello Chamber of Commerce would like to go on record as giving unanimous support for the above named project. We pledge our co-operation, support and encouragement to Energy Fuels Nuclear, Inc. in their venture.

Sincerely,

Jim Camberlango

Monticello Chamber of Commerce
Jim Camberlango, Pres.
Brent Redd, Vice Pres.

Brent Redd

Responses were not necessary for the following letters from individuals.

A. W. EGBERT
2306 IOWA AVENUE
OGDEN, UTAH

Dec 21. 78

Nuclear Regulatory Commission
Washington D.C.

Gentlemen:

I take this opportunity to place my vote for the immediate issuing of license and construction permits for the White Mesa Uranium mill by Energy Fuels Nuclear to be built just south of Blanding Utah. This country has been led into an energy gap that could easily turn into an energy crisis by just allowing and following the dictates of so many non producers who have time to create protest progress, but no time for honest work. Its time we head for self sufficiency in energy.

Please note the accompanying article.

Sincerely
Very truly
A. W. Egbert

WASATCH
FINANCIAL CORP
BOX 651 • BLANDING, UTAH 84511
PHONE (801) 678-2839

February 2, 1979

Director
Division Fuel Cycle & Material Safety
U.S. Nuclear Reg. Comm.
Washington, D.C. 20555

Dear Sir:

I am writing concerning the proposed mill at Blanding, Utah. (Energy Fuels White Mesa Uranium Project, San Juan County, Docket #40-8681.)

I am very much in favor of this project. I think it would be a very good thing for the town of Blanding and the people of San Juan County.

Your consideration will be appreciated.

Yours truly,

John W. Mitchell
WASATCH FINANCIAL CORP.

JWM/jj
cc: Division of Technical Information & Document Control
U.S. Nuclear Regulatory Comm.
Washington, D.C. 20555

WASATCH FINANCIAL CORP TR
BOX 651
BLANDING UT 84511

western union Mailgram

4-069882E033 02/02/79 ICS IPMRNCZ CSP WSHB
8016782839 MGM TDRN BLANDING UT 300 02-02 0603P EST

DIRECTOR OF THE DIVISION FUEL CYCLE
AND MATERIAL SAFETY
U.S. NUCLEAR REGULATORY COMMISSION
WASHINGTON DC 20555

REFERENCE ENERGY FUELS WHITE MESA URANIUM PROJECT SAN JUAN COUNTY UTAH DOCKET NUMBER 40-8681

ENERGY FUELS HAS OPERATED A URANIUM ORE BUYING STATION AND HAS DONE EXTENSIVE EXPLORATION NEAR BLANDING UTAH FOR SOME TIME. THIS FIRM AND THEIR EMPLOYEES HAVE BEEN VERY BENEFICIAL TO OUR AREA AND OUR ECONOMY. NOW, THEY NEED TO BUILD AN ORE PROCESSING MILL TO UTILIZE THE ORE THEY HAVE LOCATED IN THE GROUND, AND ALSO TO PROCESS THE ORE THEY HAVE PURCHASED. I URGE YOU TO GRANT ENERGY FUELS THIS AUTHORITY ON FEBRUARY 5TH.

THE CITIZENS OF BLANDING UTAH ARE VERY CONCERNED ABOUT THE SAFETY AND THE ENVIRONMENTAL IMPACT OF THIS MILL, SO WE ARE PLEASED TO KNOW THAT THEIR DESIGN IS MORE THAN ADEQUATE TO CONTAIN THE WASTE TAILINGS, AND THE PRODUCTION EMMISSIONS.

OUR NATION NEEDS TO DEVELOP THESE SAFE USES OF URANIUM AS A MATTER OF SURVIVAL, SO WE ARE FREED FROM THE CRUSHING BURDENS OF BUYING MOST OF OUR OIL OVERSEAS, AND FROM THE LACK OF THE ENERGY WE NEED. WITH THIS NUCLEAR DEVELOPMENT AMERICA CAN OVERCOME BOTH OUR INFLATION AND STAGNATION PROBLEMS.

OUR LOCAL SAN JUAN COUNTY ECONOMY DESPARATELY NEEDS A LONG TERM EMPLOYER TO HELP SOLVE OUR CRONIC UNEMPLOYMENT, WHICH IS ONE OF THE WORST IN THE NATION.

PLEASE LET YOUR INTELLIGENCE AND YOUR GOOD SENSE OVERCOME THE "ANTI-NUCLEAR" AND "ANTI-DEVELOPMENT" RADICAL GROUPS AND APPROVE THIS MILL.

YOURS TRULY,

TOM REDD

18:03 EST

MGMCOMP MGM

FROM
E. A. BLACK
Box 786
BLANDING, UTAH 84511

Message Reply

DATE 2/2/79
FILE NO
ATTENTION

PRIORITY
- [ ] URGENT!
- [ ] SOON AS POSSIBLE
- [ ] NO REPLY NEEDED

TO
US Nuclear Regulatory Commission
Office of Nuclear Material Safety
Washington D.C. 20555

SUBJECT: Uranium, Energy Development at White Mesa Mill

MESSAGE

Dear Sirs:
Upon returning from a meeting tonite held by Energy Fuels I am enthusiastic about the development of Uranium buying and milling in this area. I feel that there will be no ill effects from the White Mesa Uranium mill as Energy Fuels plans to build under Nuclear regulations.
I feel it will help the economy and further develope the community. I am pleased with the relationship I have with the Energy Fuel people who are working here.

SIGNED: E. A. Black

Blanding San Juan County Utah
Feb. 4, 1979

Subject:
Dockett # 40-8681
Energy Fuels Nuclear, Inc.
White Mesa Uranium Project
San Juan County, Utah.

DOCKETED USNRC 1979

In regards to the White Mesa Uranium Project, as a business woman and a concerned Citizen of this County I am in favor of this mill being built. It would give our County a much needed economical boost, also producing some thing for the entire nation.

I am concerned about the fact that the EPA was granted an extension and no one else was. All the E.P.A. ever does is curtail any and all projects that would help our country over come its energy problems. I have lived here in this County all my life at one time only 1 block from a talings pond no harm came to me or my family and this new mill would be much more efficient than the old style

Feb. 3, 1979

Subject:
Docket # 40-8681
Energy Fuels Nuclear Inc.
White Mesa Uranium Project
San Juan County, Utah

Dear Sirs,

I would like to encourage your support of the Uranium Mill project.

I am and have been a resident of Blanding and San Juan County for 38 years. I am a family man and would like to continue to make my home here. At the present time there are few jobs in the area to keep our young people here. I felt that the Mill would be a real boost to the economy of the area.

I have attended a public meeting presented by Energy Fuels with almost no chance of any by products or particles contaminating any thing. It is long past time the E.P.A. be cut down to size and let us get on with solving our energy problems instead of confusing issues and making more problems.

Sincerely
Zelma Acton
Box 28
Blanding, Utah
84511

Nuclear Inc; I was very impressed by the company and the quality of people that they are. I was also impressed with the mill plans. It looks like a very satisfactory design concerning pollution and waste material etc.

Your support is needed and I ask you to please grant this

Yours Truly
Calibee Black

February 4, 1979

Director
Division of Fuels Cycle & Materials Safety
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sirs,

This letter is in reference to Energy Fuels Nuclear Incorporated's White Mesa Project in San Juan County, Utah. It is Docket number 40-8681.

I am very much in favor of this project and would like to see it receive your approval. I have lived in this area most of my life. I am raising my family here, and am operating a business. I have had occassion to associate with the principals of Energy Fuels Nuclear on both a personal and business level. I have enjoyed this association.

I feel the White Mesa Project will result in a substantial economic improvement in this area. It will create jobs for local people and will inject money into the local economy. It will improve the local tax base.

I also feel the White Mesa Project is necessary on a national level also. It will do something toward relieving the present energy shortage.

Again, I urge your approval of this project. Thank you for your cooperation.

Regards,

Earl E. Stevens
Blanding, Utah

DOCKETED
USNRC
FEB 0 9 1979
NMSS
MAIL SECTION
DOCKET CLERK

February 5 1979

Subject:
Docket No. 40-8681
Energy Fuels Nuclear, Inc.
White Mesa Uranium Project
San Juan County, Utah

Dear Sir,

Concerning the above project, I would like to express my desire for your approval of this project. This area has been economically depressed since the last uranium boom. This would give us the financial shot in the arm that we have been in need of so long.

Also, I would like you to know I am not looking at the economic side of this project and not the social and environmental sides. I have known a few of the Energy Fuels people for several years and have become acquainted with many over the past 9 months. These people are honest, hard working, ambitious people and fit very well in this community.

As far as the environment is concerned I see no problem. This land out is is so vast and full of dried trees and red rocks that it is hard to fathom anything of worth being injured (save the people). From a meeting recently held it appears that Energy Fuels has taken every precaution to keep dust & other pollutants to a minimal level. My expertise does not lie in this area and hence, I am relying on your study of their proposals to insure such safety. However, if Atlas Minerals can operate in Moab for the number of years they have with the less modern equipment I'm sure the new modern plant Energy Fuels plans to install will harm none of us. Last of all, but by no means least, I would like to comment on the EPA and their underhanded tactics. As you know that organization killed the Kaparowits Project that was going to be erected in a land even more desolate than ours. And, it is my understanding that they have filed for a 15 day extension period in which to comment on this proposed project. Since my staff is much smaller than theirs and my time no more abundant than theirs it is my sincere wish that their uninformed comments be totally ignored. However, since I am sure this won't happen, it is my hope that the usual weight given this organization not be given them this time. I sincerely doubt few if any in this cut-throat group have ever visited this area, unless they flew over Blanding on their way to Lake Powell. These environmentalists want to keep this area untouched by industry so that they can continue to draw their fine salaries and periodically visit a "wilderness." If they were half as concerned about fellow human beings and what they were supposed to subsist they would undoubtedly encouraged such projects so our community is as financially healthy as their city.

In closing, it is my hope, and my prayer, that you will look upon this project with favor, and give your approval as fast as possible before the EPA (or a similar organization) ties it up it court for a number of years.

Respectfully yours,

Phil B. Acton

PHIL B. ACTON
P.O. Box 28
BLANDING, UTAH 84511

ABAJO PETROLEUM, INC.

EXXON Happy Motoring

Box 187
MONTICELLO, UTAH 84535

February 5, 1979

Director
Division of Fuel Cycle and Material Safety
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: White Mesa Uranium Project - Docket #40-8681

Gentlemen:

After studying the environmental statement and attending a public meeting held by Energy Fuels Nuclear, Inc., I, in my personal and business capacity, would like to go on record giving approval for the above named project.

Signed,

K. Brent Redd

K. Brent Redd

Subject
Dockett # 40-8681
Energy Fuels Nuclear Inc.
White Mesa Uranium Project
San Juan County, Utah

Feb. 5th-79

Concerning the Mill at White Mesa, As a young man just starting out on my own, I am in favor of this project.

This will be a great boost to our County. I can't see where there would be any thing but good come from it. We have had other Mills here and no harm came to anyone from them.

The thing I am concerned about is the fact that the E.P.A. was granted and extension and no one else was. To my way of thinking all the E.P.A. does is curtail any and all projects that would help our country over come the energy problems and its time the citizens of the U.S. get these radicals under control and start using the natural resources the almighty gave us to make this nation the strongest and most productive in the world.

Thoughtfully
Jim H. Acton
Box 28
Blanding, San Juan Co, Ut.
84511

Phil Acton
Box 28
Blanding, Ut. 84511
Feb. 5, 1978

Ref. Docket #40-8681
Energy Fuels Nuclear Inc.
White Mesa Uranium Project
San Juan County, Ut.

Dear Sir;

Being a resident of San Juan County for 25 years, also being involved in several different businesses, tax payer etc. I very much support the endeavors of Energy Fuels in erecting a mill in San Juan Co.

As I understand the present status of the applicant, they need [illegible] before a permit is issued.

Page II

I have been in and out of uranium mines and mills during the past 25 years, mining, hauling uranium ore in all of its phases. I have to the best of my knowledge & belief suffered no ill effects & know of no one who has.

San Juan Co. needs the economic benefits this project would put into our towns and citizens.

San Juan Co. comprises approximately 8000 Sq. miles of which 70% is undeveloped and uninhabited. Any ill effects to people, wild life or vegetation would be practically nil.

Energy Fuels Inc. has all the modern staff & technology to install & operate a most safe operation to all concerned, also it would contribute greatly to help in solving some of the energy problems facing

Page III

our great nation.

In closing I would like to urge the Director of Division, Fuels Cycle & Mat. Safety U.S. Nuclear Regulatory Commission Wash. D.C. to expedite Energy Fuels application, get the show on the road, be a great credit and service to the United States of America. Lets make us number one.

Sincerely Yours

[illegible]

Box 26

Blanding, Ut. 84511

February 7, 1979

Director
Division of Fuel Cycle
and Material Safety
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: Energy Fuels White Mesa Uranium Mill

Gentlemen:

The Monticello City Council endorses and supports the proposed Energy Fuels Uranium Mill located approximately five (5) miles south of Blanding, Utah. The impact of the Mill construction and operation to Monticello as well as San Juan County should be quite beneficial. Jobs will be provided to a number of individuals many of which will no doubt live in Monticello. A number of current employees of Energy Fuels already reside in Monticello.

Although an increase in population of the City of Monticello as projected from the construction and operation of the proposed uranium mill, the City is planning expansions to the utility systems and feels that it will be well able to take care of the impact of any additional residents that may locate in the City. We look forward to Energy Fuels' early commencement of construction and ask that you favorably consider the application for the source material license.

City Council of Monticello, Utah

JTN Insurance, Inc. Phone (801) 487-0101
3445 South Main, Suite 112 • P. O. Box 15585 • Salt Lake City, Utah 84115
YOUR Independent Insurance AGENT

February 8, 1979

DOCKETED USNRC FEB 14 1979 NMSS MAIL SECTION DOCKET C.

Director
Division Fuel Cycle and Material Safety
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

In reference to Docket No. 40-8681, Energy Fuel's White Mesa Uranium Project in San Juan County Utah, which we understand is to be reviewed by your commission on February 21, 1979 we would like to submit the following.

We have recently established a branch office at Blanding Utah and we are very enthused about the prospects of economical development in San Juan County. One of the highlights of this economical development is the uranium processing plant referred to above which Energy Fuels proposes to build at White Mesa, south of Blanding Utah.

We would like to voice our interest and deep concern that your commission speedily passes the project for Energy Fuels so that San Juan County may get on with the very intricate part of the development of energy for our nation as well as economic development for the people of San Juan County. We feel this would be very instrumental in not only the economic development in San Juan County but of the State of Utah and also in the interest of energy development for our nation.

Please give every consideration to the passing of this and try not to listen so intently to the chattering of some of the special interest people who try to destroy the economic development of our country.

We appreciate your consideration of this and any assistance you can give to the early passing of this project as it is our understanding that Energy Fuels is ready to begin construction in May and have went to a great deal of expense to line up ore and establish a program to begin this project in early May of this year.

Cordially yours,

Kay R. Johnson
Kay R. Johnson
Vice-President

mj

cc: Division of Technical Information and Document Control
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

A-67

RUGS
BASKETS
JEWELRY
POTTERY
RARE ARTS
SILVERSMITHS AT WORK

THIN BEAR
INDIAN ARTS, INC.
NAVAJO UTE ZUNI HOPI
ROBERT HOSLER

P. O. BOX 82[illegible] SOUTH HIGHWAY 163
BLANDING, UTAH
PH. [illegible]

DOCKETED
USNRC
FEB 09 1979
MAIL SECTION
DOCKET CLERK

To Commission Members;
Division of Fuels Cycle Materials
U.S. Nuclear Regulatory Commission.

Dear Sirs We would like you to approve the application of the Engery Fuels Nuclear, San Juan County Utah, White Mesa Project; Docket # 408681.

As we understand it they have met all the E.P.A. requirements and have set up monitoring stations for continuous checking of the environment. this project has been in process for 2 years; Please expidite it. thank you.
this is a depressed area and Navajo Indians and anglo's alike need employment,

sincerely Yours
Robert E. Hosler
[illegible]

Appendix B

BASIS FOR NRC EVALUATION OF THE WHITE MESA MILL PROPOSAL

Appendix B

BASIS FOR NRC EVALUATION OF THE WHITE MESA MILL PROPOSAL

B.1 THE NUCLEAR FUEL CYCLE

The nuclear fuel cycle comprises all the processes involved in the utilization of uranium as a source of energy for the generation of electrical power.

The nuclear fuel cycle consists of several steps:

1. extraction — removing uranium ore from the ground, separating the uranium content from the waste, and converting the uranium to a chemically stable oxide (nominally U_3O_8);

2. conversion or fluorination — changing the U_3O_8 to a fluoride (UF_6), which is a solid at room temperature but becomes a gas at slightly elevated temperatures, prior to enrichment;

3. enrichment — concentrating the fissionable isotope (uranium-235) content of the uranium from the 0.7% occurring in nature to the 2 to 4% required for use in reactors for power generation;

4. fabrication — converting the enriched uranium fluoride to uranium dioxide (UO_2), forming it into pellets, and encasing the pellets in tubes (rods) that are assembled into fuel bundles for use in power generating reactors;

5. nuclear power generation — using the heat resulting from uranium and plutonium fission to generate steam for use in the reactor turbines;

6. spent fuel reprocessing — chemical separation of fissionable and fertile values (uranium-235, uranium-238, plutonium) from fission products (waste), with concurrent separation of uranium from plutonium; and

7. waste management — storage of fission products, spent fuel, and low-level wastes in a manner that is safe and of no threat to human health or the environment.

Step 6 (reprocessing, involving the recycling of plutonium), which had traditionally been considered as an essential part of the nuclear fuel cycle, was recently deferred by the National Energy Plan (NEP)[1] as a necessary part of the cycle. The U.S. commitment to advanced nuclear technologies based on the use of plutonium recovered by the reprocessing of spent light-water-reactor (LWR) fuel has also been deferred. These policy statements enter into the staff's evaluation of the need for licensing the White Mesa mill, because without reprocessing, all LWR fuel must be derived from the mining and milling of new U_3O_8 from projects such as the White Mesa mill and the related uranium mines.

This cycle, as defined by current policy, is portrayed in Fig. B.1.

Nuclear reactor operation converts about 75% of the fissionable isotope (uranium-235) into fission products, thereby liberating thermal energy and creating plutonium, another fissionable element, in the process. Some plutonium is retained in the spent fuel.

The spent fuel removed from the reactor is stored at the reactor site (and later at the reprocessing plant, if policy changes) to "cool." The radioactivity of the fuel is reduced by a factor of about 10 after 150 days storage. Without reprocessing, this spent fuel is considered waste. Policies and methods regarding its storage and/or disposal are currently under study by the DOE and NRC.

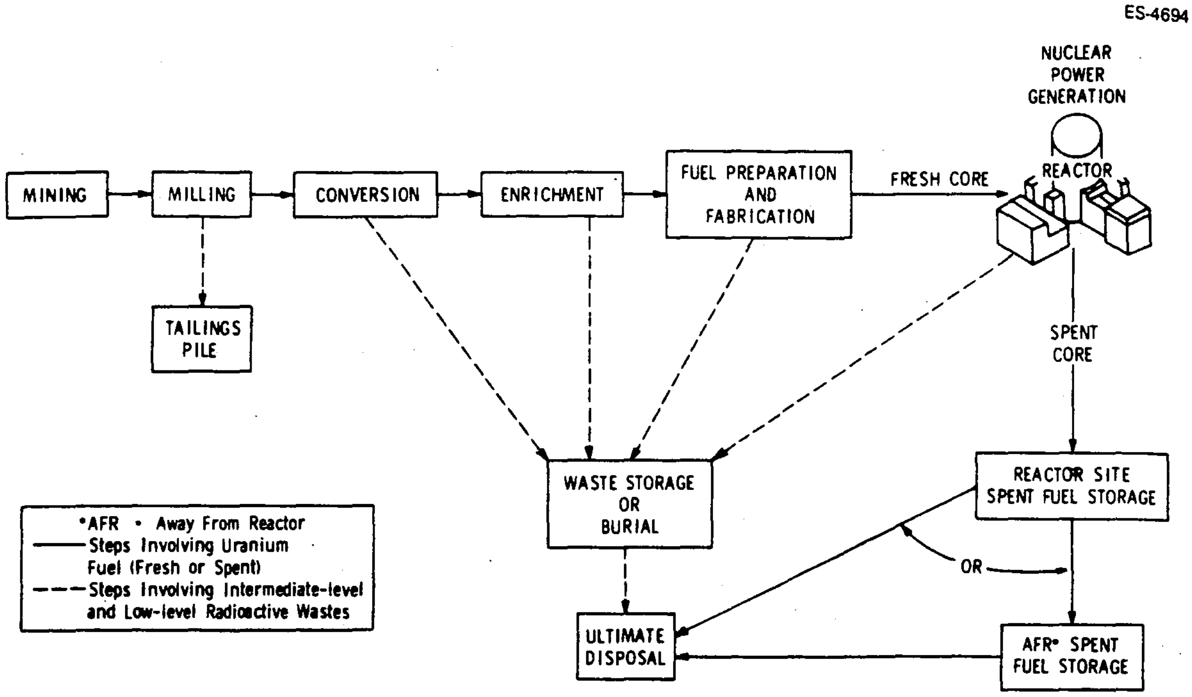

Fig. B.1. The LWR fuel cycle.

B.2 USE OF NUCLEAR FUEL IN REACTORS

Two types of reactors are currently used to generate essentially all of the nuclear energy sold in the United States: the boiling-water reactor (BWR) and the pressurized-water reactor (PWR). Each reactor type is operated with a fuel-management scheme designed to meet the requirements of the utility operator. Different fuel-management schemes result in different fuel burnup rates which, along with other design parameters, affect the quantity of residual fissionable materials, the type and amount of radioactive wastes in the spent fuel, and the quantities of nuclear fuel consumed.

The need for uranium fuel, as dictated by the installation of 380 GWe of nuclear capacity anticipated by the year 2000, is shown in Table B.1. A 1000-MWe reactor will require ≈30 MT of uranium fuel per year at a plant factor of 0.6 and ≈30 MT of uranium fuel for a plant factor of 0.8. The term "plant factor" indicates the ratio of the average power load of an electric power plant to its rated capacity. For a 3% enriched fuel and 0.25% enrichment tails assay, 7.9 times the metric tons of fuel replaced equals the standard tons of U_3O_8 required for a 1000-MWe power plant. The percentage of total electrical generating capacity over the same time period that this schedule represents is shown in Table B.2. On the basis of recent statements by the industry and the DOE, the staff believes that this schedule represents a maximum for nuclear reactor installations between 1990 and 2000 but is reasonably accurate through 1990.[2]

Cumulative requirements through the year 2000 would be 883,000 MT of uranium as U_3O_8 (Table B.1). Table B.3 compares this requirement with available uranium (reserves and probable resources) for the year 2000 and the 30-year plant lifetimes of the 380 GWe projected for installation by the year 2000. Requirements and resources are in reasonable balance;[3] that is, the sum of reserves and probable resources is approximately equal to the lifetime requirements of the 380 GWe installed by 2000.

In 1977, 23 mills produced about 12,000 MT of U_3O_8 while handling 32,000 MT of ore per day. These mills operated at 80 to 85% of capacity. The U_3O_8 content of the ore was less than 1.5 kg/MT (3 lb/ton; <0.15%).[4] Ores processed by the White Mesa mill will have a U_3O_8 content approximating this national average.

Table B.1. Projected U.S. requirements for U_3O_8, 1976–2000[a,b]

Year	Generating capacity (GWe)	Annual U_3O_8 requirements (MT)	Cumulative U_3O_8 requirements (MT)
1976	43	9,500	9,350
1977	49	10,000	19,100
1978	53	10,000	29,100
1979	57	11,000	40,200
1980	61	11,000	52,000
1981	74	17,500	69,400
1982	87	18,000	87,600
1983	100	20,500	108,000
1984	112	22,500	130,000
1985	127	26,500	157,000
1986	141	28,000	185,000
1987	154	30,000	215,000
1988	167	32,500	248,000
1989	181	35,500	283,000
1990	195	38,000	321,000
1991	210	41,000	362,000
1992	225	43,500	406,000
1993	240	46,500	452,000
1994	260	51,500	504,000
1995	280	54,500	558,000
1996	300	58,000	616,000
1997	320	61,500	678,000
1998	340	65,500	743,000
1999	360	68,500	811,000
2000	380	71,500	883,000

[a]The annual U_3O_8 requirements were calculated on the basis of annual discharges of 28 MT/GWe (0.7 plant factor) of spent fuel and replacement of that spent fuel with a 3% enriched fuel with tails assay of 0.25% in enrichment.

[b]To convert to short tons, multiply by 1.1.

Table B.2. Comparison of total and nuclear generating capacity, operating in years 1977–2000

Year	Total generating capacity (GWe)[a]		Nuclear generating capacity (GWe)				
	Minimum	Maximum	Actual	Planned or under construction	Estimated	Nuclear, minimum case (%)	Nuclear, maximum case (%)
1978	507	507	49			12	12
1980	544	627		84		16	14
1985	624	840		127		20	15
1990	734	1131		195		26	17
1995	869	1525			280	32	18
2000	1039	2092			380	36	18

[a]From "Electric Utilities Study" by TRW for ERDA, Contract E(49-1)-3885, pp. 1–19, et seq. Maximum case is 7.0% compounded annual growth through 1985, then 6.4% to 2000. Minimum case is 3.9% through 1985, then 3.5% to 2000.

Table B.3. Comparison of U.S. reactor requirements and domestic resource availability (in metric tons of U_3O_8 as of January 1978)[a,b]

Time period	Reactor demand	Resource availability	
		At \$30/lb[c]	At \$50/lb[c]
Through year 2000	883,000		
For 30-year lifetime of 380 GWe	2,051,000		
Reserves[d]		626,000	808,000
Probable resources		921,000	1,180,000
Sum of reserves and probable resources		1,550,000	2,000,000

[a]To convert to short tons multiply by 1.1.

[b]Based on information presented by U.S. Energy Research and Development Administration (now U.S. Department of Energy) at the Uranium Industry Seminar, Grand Junction, Colorado, October 1977, and in "ERDA Makes Estimate of Higher Cost Uranium Resources," U.S. Energy Research and Development Administration, June 1978.

[c]Costs include all those incurred in property exploitation and production except costs of money and taxes.

[d]Does not include 126,000 MT of U_3O_8 which could be produced as a by-product of phosphate fertilizer and copper production.

As can be seen in Table B.1, the annual requirement for U_3O_8 in 1981 (17,500 MT) exceeds the output of existing uranium mills (12,000 MT). In 1980, the White Mesa Uranium Project would produce 6% of the national capacity for tons of ore per day, and its total production of U_3O_8 through the next 15 years of operation would be about 3% of the national requirements. Although this production is not currently planned for use to meet National requirements directly, it will increase the overall U_3O_8 supply available. The project will contribute to meeting the demand forecast for the nuclear power industry.

REFERENCES FOR APPENDIX B

1. Office of the President, *National Energy Plan*, Washington, D.C., April 1977.

2. Brown and Williamson, U.S. Department of Energy, "Domestic Uranium Requirements, Policy and Evaluation," paper presented at the Uranium Seminar, Grand Junction, Colo., October 1977.

3. "ERDA Makes Preliminary Estimate of Higher Cost Uranium Resources," U.S. Energy Research and Development Administration Notice, June 1977.

4. J. F. Pacer, Jr., "Seminar on Uranium Resources," paper presented at the Uranium Seminar, Grand Junction, Colo., October 1977.

Appendix C

STATEMENTS OF GENERAL FUND REVENUES AND EXPENDITURES FOR SAN JUAN COUNTY, BLANDING AND MONTICELLO

SAN JUAN COUNTY
GENERAL FUND
STATEMENT OF REVENUES, EXPENDITURES, AND COMPARISON WITH BUDGET
FOR THE YEAR ENDED DECEMBER 31, 1977

EXPENDITURES	BUDGET	1977 TOTAL ACTUAL	OVER (UNDER) BUDGET	1976 ACTUAL PRIOR YEAR
GENERAL GOVERNMENT:				
Commission	$ 31,950	$ 31,434	$ (516)	$ 28,785
District court	3,150	2,994	(156)	3,252
City and precinct courts	15,000	22,364	7,364	15,818
Other judicial	6,500	1,907	(4,593)	922
Clerk and auditor	40,250	34,284	(5,966)	35,005
Recorder	36,980	39,877	2,897	34,648
Attorney	24,100	22,974	(1,126)	21,781
Treasurer	16,380	15,094	(1,286)	13,978
Assessor	23,825	26,336	2,511	26,086
Surveyor	39,970	37,706	(2,264)	40,340
Planning commission	1,000	727	(273)	
Non-departmental	185,500	222,525	37,025	192,005
Buildings	18,150	21,143	2,993	18,258
Advertising and community promotion	68,070	31,820	(36,250)	37,662
Total general government	$ 510,825	$ 511,185	$ 360	$ 468,540
PUBLIC SAFETY:				
Sheriff	$ 155,820	$ 144,320	$(11,500)	$ 145,648
Fire department	5,835	5,787	(48)	4,273
Corrections (jail)	36,100	36,156	56	31,021
Other protection	12,600	11,859	(741)	11,272
Total public safety	$ 210,355	$ 198,122	$(12,233)	$ 192,214
PUBLIC HEALTH:				
Health services	$ 326,315	$ 250,157	$(76,158)	$ 155,538
HIGHWAY AND PUBLIC IMPROVEMENT:				
Highways	$ 653,500	$ 750,896	$ 97,396	$ 767,420
Class "B" roads	550,000	310,992	(239,008)	328,004
Collector roads	580,000	96,583	(483,417)	203,713
Miscellaneous	119,800	17,899	(101,901)	11,939
Total highway and public improvement	$1,903,300	$1,176,370	($726,930)	$1,311,076

SAN JUAN COUNTY
GENERAL FUND
STATEMENT OF REVENUES, EXPENDITURES, AND COMPARISON WITH BUDGET
FOR THE YEAR ENDED DECEMBER 31, 1977

EXPENDITURES	BUDGET	1977 TOTAL ACTUAL	OVER (UNDER) BUDGET	1976 ACTUAL PRIOR YEAR
PARKS, RECREATION AND PUBLIC PROPERTY:				
Parks and recreation	$ 71,293	$ 71,602	$ 309	$ 63,823
Television	9,600	17,436	7,836	18,702
Total parks, recreation and public property	$ 80,893	$ 89,038	$ 8,145	$ 82,525
CONSERVATION AND ECONOMIC DEVELOPMENT:				
Agriculture and extension service	$ 13,875	$ 16,073	$ 2,198	$ 13,346
Total conservation and economic development	$ 13,875	$ 16,073	$ 2,198	$ 13,346
TOTAL EXPENDITURES - GENERAL FUND	$3,045,563	$2,240,945	$(804,618)	$2,223,239
EXCESS REVENUES (EXPENDITURES)	$ (537,428)	$ 444,977	$ 982,405	$ 310,766

Source: San Juan County Audit for 1977.

SAN JUAN COUNTY
GENERAL FUND
STATEMENT OF REVENUES, EXPENDITURES, AND COMPARISON WITH BUDGET
FOR THE YEAR ENDED DECEMBER 31, 1977

REVENUES	BUDGET	1977 TOTAL ACTUAL	OVER (UNDER) BUDGET	1976 ACTUAL PRIOR YEAR
TAXES:				
General property taxes		$ 891,085		$ 846,129
Delinquent prior years' taxes		8,918		13,714
General sales and use taxes		87,496		74,374
Penalties and interest on taxes		6,020		5,174
Total taxes (Note 2)	$ 891,085	$ 993,519	$ 102,434	$ 939,391
LICENSES AND PERMITS:				
Business licenses and permits		$ 3,150		$ 3,250
Non-business licenses and permits		816		463
Total licenses and permits	$ ...	$ 3,966	$ 3,966	$ 3,713
INTERGOVERNMENTAL REVENUES:				
Federal grants	$	$ 11,655	$ 11,655	$ 11,892
Federal shared revenue		119,029	119,029	186,671
Federal payments in lieu of taxes	445,000	292,902	(152,098)	
State grants	14,000	36,392	22,392	9,453
State shared revenues	550,000	539,838	(10,162)	525,572
Grants from other units	134,000	114,712	(19,288)	92,331
Total intergovernmental revenues	$1,143,000	$1,114,528	$(28,472)	$ 825,919
CHARGES FOR SERVICES:				
General government	$ 119,850	$ 81,055	$(38,795)	$ 74,934
Public safety	7,500	5,814	(1,686)	10,591
Streets and public improvements	142,000	155,144	13,144	305,882
Health		3,120	3,120	4,160
Parks and public property	24,000	12,755	(11,245)	24,283
Miscellaneous services	19,700	32,834	13,134	29,528
Total charges for services	$ 313,050	$ 290,722	$(22,328)	$ 449,378
FINES AND FORFEITURES:				
Fines	$ 61,000	$ 91,697	$ 30,697	$ 72,202
MISCELLANEOUS REVENUES:				
Interest earnings		$ 79,409		$ 61,114
Rents and concessions		38,909		119,276
Sale of materials and supplies		73,172		63,012
Total miscellaneous revenues	$ 100,000	$ 191,490	$ 91,490	$ 243,402
TOTAL REVENUES - GENERAL FUND	$2,508,135	$2,685,922	$ 177,787	$2,534,005

CITY OF BLANDING
Blanding City, Utah

SCHEDULE: "E"

STATEMENT OF GENERAL FUND REVENUES and EXPENDITURES - FISCAL YEARS ENDED JUNE 30, 1976 - 1977

	June 30, 1976		June 30, 1977	
REVENUE RECEIPTS:				
Current Year Property Taxes	$ 37,959.53		$ 44,393.96	
Redemption - Prior Years Taxes	3,488.70		1,691.72	
Sales and Use Taxes	43,336.72		55,313.55	
Business Licenses	489.00		450.00	
Building and Construction Permits	645.80		1,387.60	
Bicycle Permits	7.00		6.00	
Other Licenses and Permits	85.00		245.00	
Grants From Federal Government	5,937.30		770.00	
Federal Revenue Sharing	14,087.00		18,227.00	
State Liquor Fund Allotment	4,248.20		4,248.20	
Class "C" Road Fund Allotment	6,940.83		14,278.44	
Other Governmental Grants	2,056.46		5,626.70	
Airport Revenue	1,782.33		1,351.87	
Cemetery Lot Sales	700.00		280.00	
Court Fines and Penalties	7,879.00		6,718.50	
Waste Collection and Disposal Fees	17,451.37		18,462.50	
Waste Collection and Disposal Penalties	80.61		102.61	
Earned Interest - Class "C" Road Fund	907.56		480.26	
Earned Interest - Revenue Sharing Fund	1,335.16		760.33	
Earned Interest - Airport Construction Fund	70.12		98.79	
Proceeds From Sale of G. O. Bonds	-- --		225,000.00	
Earned Interest - G. O. Bond Funds	577.42		3,389.71	
Miscellaneous Revenues	318.52		1,193.31	
Total Receipts		$150,383.63		$404,476.05
Cash Accountability Adjustments -				
Add:				
Cash Contribution - Electric, Water and Sewer Fund, Account Current		7,770.05		-- --
Deduct:				
Discounts Allowed - Waste Collection and Disposal		(134.65)		(87.73)
Balance - Cash Receipts		$158,019.03		$404,388.32
Add:				
Non-Cash Revenues:				
Service Fees (Waste Collection and Disposal)- Representative of Uncollectible Accounts Charged	127.25		180.00	
Electric, Water and Sewer Utility Fund- Account Current Credits	11,525.33		9,672.01	
Employee Payroll Taxes, Retirement Funds, and Insurance Premiums Withheld	8,219.98		9,845.59	
Elected Officials and Firemen Employee Benefits Allowed; Insurance Premiums	-- --		1,522.94	
Total Revenue Adjustments		$ 19,872.56		$ 21,220.54
TOTAL GROSS REVENUES		$177,891.59		$425,608.86

CITY OF BLANDING

Blanding City, Utah

SCHEDULE: "E" STATEMENT OF GENERAL FUND REVENUES AND EXPENDITURES - FISCAL YEARS ENDED JUNE 30, 1976 - 1977 . . . . CONTINUATION . . . .

EXPENDITURE CHARGES:				
Operating Expenditures:				
Administrative	$ 6,044.01		$ 5,606.53	
Municipal Court	2,742.42		3,536.93	
Election Expense	388.14		1,086.75	
Audit Expense	589.50		589.50	
Police Department Expense	47,288.56		46,929.58	
Fire Department Expense	2,396.21		4,744.42	
Inspection Department Expense	60.00		60.00	
Street Department Expense	17,969.27		26,960.59	
Debt Service Redemptions:				
Water Bonds - Series 11-1-47	1,105.00		1,075.00	
Sewer Bonds - Series 12-1-54	1,532.20		1,498.50	
Light Bonds - Series 5-1-57	6,522.50		6,275.00	
Water Bonds - Series 5-1-74	18,887.50		18,188.40	
Waste Collection and Disposal Expense	12,725.04		14,666.88	
Airport Expense	3,352.04		4,824.35	
Class "C" Road Fund Expense	2,180.06		-- --	
Parks and Recreation Expense	75.13		105.34	
Total Operating Expenditures		$123,857.98		$136,147.77
Other Expenditures:				
Surplus Invested In Fixed Assets	7,480.83		11,396.36	
Remittance - Employees' Withheld Taxes and Insurance Premiums	8,332.04		10,686.07	
Contribution - Electric, Water and Sewer, Account Current	154,330.36		48,344.32	
Refunds - Waste Collection and Disposal	4.00		-- --	
Total Other Expenditures		170,147.23		70,427.80
TOTAL EXPENDITURES		$294,005.21		$206,575.57
EXCESS (DEFICIT): Revenue Receipts Over Expenditures		($116,113.62)		$219,033.29
Adjustments:				
Incremental Increase in Unappropriated Surplus -				
Employees' Insurance Premiums Advanced, Increase		(11.72)		(1,032.76)
Waste Collection and Disposal Accounts Receivable, Increase		21.38		28.37
Payroll Taxes Payable, Increase		123.78		142.98
Electric, Water and Sewer - Account Current, Increase		135,034.98		38,672.31
Net Increase In Unappropriated Surplus		$19,054.80		$256,844.19

MONTICELLO

GENERAL FUND

	1977-1978 Adjusted Budget
Revenues	
Property taxes	$ 37,536
Sales tax	79,908
Court fines	16,422
Class "C" Road Fund	4,950
State Liquor Allotment	2,702
Business licenses	1,602
Other licenses and permits	2,066
Other revenues	2,450
Total Revenues	$147,636
Disbursements	
Administration	$ 54,800
Court	3,700
Police	49,400
Fire	1,700
Streets	10,200
Parks	2,000
Total Disbursements	$121,800
Transfer to Bond Redemption & Interest Fund	19,500
	$141,300
Excess of Revenues over Disbursements and Transfers	$ 6,336

Appendix D

DETAILED RADIOLOGICAL ASSESSMENT

APPENDIX D. DETAILED RADIOLOGICAL ASSESSMENT

Supplemental information is provided below which describes the models, data, and assumptions utilized by the staff in performing its radiological impact assessment of the White Mesa Uranium Project. The primary calculational tool employed by the staff in performing this assessment is an NRC-modified version of the UDAD (Uranium Dispersion and Dosimetry) computer code, originated at Argonne National Laboratory (Ref. 1).

D.1 ANNUAL RADIOACTIVE MATERIAL RELEASES

Estimated annual activity releases for the White Mesa site are provided in Table 3.3. They are based on the data and assumptions given in Table 3.2 and described elsewhere in Section 3 and in Appendix F, with the exception of the annual average dusting rate for exposed tailings sands. This dusting rate is calculated in accordance with the following equation:

$$M = \frac{3.156 \times 10^7}{0.5} \sum_s R_s F_s \qquad \text{(D-1)}$$

where F_s is the annual average frequency of occurrence of wind speed group s, dimensionless;
R_s is the dusting rate for tailings sands at the average wind speed for wind speed group s, for particles $\leq$ 20 μm diameter, g/m²-sec;
M is the annual dust loss per unit area, g/m²-yr;
3.156×10^7 is the number of seconds per year; and
0.5 is the fraction of the total dust loss constituted by particles $\leq$ 20 μm diameter, dimensionless (Ref. 1).

The values of R_s and F_s utilized by the staff are as given in Table D.1. The calculated value of the annual dusting rate, M, is 555 g/m²-yr. Annual curie releases from the tailings piles are then given by the following relationship:

$$S = MA\,(1-f_c)\,f_t\,(423)(2.5)(1\times10^{-12}) \qquad \text{(D-2)}$$

where A is the assumed beach area of the pile, m²;
f_c is the fraction of the dusting rate controlled by mitigating actions, dimensionless;
f_t is the fraction of the ore content of the particular nuclide present in the tails;
S is the annual release for the particular beach area, Ci/yr;
423 is the assumed raw ore activity, pCi/g;
2.5 is the dust to tails activity ratio; and
1×10^{-12} is Ci/pCi.

Table D.1 Parameter Values for Calculation of Annual Dusting Rate for Exposed Tailings Sands

Wind Speed Group, knots	Average Wind Speed, mph	Dusting Rate[(a)] (R_s), g/m²-sec	Frequency of Occurrence(F_s)[(b)]
0-3	1.5	0	--
4-6	5.5	0	--
7-10	10.0	3.92×10^{-7}	0.2836
11-16	15.5	9.68×10^{-6}	0.1736
17-21	21.5	5.71×10^{-5}	0.0395
>21	28.0	2.08×10^{-4}	0.0229

(a) Dusting rate as a function of wind speed is computed by the UDAD code (Ref. 1).
(b) Wind speed frequencies obtained from annual joint frequency data presented in Table D.2.

UDAD4, MODIX

METSET BLANDING, UTAH

JOINT FREQUENCY DATA IN PERCENT

MPH	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTALS
STABILITY CLASS 1																	
1.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0387	0.0000	0.0000	0.0000	0.0000	0.0000	.0387
5.5	0.0000	0.0000	0.0000	0.0000	.0387	0.0000	.0387	0.0000	.1550	.0387	.1162	.0387	.0387	0.0000	0.0000	0.0000	.4647
10.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	0.0000	0.0000	0.0000	0.0000	.0387	0.0000	.0387	0.0000	.1550	.0387	.1549	.0387	.0387	0.0000	0.0000	0.0000	.5034
STABILITY CLASS 2																	
1.5	.0775	.0387	.0775	.0387	0.0000	.0775	.0775	.0387	.1550	.0775	.1937	.1162	.0387	0.0000	.1550	.0387	1.2009
5.5	.1162	.0775	.1162	.0775	.2325	.1937	.9812	.7361	1.2011	.4262	.5812	.2712	.2712	.1550	.1162	.0775	5.6305
10.0	0.0000	0.0000	.0775	.0775	.0387	.1162	.6199	.7361	1.3581	.2325	.4262	.1550	.3487	.0387	.0387	0.0000	4.2638
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	.1937	.1162	.2712	.1937	.2712	.3874	1.6786	1.5109	2.7142	.7362	1.2011	.5424	.6586	.1937	.3099	.1162	11.0952
STABILITY CLASS 3																	
1.5	0.0000	.0387	.0387	0.0000	.0387	0.0000	.0387	.0387	0.0000	0.0000	.1162	.0387	.0775	0.0000	0.0000	.0387	.4646
5.5	.1937	.2325	.5087	.3487	.5812	.2325	.6587	.3874	.6082	.3910	.5317	.1937	.1550	.0775	.2712	.1162	5.4879
10.0	.1550	.0775	.0775	.0387	.0775	.1550	.2712	.2325	.9686	.8136	.6974	.1937	.1162	.1162	.3487	.0775	4.4168
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.2325	.1937	.2325	.3874	.5812	.1162	.1162	.0775	.1162	.0387	2.0921
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0775	0.0000	0.0000	.0387	0.0000	0.0000	0.0000	0.0000	.1162
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	.0387	0.0000	.0387	0.0000	0.0000	0.0000	0.0000	.0774
ALL	.3487	.3487	.6249	.3874	.6974	.3875	1.2011	.8523	1.8868	1.6307	1.9265	.6197	.4649	.2712	.7361	.2711	12.6550
STABILITY CLASS 4																	
1.5	.1550	.1162	.1162	.1937	.2325	.3487	.1162	.2325	.2325	.1162	.0387	.1162	.0387	.1550	.0387	.1550	2.4020
5.5	.3100	.5037	1.0171	.9395	.9395	.9782	.7749	.5424	.3874	.2712	.4649	.1550	.2712	.3100	.1550	.2325	8.2525
10.0	.1550	.5812	.6974	.2325	.1162	.1937	.4262	.4262	.6974	.5424	.3874	.1937	.1937	.3487	.4649	.2325	5.8891
15.5	.6199	1.0074	.6974	.1162	.1162	.4649	.4649	.4262	1.5498	1.4336	1.4723	.8911	1.0849	.5037	1.4723	.7361	13.0569
21.5	.2325	.0775	.0775	0.0000	0.0000	.1162	.0387	0.0000	.1937	.6974	.5037	.5037	.4262	.1550	.4649	.3487	3.8357
28.0	.0387	0.0000	0.0000	0.0000	0.0000	.0387	.0775	0.0000	.0775	.4262	.3487	.1550	.1550	.1937	.5424	.1550	2.2084
ALL	1.5111	2.2860	2.6056	1.4819	1.4044	2.1404	1.8984	1.6273	3.1383	3.4870	3.2157	2.0147	2.1697	1.6661	3.1382	1.4598	35.6446
STABILITY CLASS 5																	
1.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5.5	.3874	.5812	.8138	.4649	.1550	.1550	.1937	.1937	.3487	.1550	.2712	.1162	.0387	.1937	.3874	.4649	4.9205
10.0	1.1236	1.3173	1.8985	.1937	.0775	0.0000	.1162	.0775	.3487	.6974	.4649	.1550	.3487	.2712	1.5110	1.2011	9.8023
15.5	.1162	.2325	.3100	0.0000	.0775	.0387	0.0000	.0775	0.0000	.0775	.1550	.1162	.1937	0.0000	.5037	.3100	2.2085
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	1.6272	2.1310	3.0223	.6586	.3100	.1937	.3099	.3487	.6974	.9299	.8911	.3874	.5811	.4649	2.4021	1.9760	16.9313
STABILITY CLASS 6																	
1.5	.3564	.1627	.2402	.1550	.3487	.1162	.1162	.3100	.1550	.0775	.1550	.1162	.1937	.2712	.3178	.2403	3.3321
5.5	1.4491	1.7590	1.8752	1.0849	.4649	.5037	.4262	.4262	.6587	.8911	.7749	.3874	.8911	.8136	2.1852	1.6428	16.2340
10.0	.4339	.5501	.4339	.2325	0.0000	.0387	.0387	.0387	.1937	.1162	.1937	.0387	.0387	.2712	.3565	1.0152	3.9904
15.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
21.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
28.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ALL	2.2394	2.4718	2.5493	1.4724	.8136	.6586	.5811	.7749	1.0074	1.0848	1.1236	.5423	1.1235	1.3560	2.8595	2.8983	23.5565
ALL	5.9201	7.3537	9.0733	4.1980	3.5353	3.7676	5.7078	5.1141	9.5991	7.9073	8.5129	4.1452	5.0365	3.9519	9.4458	7.1214	100.3860

Table D.2 White Mesa Joint Frequency Meteorological Data

For the White Mesa site, it was assumed that two 100-acre cells would be available for dusting while drying prior to reclamation. Required mitigating actions to reduce dusting were assumed to reduce dust losses by 80 percent for these cells. It was also assumed that half of a third 100-acre cell being filled would be beach area and available for dusting. No control was assumed for the exposed beach area of the operational cell.

Dust losses from the six-acre ore storage pile were estimated by assuming they would be about one percent of those from an equivalent area of tailings beach.

D.2 ATMOSPHERIC TRANSPORT

The staff analysis of off site air concentrations of radioactive materials released at the White Mesa mill site has been based on a full year of meteorological data collected on site over the period 3/1/77 through 2/28/78 (Ref. 2). The collected meteorological data is entered into the UDAD code as input, after assemblage and reduction, in the form of a joint frequency distribution by stability class, wind speed group, and direction. The joint frequency data employed by the staff for this analysis are presented in Table D.2.

The dispersion model employed by the UDAD code is the basic straight-line Gaussian plume model (Ref. 1). Ground level, sector-average concentrations are computed using this model and are corrected for decay and ingrowth in transit (for Rn-222 and daughters) and for depletion due to deposition losses (for particulate material). Area sources are treated using a virtual point source technique. Resuspension into the air of particulate material initially deposited on ground surfaces is treated using a resuspension factor which depends on the age of the deposited material and its particle size (Ref. 1). For the isotopes of concern here, the total air concentration including resuspension is about 1.6 times the ordinary air concentration.

The assumed particle size distribution, particle density, and deposition velocities for each source are presented in Table D.3.

Table D.3 Physical Characteristics Assumed for Particulate Material Releases

Activity Source	Diameter, μm	Density, g/cm^3	Deposition Velocity, cm/sec	AMAD[a], μm
Crusher Dusts	1.0	2.4	1.0	1.55
Yellowcake Dusts	1.0	8.9	1.0	2.98
Tailings, Ore Pile	5.0 (30%)	2.4	1.0	7.75
Dusts	35.0 (70%)	2.4	8.8	54.2
In-grown Rn Daughters	--	1.0	0.3	0.3

[a]Aerodynamic equivalent diameter, used in calculating inhalation doses (Ref. 1).

D.3 CONCENTRATIONS IN ENVIRONMENTAL MEDIA

Information provided below describes the methods and data used by the staff to determine the concentrations of radioactive materials in the environmental media of concern in the vicinity of the White Mesa site. These include concentrations in the air (for inhalation and direct external exposure), on the ground (for direct external exposure), and in meat and vegetables (for ingestion exposure). Concentration values are computed explicitly by the UDAD code for U-238, Th-230, Ra-226, Rn-222 (air only), and Pb-210. Concentrations of Th-234, Pa-234, and U-234 are assumed to be equal to that of U-238. Concentrations of Bi-210 and Po-210 are assumed to be equal to that of Pb-210.

D.3.1 Air Concentrations

Ordinary, direct air concentrations are computed by the UDAD code for each receptor location, from each activity source, by particle size (for particulates). Direct air concentrations computed by UDAD include depletion by deposition (particulates) or the effects of ingrowth and decay in transit (radon and daughters). In order to compute inhalation doses, the total air concentration of each isotope at each location, as a function of particle size, is computed as the sum of the direct air concentration and the resuspended air concentration:

$$C_{aip}(t) = C_{aipd} + C_{aipr}(t) \quad \text{(D-3)}$$

where $C_{aip}(t)$ is the total air concentration of isotope i, particle size p, at time t, pCi/m^3;
C_{aipd} is the direct air concentration of isotope i, particle size p, (constant) pCi/m^3; and
$C_{aipr}(t)$ is the resuspended air concentration of isotope i, particle size p, at time t, pCi/m^3.

The resuspended air concentration is computed using a time dependent resuspension factor, R(t), defined by

$$R_p(t) = (1/V_p)10^{-5}\ e^{-\lambda_R t} \quad \text{(for } t \leq 1.82 \text{ yrs)} \qquad \text{(D-4a)}$$

$$R_p(t) = (1/V_p)10^{-9} \quad \text{(for } t > 1.82 \text{ yrs)} \qquad \text{(D-4b)}$$

where $R_p(t)$ is the ratio of the resuspended air concentration to the ground concentration, for a ground concentration of age t yrs, of particle size p, m^{-1};
V_p is the deposition velocity of particle size p, cm/sec;
λ_R is the assumed decay constant of the resuspension factor (equivalent to a 50-day halflife), 5.06 yr;
10^{-5} is the initial value of the resuspension factor (for particles with a deposition velocity of 1 cm/sec), m^{-1};
10^{-9} is the terminal value of the resuspension factor (for particles with a deposition velocity of 1 cm/sec), m^{-1}; and
1.82 is the time required to reach the terminal resuspension factor, yrs.

The basic formulation of the above expression for the resuspension factor, the initial and final values, and the assigned decay constant derive from experimental observations (Ref. 3). The inverse relationship to deposition velocity eliminates mass balance problems involving resuspension of more than 100% of the initial ground deposition for the 35 μm particle size (see Table D.3). Based on this formulation, the resuspended air concentration is given by

$$C_{aipr}(t) = 0.01\ C_{aipd} \left[10^{-5} \left\{ \frac{1 - \exp\left[-(\lambda_i^* + \lambda_R)\ 1.82\right]}{(\lambda_i^* + \lambda_R)} \right\} + 10^{-9} \left\{ \frac{\exp(-1.82\lambda_i^*) - \exp(-\lambda_i^* t)}{\lambda_i^*} \right\} \right] \qquad \text{(D-5)}$$

where λ_i^* is the effective decay constant for isotope i on soil (see Equation D-7), yr^{-1}; and
0.01 is m/cm.

Total air concentrations are computed using Equations D-5 and D-3 for all particulate effluents. Radon daughters which grow in from released radon are not depleted due to deposition losses and are therefore not assumed to resuspend.

D.3.2 Ground Concentrations

Concentrations of particulate materials in and on soil are computed from direct air concentrations. Resuspension of deposited activity is not treated as a loss mechanism and redeposition is ignored. Ground concentrations are given by

$$C_{gip}(t) = 0.01\ C_{aipd}\ V_p \left[\frac{1 - \exp(-\lambda_i^* t)}{\lambda_i^*} \right] \qquad \text{(D-6)}$$

where $C_{gip}(t)$ is the ground concentration of isotope i, particle size p, at time t, pCi/m^2; and

λ_i^* is the effective decay constant for isotope i on or in soil, yr^{-1};

and where $\lambda_i^* = \lambda_i + \lambda^*$ (D-7)

where λ_i is the radiological decay constant, yr^{-1}; and

λ^* is the assumed environmental loss constant for activity in soil (equivalent to a 50-yr halflife), 1.39×10^{-2}/yr.

In general, the half-lives of the pertinent isotopes are such that it is appropriate to assume either complete ingrowth or no ingrowth. However, ingrowth of Pb-210 from Ra-226 is treated explicitly using the standard Bateman formulation.

D.3.3 Vegetation Concentrations

Concentrations of released particulate materials can be environmentally transferred to the edible portions of vegetables, or to hay or pasture grass consumed by animals, by two mechanisms - direct foliar retention and root intake. Five categories of vegetation are treated by the staff modified version of the UDAD code. They are edible above ground vegetables, potatoes, other edible below ground vegetables, pasture grass, and hay. Vegetation concentrations are computed using the following equation

$$C_{vip} = 0.01\, V_p\, C_{aip}\, F_r\, E_v \left[\frac{1 - \exp(-\lambda_w t_v)}{Y_v \lambda_w} \right] + C_{gip} \frac{B_{vi}}{P} \qquad \text{(D-8)}$$

where B_{vi} is the soil to plant transfer factor for isotope i, vegetation type v, dimensionless;

C_{vip} is the resulting concentration of isotope i, particle size p, in vegetation v, pCi/kg;

E_v is the fraction of the foliar deposition reaching edible portions of vegetation v, dimensionless;

F_r is the fraction of the total deposition retained on plant surfaces, 0.2, dimensionless;

P is the assumed areal soil density for surface mixing, 240 kg/m^2;

t_v is the assumed duration of exposure while growing for vegetation v, sec;

Y_v is the assumed yield density of vegetation v, kg/m^2;

λ_w is the decay constant accounting for weathering losses (equivalent to a 14-day half-life), 6.73×10^{-7}/sec; and

0.01 is m/cm.

The value of E_v is assumed to be 1.0 for all above grounnd vegetation, and 0.1 for all below ground vegetables (Ref. 4). The value of t_v is taken to be 60 days, except for pasture grass where a value of 30 days is assumed. The yield density, Y_v, is taken to be 2.0 kg/m^2 except for pasture grass, where a value of 0.75 kg/m^2 is applied. Values of the soil to plant transfer coefficients, B_{vi}, are provided in Table D.4.

Table D.4 Environmental Transfer Coefficients

	U	Th	Ra	Pb
I. Plant/Soil (B_{vi}'s)				
a) Edible Above Ground:	2.5×10^{-3}	4.2×10^{-3}	2.0×10^{-2}	4.2×10^{-3}
b) Potatoes:	2.5×10^{-3}	4.2×10^{-3}	3.2×10^{-3}	4.2×10^{-3}
c) Other Below Ground:	2.5×10^{-3}	4.2×10^{-3}	2.0×10^{-2}	4.2×10^{-3}
d) Pasture Grass:	2.5×10^{-3}	4.2×10^{-3}	6.6×10^{-2}	7.8×10^{-2}
e) Stored Feed (Hay):	2.5×10^{-3}	4.2×10^{-3}	6.6×10^{-2}	7.8×10^{-2}
II. Beef/Feed (F_{bi}'s)				
pCi/kg per pCi/day:	3.4×10^{-4}	2.0×10^{-4}	3.0×10^{-3}	2.9×10^{-4}

D.3.4 Meat Concentrations

Radioactive materials can be deposited on grasses, hay, or silage which are eaten by meat animals, which are in turn eaten by man. For the White Mesa site, it has been assumed that meat animals obtain their entire feed requirement by grazing, 6 months per year, and by eating locally grown stored feed the remainder of the year. The equation used to estimate meat concentrations is

$$C_{mi} = Q\,F_{bi}\,(0.5\,C_{pgi} + 0.5\,C_{hi}) \qquad \text{(D-9)}$$

where C_{pgi} is the concentration of isotope i in pasture grass, pCi/kg;

C_{hi} is the concentration of isotope i in hay (or other stored feed), pCi/kg

C_{mi} is the resulting concentration of isotope i in meat, pCi/kg;

F_{bi} is the feed to meat transfer factor for isotope i, pCi/kg per pCi/day (see Table D.4);

Q is the assumed feed ingestion rate, 50 kg/day; and

0.5 is the fraction of the total annual feed requirement assumed to be satisfied by pasture grass or locally grown stored feed.

D.4 DOSES TO INDIVIDUALS

Doses to individuals have been calculated for inhalation, external exposure to air and ground concentrations, and ingestion of vegetables and meat. Internal doses are calculated by the staff using dose conversion factors which yield the 50-yr dose commitment, i.e., the entire dose insult received over a period of 50 years following either inhalation or ingestion. Annual doses given are the 50-yr dose commitments resulting from a one-year exposure period. The one-year exposure period was taken to be the final year of mill operation when environmental concentrations resulting from plant operations are expected to be at their highest level.

D.4.1 Inhalation Doses

Inhalation doses have been computed using air concentrations obtained by Equation D-3 (resuspended air concentrations are included) for particulate materials, and the dose conversion factors presented in Table D.5. These dose conversion factors have been computed by Argonne National Laboratory's UDAD code (Ref. 1) in accordance with the Task Ground Lung Model of the International Commission on Radiological Protection (Ref. 5).

Doses to the bronchial epithelium from Rn-222 and short-lived daughters were computed based on the assumption of indoor exposure at 100% occupancy. The dose conversion factor for bronchial epithelium exposure from Rn-222 is derived as follows (see Appendix I for additional details):

1) 1 pCi/m^3 Rn-222 = 5 x 10^{-6} Working level (WL).*

2) Continuous exposure to 1 WL = 25 cumulative working level months (WLM) per year.

3) 1 WLM = 5000 mrem (Ref. 6)

Therefore:

$$1\ pCi/m^3\ \text{Rn-222} \times (5 \times 10^{-6}\ \frac{WL}{pCi/m^3}) \times (25\ \frac{WLM}{WL}) \times (5000\ \frac{mrem}{WLM}) = 0.625\ mrem$$

and the Rn-222 bronchial epithelium dose conversion factor is taken to be 0.625 mrem/yr per pCi/m^3.

D.4.2 External Doses

External doses from air and ground concentrations are computed using the dose conversion factors provided in Table D.6 (Ref. 1). Doses were computed based on 100% occupany at the particular location. Indoor exposure was assumed to occur 14 hrs/day at a dose rate of 70% of the outdoor dose rate.

D.4.3 Ingestion Doses

Ingestion doses have been computed for vegetables and meat (beef and lamb). Ingestion doses reported are based on concentrations obtained using Equations D-8 and D-9, ingestion rates given

*One WL concentration is defined as any combination of short-lived radioactive decay products of Rn-222 in one liter of air that will release 1.3 x 10^5 MeV of alpha particle energy during their radioactive decay to Pb-210.

Table D.5 Inhalation Dose Conversion Factors (mrem/year/pCi/m^3)

Particle Size = 0.3 Microns	PB210	PO210
Whole Body	7.46E+00	1.29E+00
Bone	2.32E+02	5.24E+00
Kidney	1.93E+02	3.87E+01
Liver	5.91E+01	1.15E+01
Mass Average Lung	6.27E+01	2.66E+02

Particle Size = 1.0 Microns Density = 8.9 g/cm^3	U238	U234	TH230	RA226	PB210	PO210
Whole Body	1.44E+00	1.64E+00	1.37E+02	3.97E+01	9.42E+00	1.77E+00
Bone	2.42E+01	2.64E+01	4.90E+03	3.97E+02	2.87E+02	7.22E+00
Kidney	5.53E+00	6.30E+00	1.37E+03	1.40E+00	2.39E+02	5.33E+01
Liver	0.	0.	2.82E+02	4.94E-02	7.32E+01	1.59E+01
Mass Average Lung	2.13E+03	2.42E+03	2.37E+03	3.04E+02	2.49E+01	1.12E+02

Particle Size = 1.0 Microns Density = 2.4 g/cm^3	U238	U234	TH230	RA226	PB210	PO210
Whole Body	1.65E+00	1.87E+00	1.66E+02	3.40E+01	8.24E+00	1.54E+00
Bone	2.78E+01	3.03E+01	5.95E+03	3.40E+02	2.56E+02	6.29E+00
Kidney	6.33E+00	7.22E+00	1.67E+03	1.20E+00	2.13E+02	4.64E+01
Liver	0.	0.	3.43E+02	4.22E-02	6.53E+01	1.38E+01
Mass Average Lung	2.88E+03	3.28E+03	3.22E+03	4.04E+02	3.38E+01	1.48E+02

Particle Size = 5.0 Microns	U238	U234	TH230	RA226	PB210	PO210
Whole Body	1.16E+00	1.32E+00	1.01E+02	4.47E+01	1.00E+01	1.96E+00
Bone	1.96E+01	2.14E+01	3.60E+03	4.47E+02	3.11E+02	7.99E+00
Kidney	4.47E+00	5.10E+00	1.00E+03	1.57E+00	2.59E+02	5.89E+01
Liver	0.	0.	2.07E+02	5.55E-02	7.93E+01	1.76E+01
Mass Average Lung	1.24E+03	1.42E+03	1.38E+03	1.87E+02	1.45E+01	7.01E+01

Particle Size = 35.0 Microns	U238	U234	TH230	RA226	PB210	PO210
Whole Body	7.92E-01	9.02E-01	5.77E+01	4.40E+01	9.66E+00	1.93E+00
Bone	1.34E+01	1.46E+01	2.07E+03	4.40E+02	3.00E+02	7.84E+00
Kidney	3.05E+00	3.47E+00	5.73E+02	1.55E+00	2.50E+02	5.79E+01
Liver	0.	0.	1.19E+02	5.47E-02	7.65E+01	1.73E+01
Mass Average Lung	3.33E+02	3.80E+02	3.71E+02	6.38E+01	3.91E+00	2.58E+01

Table D.6 Dose Conversion Factors for External Exposure

Dose Factors for Doses from Air Concentrations, mrem/yr per pCi/m^3

ISOTOPE	SKIN	WHOLE BODY
U238	1.05E-05	1.57E-06
TH234	6.63E-05	5.24E-05
PAM234	8.57E-05	6.64E-05
U234	1.36E-05	2.49E-06
TH230	1.29E-09	3.59E-06
RA226	6.00E-05	4.90E-05
RN222	3.46E-10	2.83E-06
PO218	8.18E-07	6.34E-07
PB214	2.06E-03	1.67E-03
BI214	1.36E-02	1.16E-02
PO214	9.89E-07	7.66E-07
PB210	4.17E-05	1.43E-05

Table D.6 Cont'd

Dose Factors for Doses from Ground Concentrations, mrem/yr per pCi/m^2

ISOTOPE	SKIN	WHOLE BODY
U238	2.13E-06	3.17E-07
TH234	2.10E-06	1.66E-06
PAM234	1.60E-06	1.24E-06
U234	2.60E-06	4.78E-07
TH230	2.20E-06	6.12E-07
RA226	1.16E-06	9.47E-07
RN222	6.15E-08	5.03E-08
P0218	1.42E-08	1.10E-08
PB214	3.89E-05	3.16E-05
BI214	2.18E-04	1.85E-04
P0214	1.72E-08	1.33E-08
PB210	6.65E-06	2.27E-06

in Table D-7, and dose conversion factors given in Table D-8 (Ref. 1 and Ref. 7). Vegetable ingestion doses were computed assuming an average 50% activity reduction due to food preparation (Ref. 4). Ingestion doses to children and teenagers were computed but found to be equivalent to or less than doses to adults.

Table D.7 Assumed Food Ingestion Rates,[a] kg/yr

	Child	Teen	Adult
I. Vegetables (Total):	48	76	105
a) Edible Above Ground:	16	29	42
b) Potatoes	27	42	60
c) Other Below Ground:	5	5	3
II. Meat (Beef and Lamb):	28	45	78

[a] All data taken from Reference 4. Ingestion rates are averages for typical rural farm households. No allowance is credited for portions of year when locally or home grown food may not be available.

Table D.8 Ingestion Dose Conversion Factors (mrem/pCi ingested)

Age Group	Organ	238U	234U	234TH	230TH	226RA	210PB	210BI	210PO
Infant	Wh. Bod	3.33E-04	3.80E-04	2.00E-08	1.06E-04	1.07E-02	2.38E-03	3.58E-07	7.41E-04
	Bone	4.47E-03	4.88E-03	6.92E-07	3.80E-03	9.44E-02	5.28E-02	4.16E-06	3.10E-03
	Liver	0.	0.	3.77E-08	1.90E-04	4.76E-05	1.42E-02	2.68E-05	5.93E-03
	Kidney	9.28E-04	1.06E-03	1.39E-07	9.12E-04	8.71E-04	4.33E-02	2.08E-04	1.26E-02
Child	Wh. Bod	1.94E-04	2.21E-04	9.88E-09	9.91E-05	9.87E-03	2.09E-03	1.69E-07	3.67E-04
	Bone	3.27E-03	3.57E-03	3.42E-07	3.55E-03	8.76E-02	4.75E-02	1.97E-06	1.52E-03
	Liver	0.	0.	1.51E-08	1.78E-04	1.84E-05	1.22E-02	1.02E-05	2.43E-03
	Kidney	5.24E-04	5.98E-04	8.01E-08	8.67E-04	4.88E-04	3.67E-02	1.15E-04	7.56E-03
Teenager	Wh. Bod	6.49E-05	7.39E-05	3.31E-09	6.00E-05	5.00E-03	7.01E-04	5.66E-08	1.23E-04
	Bone	1.09E-03	1.19E-03	1.14E-07	2.16E-03	4.09E-02	1.81E-02	6.59E-07	5.09E-04
	Liver	0.	0.	6.68E-09	1.23E-04	8.13E-06	5.44E-03	4.51E-06	1.07E-03
	Kidney	2.50E-04	2.85E-04	3.81E-08	5.99E-04	2.32E-04	1.72E-02	5.48E-05	3.60E-03
Adult	Wh. Bod	4.54E-05	5.17E-05	2.13E-09	5.70E-05	4.60E-03	5.44E-04	3.96E-08	8.59E-05
	Bone	7.67E-04	8.36E-04	8.01E-08	2.06E-03	4.60E-02	1.53E-02	4.61E-07	3.56E-04
	Liver	0.	0.	4.71E-09	1.17E-04	5.74E-06	4.37E-03	3.18E-06	7.56E-04
	Kidney	1.75E-04	1.99E-04	2.67E-08	5.65E-04	1.63E-04	1.23E-02	3.83E-05	2.52E-03

REFERENCES FOR APPENDIX D

1. M. Momeni et al., "Uranium Dispersion and Dosimetry (UDAD) Code", Argonne National Laboratory Report, in preparation.

2. Personal communication (letter), Environmental Coordinator, Energy Fuels Nuclear, Inc., to U.S. NRC, November 8, 1978.

3. Generic Environmental Impact Statement on Uranium Milling, NUREG-0511, April 1979.

4. J. F. Fletcher and W. L. Dotson (compilers), "HERMES - A Digital Computer Code for Estimating Regional Radiological Effects from the Nuclear Power Industry", Hanford Engineering Development Laboratory, HEDL-TME-71-168, December 1971.

5. ICRP Task Group on Lung Dynamics, "Deposition and Retention Models for Internal Dosimetry of the Human Respiratory Tract", Health Physics 12:181, 1966.

6. National Academy of Sciences - National Research Council, "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," Report of the Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR), U.S. Government Printing Office, 1972.

7. G. R. Hoenes and J. K. Soldat, "Age - Specific Radiation Dose Conversion Factors for a One-Year Chronic Intake," Battelle Pacific Northwest Laboratories, U.S.NRC Report NUREG-0172, November 1977.

Appendix E

LETTER TO THE ADVISORY COUNCIL ON HISTORIC PRESERVATION

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

Advisory Council on
Historic Preservation
Western Office
Review & Compliance
ATTN: Mr. Louis S. Wall, Chief
P.O. Box 25085
Denver, Colorado 90203

Gentlemen:

Pursuant to 36 CFR 63.3 the U.S. Nuclear Regulatory Commission submitted to the Keeper of the National Register a request for a determination of eligibility for the area included within the site of the proposed Energy Fuels Nuclear, Inc., White Mesa Uranium Mill, with the exception of the NE1/4 of Section 33. T37S, R22E. (The NE1/4 of Section 33, T37S, R22E has been surveyed but the significance of the sites has not been determined.) The attached Preliminary Case Report and a proposal for the contents of a Memorandum of Agreement have been prepared and are being submitted pursuant to 36 CFR 800. Also attached is a letter from the Utah State Historic Preservation Officer which contains his concurrence on the proposal.

Sincerely,

Ross A. Scarano

Ross A. Scarano, Section Leader
Uranium Recovery Licensing Branch
Division of Waste Management

Enclosures: As Stated

cc: Mr. J. Phillip Keene III
Utah State Historic Preservation Officer
(w/o enclosures)

PRELIMINARY CASE REPORT
Concerning The Lands to be Impacted by the Proposed
White Mesa Uranium Mill

In response to a request by Energy Fuels Nuclear, Inc., the U.S. Nuclear Regulatory Commission proposes to issue a Source Material License to possess and use source material at a uranium mill to be located on the White Mesa approximately five (5) miles south of Blanding, Utah. Under the provisions of the Atomic Energy Act of 1954, as amended, and the regulations in Title 10, Code of Federal Regulations, Part 40, the activity is subject to statutory licensing provisions administered by the U.S. Nuclear Regulatory Commission. Energy Fuels Nuclear, Inc. submitted its application for a Source Material License on February 6, 1978. The application is being considered for approval under the applicable laws and regulations.

A draft environmental statement (DES), copy attached, relating to the proposed issuance of the Source Material License was issued in December of 1978. The DES provides a description of the proposed project and an assessment of the environmental impacts. Comments were requested and received from various agencies of the federal government, agencies of the state and local governments, and interested individuals. The target date for issuance of the final environmental statement (FES) is May 15, 1979. The area of the proposed mill lies within an archaeological district which has been determined to be eligible for inclusion in the National Register of Historic Places. A description of specific sites which will be affected by the project is set forth in reports issued by the Division of State History, State of Utah. The reports are attached hereto as Exhibits B, C, and D.

The opinion of the Utah State Historic Preservation Officer (SHPO) concerning the affected sites is stated in letters to the Nuclear Regulatory Commission dated December 5, 1978 and January 4, 1979, copies of which are attached hereto as Exhibits E and F.

Alternative locations for the proposed project have been considered by the Nuclear Regulatory Commission, the Utah SHPO and Energy Fuels. The Utah SHPO, in a letter to the Commission dated January 12, 1979, a copy of which is attached hereto as Exhibit G, stated that the project site selected by Energy Fuels will have the least adverse effect on archeological resources of any of the alternative sites considered in the area.

A proposal for the contents of a Memorandum of Agreement has been developed by the Commission and is being forwarded. Sites which can be feasibly and prudently avoided will be avoided.

Energy Fuels has agreed to pay the full cost of the data recovery program.

The cost of construction of the project from its inception to the date of the commencement of the operation is to borne solely by the Energy Fuels Nuclear, Inc. The federal government will not contribute to any part of the estimated cost of the project.

PRELIMINARY CASE REPORT

ENCLOSURES

1. U.S. Nuclear Regulatory Commission, "Draft Statement Related to the Operation of White Mesa Uranium Project, Energy Fuels Nuclear, Inc.," Docket No. 40-8681, December 1978.

2. Exhibit A - Map of the area south of Blanding, Utah. This map shows the entire White Mesa and surrounding areas. The area surveyed for archaeological sites is delineated by the checked, heavy line. This area covers all of the mill site with the exception of the NE¼ of Section 33 as well as additional area in Section 32, T37S, R22E. This map identifies by legal subdivision (sections) the District boundaries.

3. Exhibit B - "Archeological Test Excavations on White Mesa, San Juan County, Southeastern Utah," by LaMar Lindsay, May 1978.

   Note: The Plot Plan for the White Mesa Uranium Mill is included. The boundary of the mill site is delineated by the dark blue line and the area for designation as an Archeological District is delineated in pink. The pink line on the Plot Plan corresponds to the checked line on the map referred to in the description of Exhibit "A" above. The Plot Plan shows the individual archeological sites.

4. Exhibit C - "Additional Archeological Test Excavations and Inventory on the White Mesa, San Juan County, Southeastern Utah," by Asa S. Nielson, January 1979. Photographs are glossy black-and-white.

5. Exhibit D - Report prepared by David Merrill of the Utah State Historical Society. This report summarizes the findings of the historic survey of the White Mesa Area.

6. Exhibit E - Ltr from Utah SHPO to NRC, dated December 5, 1978.

7. Exhibit F - Ltr from Utah SHPO to NRC, dated January 4, 1979.

8. Exhibit G - Ltr from Utah SHPO to NRC, dated January 12, 1979.

05/01/79

PROPOSAL FOR THE CONTENTS OF A MEMORANDUM OF AGREEMENT

Concerning the Mitigation of Adverse Effect at the White Mesa Project Millsite

The U.S. Nuclear Regulatory Commission proposes to issue a Source Material License, pursuant to the Atomic Energy Act of 1954, (42 U.S.C. 2011ff., as amended, 68 Stat. 919), to Energy Fuels Nuclear Inc. in connection with its White Mesa Uranium Mill (hereinafter referred to as the "project") located approximately five (5) miles south of Blanding, Utah.

Energy Fuels Nuclear, Inc. has requested technical assistance from the Division of State History, State of Utah, in the identification, protection and management of cultural resources. This assistance has been provided in the form of cultural surveys and excavations on the lands involved in the project (project site). Those activities revealed numerous sites of cultural significance. (See Exhibits B, C and D.)

Accordingly, the Secretary of the Interior was requested to make a determination of eligibility. The resulting determination, as set forth in Exhibit E, is that the area delineated in Exhibit A constitutes a district which is part of some as yet undefined larger Archeological District eligible for inclusion in the National Register of Historic Places.

The U.S. Nuclear Regulatory Commission in consultation with the Utah State Historic Preservation Officer, has determined that the land-modifying operations associated with the licensed activities (hereinafter referred to as "undertaking") could have an adverse effect upon the property and pursuant to Section 106 of the National Historic Preservation Act of 1966 (16 U.S.C. 470F, as amended, 90 Stat. 1320), the U.S. Nuclear Regulatory Commission has requested the comments of the Advisory Council on Historic Preservation (hereinafter referred to as the "Council").

Pursuant to the regulations for the"Protection of Historic and Cultural Properties" (36 CFR Part 800), the Utah State Historic Preservation Officer and representatives of the Advisory Council on Historic Preservation, and the U.S. Nuclear Regulatory Commission have consulted and reviewed the undertaking to consider feasible and prudent alternatives to avoid, satisfactorily mitigate, or minimize the adverse effect. Energy Fuels Nuclear, Inc. was invited to participate in the consultation.

In the light of such consultation, the Commission agrees that it will take the following actions:

1. If the Commission issues a license for the undertaking, it will include conditions similar to the following therein:

   a. The licensee shall avoid by project design where feasible the sites designated "Eligible" in the attached Table A. Sites that will ultimately be located within 100 feet of the perimeter of the reclaimed tailings impoundment area are considered unavoidable and shall be recovered through archeological excavation.

   b. The licensee shall conduct testing as required to enable the Commission to determine if those sites designated "Undetermined" in Table A are of significance warranting their redesignation as "Eligible." This action by the licensee will be completed by January 1, 1981. In all cases such testing will be completed before any aspect of the undertaking affects a site.

   c. The licensee shall conduct archeological and historic surveys and testing on the NE1/4 of Section 33, T37S, R22E to identify such additional sites as may be located there and to enable the Commission to evaluate their significance. The results of surveys and testing shall be reported to the Commission no later than December 31, 1979. The licensee shall avoid any site within this area until the Commission has reviewed the licensee's report and has advised the licensee of its determinations. If the Commission, upon review, amends Table A to include additional sites, the licensee shall take such action with respect to such additional sites as may be required for the sites that have initially been designated.

   d. Condition c, above, will apply to lands associated with the undertaking, but which have not currently been identified, e.g., to borrow areas outside the current project boundaries, with the exception that the results of surveys and testing may be reported to the Commission after December 31, 1979.

   e. The licensee shall avoid any site designated "Undetermined" in Table A.

   f. When it is not feasible to avoid a site designated "Eligible" in Table A, the licensee shall institute a data recovery program with respect to the site which the Commission determines will satisfactorily mitigate any adverse effect.

g. The Commission may amend Table A, with the consent of the licensee, without amendment to this license. The licensee's failure to object within 10 days after the Commission amends Table A in writing shall be deemed to constitute its consent.

h. The licensee shall cooperate with the Commission in the development and implementation of a monitoring program with respect to the preservation of cultural resources. The licensee shall have obtained the approval of the Commission with respect to this program before initiation of ground-disturbing activities. The plan shall, among other things, include provision for (1) the presence during specified operations of an archeological contractor satisfactory to the Commission and (2) appropriate action, including notice to the Commission and the SHPO and suspension of ground disturbing activities, upon discovery of previously unidentified cultural resources. An archeological contractor acceptable to the SHPO and meeting the minimum standards for a principal investigator as specified by the Secretary of the Interior will be considered satisfactory to the Commission.

i. Thelicensee shall recover through archeological excavation all "Eligible" sites listed in Table A which are located in borrow areas, stockpile storage areas and construction areas. Recovery of all sites will be completed no later than December 31, 1982, with sites in the area of the first three tailings impoundment cells (the two evaporation cells and the first tailings cell) being recovered first.

j. The licensee shall have the archeological contractor specify the layout of haul raods, i.e., to best avoid sites, and shall obtain the approval of the Commission for this layout prior to earth moving activities.

k. The licensee shall provide the additional documentation required to obtain a determination of eligibility for the "Earth Dam", "Range War Site", "Kunen Jones Home", "Posey War Sites", and "White Mesa Community" cultural sites prior to October 1, 1979. If the Earthen Dam is determined to be "Eligible", the licensee shall ensure that the Earthen Dam is recorded prior to its demolition or alternation so that there will be a permanent record of its existence. Energy Fuels Nuclear, Inc., for the NRC, will first contact the Historic American Engineering Record (HAER), Heritage Conservation and Recreation Service (Department of the Interior, Washington, D.C. 20243; telephone (202) 343-4256) to determine the level of documentation required. All documentation must be accepted by the HAER prior to demolition or excavation.

TABLE A

Archeological Sites Related to the White Mesa Project

Eligible Sites		Undetermined Sites			Non-Eligible Sites
42Sa 6379	6699	42Sa 3766	6436	7685	42Sa 6380
6385	6739	6381	6437	7686	6384
6387	6740	6382	6438	7688	6386
6388	7653	6383	6440	7692	6397
6392	7655	6389	6442	7694	6404
6393	7656	6390	6445	7695	6684
6394	7657	6391	6686	7696	6685
6395	7658	6398	6697	7699	6754
6396	7659	6399	6752	7750	7654
6403	7660	6400	6753	7751	7698
6405	7661	6401	6757	7752	
6408	7665	6402	7662	7753	
6427	7668	6406	7663	7754	
6429	7675	6407	7664	7875	
6430	7684	6419	7669	7876	
6432	7687	6420	7670		
6435	7689	6421	7671		
6439	7690	6422	7672		
6441	7691	6423	7673		
6443	7693	6424	7674		
6444	7696	6425	7676		
6698	7700	6426	7679		
		6428	7680		
		6431	7681		
		6433	7682		
		6434	7683		
Total: 44		Total: 67			Total: 10

2. The Commission will review all determinations of the State Historic Preservation Officer with respect to sites whose status (eligibility) has to date been found to be "undetermined" or which are subsequently reported to the Commission as a result of surveys or discovery during the conduct of the undertaking. If the Commission concurs with the determinations of the SHPO, the Commission will take the indicated administrative action (i.e., amend Table A, as referred to in the license conditions). If the Commission does not concur with the determinations of the SHPO, it will request the comments of the Council before any adverse effects upon such sites are permitted.

3. The Commission will consult with the SHPO with respect to any data recovery program to be undertaken by the licensee to mitigate adverse effects and with respect to the monitoring program which the licensee will be required to implement. If the Commission concurs with the recommendations of the SHPO, it will require the licensee to institute programs in accordance therewith. Otherwise, the Commission will request the comments of the Council before any adverse effects upon the affected sites are permitted.

4. The Commission will consult with the SHPO with respect to the layout of haul roads prior to giving its approval to any request of the licensee with respect thereto.

5. The Commission will exercise its inspection and enforcement authority in good faith to assure that the activities of the licensee are carried out in accordance with its license and the provisions of this Agreement.

6. The Commission will submit to the Keeper of the National Register a request to expand the area of the Archeological District to include the NE1/4 of Section 33, T37S, R22E, when initial determinations have been made concerning the significance of individual sites within that area.

PROPOSAL FOR THE CONTENTS OF A MEMORANDUM OF AGREEMENT

ENCLOSURES

1. Exhibit A - Map of the area south of Blanding, Utah. This map shows the entire White Mesa and surrounding areas. The area surveyed for archaeological sites is delineated by the checked, heavy line. This area covers all of the mill site with the exception of the NE¼ of Section 33 as well as additional area in Section 32, T37S, R22E. This map identifies by legal subdivision (sections) the District boundaries.

2. Exhibit B - "Archeological Test Excavations on White Mesa, San Juan County, Southeastern Utah," by LaMar Lindsay, May 1978.

   Note: The Plot Plan for the White Mesa Uranium Mill is included. The boundary of the mill site is delineated by the dark blue line and the area for designation as an Archeological District is delineated in pink. The pink line on the Plot Plan corresponds to the checked line on the map referred to in the description of Exhibit "A" above. The Plot Plan shows the individual archeological sites.

3. Exhibit C - "Additional Archeological Test Excavations and Inventory on the White Mesa, San Juan County, Southeastern Utah," by Asa S. Nielson, January 1979. Photographs are glossy black-and-white.

4. Exhibit D - Report prepared by David Merrill of the Utah State Historical Society. This report summarizes the findings of the historic survey of the White Mesa Area.

5. Exhibit E - Ltr from Keeper of the National Register, National Park Service, DOI to NRC, dated April 26, 1979.

NOTE: Exhibits A, B. C and D are common to both the Preliminary Case Report and the proposal for a Memorandum of Agreement.

STATE OF UTAH

Scott M. Matheson, Governor

DEPARTMENT OF DEVELOPMENT SERVICES

J. Phillip Keene III
Executive Director
104 State Capitol
Salt Lake City, Utah 84114
Telephone: (801) 533-5961

May 3, 1979

Mr. Ross A. Scarano, Section Leader
Uranium Mill Licensing Section
Fuel Processing and Fabrication Branch
Division of Fuel Cycle and
Material Safety
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

RE: Proposal for the Contents of a Memorandum of Agreement
White Mesa, San Juan County

Dear Mr. Scarano:

The staff has reviewed the proposed memorandum of agreement. The memorandum of agreement will satisfy the necessary mitigation under the requirements of 106 review procedures.

However, the agreement does call for some unnecessary mitigation by the developer. We would like to review these items individually at a later date.

If you have any questions, please contact Wilson G. Martin, 801-533-6017, or Jim Dykman, 801-533-6000.

Sincerely,

J. Phillip Keene III
Executive Director
and
State Historic Preservation Officer

cc: Energy Fuels Nuclear, Suite 900, Three Park Central, 1515 Arapahoe Drive, Denver, CO 80202

WGM:jr:B746SJ

PS: Table A should be amended to list sites 6391, 6436, 6437, 6445, 6686, 6697, 6757, 7696 in Eligible column, instead of Undetermined. The table is correct to the best of our knowledge except for the above change.

DIVISION OF: INDUSTRIAL PROMOTION · TRAVEL DEVELOPMENT · EXPOSITIONS · STATE HISTORY · FINE ARTS

Appendix F

RADON RELEASE DURING MILLING OPERATIONS

APPENDIX F. RADON RELEASE DURING MILLING OPERATIONS

F.1 ORE PADS

The radon-222 release from the ore pad can be estimated by the following data and assumptions:

Area of the ore pads (A)	2.43×10^8 cm^2 (6 acres)
Thickness of ore piles (t)	670 cm (22 ft) — maximum case; and 305 cm (10 ft) — equilibrium case
Radium-226 concentration (C_{Ra})	423 pCi per gram of ore
Density of ore (ρ)	1.6 g/cm^3
Decay constant of radon-222 (λ)	2.1×10^{-6} sec^{-1}
D_e/v (diffusion coefficient/void fraction)	2.5×10^{-2} cm^2/sec
Radon emanation coefficient (generic value given, actual ore from numerous mines may vary widely) (E).	0.2

The radon-222 flux (J) at the surface of an area with a finite depth of uniform material may be estimated:

$$J = C_{Ra}\rho E \sqrt{\lambda(D_e/v)} \tanh[\sqrt{\lambda/(D_e/v)}t] \ ,$$

where the symbols are as defined above.

The hyperbolic tangent factor corrects the infinite thickness radon flux for the thickness of the pile. Substituting into this correction factor for a 670-cm (22-ft) pile and a 305-cm (10-ft) pile reveal that the radon release is reduced by $\underline{9} \times 10^{-6}$% and 0.75% respectively. This reduction is negligible so the piles may be considered infinitely thick.

The radon flux (J) for an infinitely thick pile is given by

$$J = C_{Ra}\rho E \sqrt{\lambda(D_e/v)} \ .$$

Substitution of the above values gives

$$J = (423 \text{ pCi/g})(1.6 \text{ g/cm}^3)(0.2)\sqrt{(2.1 \times 10^{-6} \text{ sec}^{-1})(2.5 \times 10^{-2} \text{ cm}^2\text{/sec})} = 0.031 \text{ pCi/cm}^2\cdot\text{sec} \ .$$

Multiplication by the area gives the release rate:

$$JA = (0.031\ \text{pCi/cm}^2\cdot\text{sec})(2.43 \times 10^8\ \text{cm}^2) = 7.54 \times 10^6\ \text{pCi/sec} = 7.54\ \mu\text{Ci/sec} = 240\ \text{Ci/year}\ .$$

This value applied to both the maximum and equilibrium stockpiles, as the flux is a function of area rather than thickness.

F.2 TAILINGS IMPOUNDMENT

For fill operations and prereclamation conditions the impoundment is assumed to have areas of saturated tailings, areas of moist tailings, and areas of relatively dry tailings. The following data and assumptions were used to determine radon-222 release rates from the different areas.

Radium concentration (C_{Ra}) of solids	423 pCi/g
Density	1.6 g/cm^3
Emanation factor	0.2
D_e/v for dry tailings (8% moisture)	5 x 10^{-2} cm^2/sec (ref. 1, Table 9.29)
D_e/v for moist tailings (15% moisture)	1 x 10^{-2} cm^2/sec (ref. 1, Table 9.29)
D_e/v for saturated tailings (37% moisture)	5.7 x 10^{-6} cm^2/sec (ref. 1, Table 9.29)

The "infinite thickness" flux is calculated by the expression

$$J_\infty = C_{Ra}\rho E \sqrt{\lambda(D_e/v)}\quad .$$

Substitution of the above values gives

J_∞, dry tails = 439 pCi/m^2-sec;

J_∞, moist tails = 196 pCi/m^2-sec; and

J_∞, saturated tails = 4.7 pCi/m^2-sec.

Based on the conservative assumptions of 40 ha (100 acres) dry tails, 40 ha (100 acres) moist tails, and 20 ha (50 acres) saturated tails, the annual radon-222 release from the tailings impoundment system is calculated to be 8064 Ci. Radon releases from ponded areas are negligible. Radon-222 releases from dry, moist, and saturated tails are 5552 Ci/yr, 2482 Ci/yr, and 30 Ci/yr, respectively.

F.3 TAILINGS COVER REQUIREMENTS

The following formula was used in calculating the reduction in radon flux produced by the proposed cover system:

$$J = J_\rho \exp\left[-\sum_{i=1}^{n}\sqrt{\lambda/(D_e/v)_i}\, x_i\right],$$

where

i = the ith layer of a multicomponent cover (n is the number of components) ,

λ = decay constant for radon-222 (2.1×10^{-6} sec^{-1}) ,

x = thickness of cover layer (cm) ,

J = resulting radon flux after attenuation through cover ($pCi/m^2 \cdot sec$) ,

J_ρ = radon flux at the surface of the tailings ($pCi/m^2 \cdot sec$) .

The cover proposed by the applicant consists of 61 cm (2 ft) of compacted clay overlain by 1.2 m (4 ft) of silt-sand soil, a 1.8-m (6-ft) layer of rock overburden material, and 15 cm (0.5 ft) of topsoil. The estimated D_e/v for these materials are 1.2×10^{-3} cm^2/sec for the clay and 2.2×10^{-2} cm^2/sec for the rest of the cover.[2] The dry tailings (8% moisture) infinite thickness flux of 439 $pCi/m^2 \cdot sec$ is assumed to model the long-term conditions for the system. Substitution of these values into the equation yields

$$J = (439\ pCi/m^2 \cdot sec)\exp\left\{-\sqrt{(2.1 \times 10^{-6})/(2.2 \times 10^{-2})}(320) - \sqrt{(2.1 \times 10^{-6})/(1.2 \times 10^{-3})}(61)\right\}$$

$$= (439\ pCi/m^2 \cdot sec)(3.42 \times 10^{-3})$$

$$= 1.5\ pCi/m^2 \cdot sec\ .$$

As reported in the Supplemental Environmental Report[3] the average background flux is 0.64 $pCi/m^2 \cdot sec$. Because of its thickness, the silt-sand material is expected to contribute background flux, so the total radon flux would be essentially twice background. The proposed cover is adequate for areas where there is no significant accumulation of slimes. The applicant's proposed operating plan should prevent excessive sand-slimes segregation.

REFERENCES FOR APPENDIX F

1. R. E. Blanco et al., *Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents*, vol. 1, Report ORNL/TM-4903, Oak Ridge National Laboratory, Oak Ridge, Tenn., May 1975, Table 9.29.

2, Energy Fuels Nuclear, Inc., *Supplement to the Proposed Tailings Disposal System, White Mesa Uranium Project,* Oct. 16, 1978.

3. Energy Fuels Nuclear, Inc., *Supplemental Report, Baseline Radiology Environmental Report, White Mesa Uranium Project, San Juan County, Utah,* Sept. 26, 1978, p. 15.

Appendix G

CALCULATIONS OF TAILINGS PILE GAMMA RADIATION ATTENTUATION

APPENDIX G

CALCULATIONS OF TAILINGS PILE GAMMA RADIATION ATTENUATION

Assuming soil to be composed mainly of SiO_2, the mass attenuation coefficient for 1-2 MeV gamma ray is 0.0518 cm^2/g.[1] (Most of the dose rate from a typical natural emitter is in this range.[2]) Assuming the gamma radiation from the uncovered tailings pile to be approximately 12 R/year (same as for Bear Creek project) and the bulk density of the soil to be 1.5 g/cm^3, the effect of the 3.28 m (10.75 ft) of soil materials proposed (excluding the shale layer) would reduce the gamma radiation to approximately 10.3 pR year.

$$I/I_o = \exp[-(\mu en/\rho)\rho x] = \exp[-(0.0518\ cm^2/g)(1.5\ g/cm^3)(328\ cm)] = 8.5 \times 10^{-12}\ ;$$

$$I = (8.5 \times 10^{-12})(12\ R/year) = 10.3\ pR/year\ .$$

The background radiation dose as measured by the applicant[3] is 77.7 mR/year. The gamma radiation from the deposited tailings would be insignificant compared to the natural gamma background.

REFERENCES FOR APPENDIX G

1. U.S. Department of Health, Education, and Welfare, *Radiological Health Handbook*, U.S. Government Printing Office, Washington, D.C., January 1970, p. 139.

2. H. May and L. D. Marinelli, "Cosmic Ray Contribution to the Background of Low Level Scintillation Spectrometry," Chap. 29 in *The Natural Radiation Environment*, J. A. S. Adams and W. M. Lowder, Eds., University of Chicago Press, Chicago, 1964.

3. Energy Fuels Nuclear, Inc., *Supplemental Report, Baseline Radiology Environmental Report, White Mesa Uranium Project*, Sept. 26, 1978, p. 27.

Appendix H

ATMOSPHERIC DISPERSION COEFFICIENTS

APPENDIX H

ATMOSPHERIC DISPERSION COEFFICIENTS

Tables H.1 through H.4 list χ/Q (sec/m^3) values calculated by the staff using AIRDOS-II, a FORTRAN computer code,[1] and onsite meteorological data supplied by the applicant.[2]

Table H.1. Annual average χ/Q (sec/m^3) at various distances for the 16 compass directions, release height 1 m

Wind	Distance from effluent (m)						
Toward	335	790	940	1095	1400	1720	2400
N	7.13E-6	1.23E-6	8.55E-7	6.35E-7	3.96E-7	2.66E-7	1.39E-7
NNW	5.19E-6	9.05E-7	6.34E-7	4.72E-7	2.96E-7	2.00E-7	1.05E-7
NW	6.65E-6	1.16E-6	8.09E-7	6.01E-7	3.76E-7	2.54E-7	1.33E-7
WNW	3.94E-6	6.88E-7	4.82E-7	3.59E-7	2.25E-7	1.52E-7	7.99E-8
W	3.00E-6	5.03E-7	3.49E-7	2.58E-7	1.60E-7	1.07E-7	5.58E-8
WSW	2.54E-6	4.32E-7	3.01E-7	2.23E-7	1.39E-7	9.38E-8	4.91E-8
SW	6.34E-6	1.06E-6	7.33E-7	5.42E-7	3.38E-7	2.27E-7	1.19E-7
SSW	1.04E-5	1.69E-6	1.17E-6	8.59E-7	5.34E-7	3.57E-7	1.85E-7
S	5.31E-5	8.24E-6	5.62E-6	4.09E-6	2.51E-6	1.66E-6	8.36E-7
SSE	2.88E-5	4.54E-6	3.11E-6	2.27E-6	1.40E-6	9.28E-7	4.72E-7
SE	2.54E-5	3.98E-6	2.72E-6	1.98E-6	1.22E-6	8.09E-7	4.11E-7
ESE	9.82E-6	1.57E-6	1.08E-6	7.93E-7	4.91E-7	3.27E-7	1.68E-7
E	8.40E-6	1.37E-6	9.46E-7	6.96E-7	4.32E-7	2.89E-7	1.49E-7
ENE	6.09E-6	1.03E-6	7.20E-7	5.33E-7	3.34E-7	2.25E-7	1.18E-7
NE	1.27E-5	2.16E-6	1.51E-6	1.12E-6	6.99E-7	4.71E-7	2.47E-7
NNE	1.00E-5	1.73E-6	1.21E-6	9.01E-7	5.65E-7	3.82E-7	2.01E-7

Table H.2. Annual average χ/Q (sec/m^3) at various distances for the 16 compass directions, release height 6 m

Wind	Distance from effluent (m)						
Toward	335	790	940	1095	1400	1720	2400
N	7.10E-6	1.54E-6	1.09E-6	8.13E-7	5.10E-7	3.43E-7	1.79E-7
NNW	5.10E-6	1.11E-6	7.93E-7	5.93E-7	3.74E-7	2.53E-7	1.33E-7
NW	6.61E-6	1.43E-6	1.02E-6	7.60E-7	4.78E-7	3.23E-7	1.69E-7
WNW	3.91E-6	8.42E-7	5.99E-7	4.48E-7	2.82E-7	1.91E-7	1.00E-7
W	2.94E-6	6.70E-7	4.75E-7	3.53E-7	2.21E-7	1.48E-7	7.67E-8
WSW	2.34E-6	5.53E-7	3.95E-7	2.95E-7	1.87E-7	1.27E-7	6.64E-8
SW	6.05E-6	1.44E-6	1.02E-6	7.60E-7	4.77E-7	3.21E-7	1.66E-7
SSW	9.24E-6	2.34E-6	1.67E-6	1.24E-6	7.85E-7	5.28E-7	2.74E-7
S	4.59E-5	1.22E-5	8.63E-6	6.42E-6	4.02E-6	2.69E-6	1.37E-6
SSE	2.42E-5	6.49E-6	4.63E-6	3.45E-6	2.17E-6	1.46E-6	7.50E-7
SE	2.18E-5	5.78E-6	4.11E-6	3.06E-6	1.92E-6	1.28E-6	6.57E-7
ESE	8.61E-6	2.22E-6	1.58E-6	1.18E-6	7.41E-7	4.97E-7	2.56E-7
E	7.52E-6	1.88E-6	1.34E-6	9.97E-7	6.28E-7	4.22E-7	2.19E-7
ENE	5.57E-6	1.34E-6	9.58E-7	7.17E-7	4.54E-7	3.07E-7	1.61E-7
NE	1.20E-5	2.77E-6	1.97E-6	1.47E-6	9.30E-7	6.27E-7	3.28E-7
NNE	9.58E-6	2.17E-6	1.54E-6	1.16E-6	7.30E-7	4.94E-7	2.59E-7

Table H.3. Annual average χ/Q (sec/m^3) at various distances for the 16 compass directions, release height 13.7 m

Wind Toward	Distance from effluent (m) 335	790	940	1095	1400	1720	2400
N	3.92E-6	1.19E-6	9.31E-7	7.43E-7	5.06E-7	3.61E-7	2.02E-7
NNW	2.81E-6	8.78E-7	6.84E-7	5.45E-7	3.71E-7	2.64E-7	1.48E-7
NW	3.67E-6	1.13E-6	8.80E-7	7.01E-7	4.77E-7	3.39E-7	1.90E-7
WNW	2.22E-6	6.79E-7	5.25E-7	4.16E-7	2.82E-7	2.00E-7	1.12E-7
W	1.29E-6	4.76E-7	3.84E-7	3.13E-7	2.18E-7	1.58E-7	8.91E-8
WSW	9.58E-7	3.83E-7	3.11E-7	2.55E-7	1.79E-7	1.30E-7	7.43E-8
SW	2.15E-6	9.47E-7	7.85E-7	6.51E-7	4.63E-7	3.39E-7	1.94E-7
SSW	2.21E-6	1.37E-6	1.18E-6	1.00E-6	7.32E-7	5.43E-7	3.16E-7
S	5.82E-6	6.28E-6	5.70E-6	4.95E-6	3.70E-6	2.78E-6	1.63E-6
SSE	3.11E-6	3.36E-6	3.05E-6	2.65E-6	1.97E-6	1.48E-6	8.73E-7
SE	3.25E-6	3.02E-6	2.73E-6	2.37E-6	1.76E-6	1.32E-6	7.75E-7
ESE	1.76E-6	1.25E-6	1.10E-6	9.36E-7	6.88E-7	5.12E-7	2.99E-7
E	2.10E-6	1.12E-6	9.61E-7	8.11E-7	5.88E-7	4.35E-7	2.52E-7
ENE	2.04E-6	8.95E-7	7.38E-7	6.09E-7	4.32E-7	3.16E-7	1.82E-7
NE	5.30E-6	1.94E-6	1.57E-6	1.28E-6	8.96E-7	6.50E-7	3.70E-7
NNE	4.74E-6	1.60E-6	1.27E-6	1.02E-6	7.09E-7	5.10E-7	2.89E-7

Table H.4. Annual average χ/Q (sec/m^3) at various distances for the 16 compass directions, release height 27.4 m

Wind Toward	Distance from effluent (m) 335	790	940	1095	1400	1720	2400
N	2.06E-6	8.07E-7	6.38E-7	5.20E-7	3.72E-7	2.81E-7	1.75E-7
NNW	1.35E-6	5.88E-7	4.69E-7	3.84E-7	2.76E-7	2.09E-7	1.30E-7
NW	1.82E-6	7.62E-7	6.06E-7	4.95E-7	3.55E-7	2.68E-7	1.67E-7
WNW	1.07E-6	4.63E-7	3.69E-7	3.01E-7	2.15E-7	1.61E-7	9.93E-8
W	5.68E-7	2.76E-7	2.27E-7	1.91E-7	1.44E-7	1.13E-7	7.43E-8
WSW	3.95E-7	2.07E-7	1.73E-7	1.48E-7	1.14E-7	9.04E-8	6.04E-8
SW	7.43E-7	4.74E-7	4.05E-7	3.53E-7	2.79E-7	2.27E-7	1.56E-7
SSW	5.82E-7	5.13E-7	4.73E-7	4.38E-7	3.75E-7	3.23E-7	2.37E-7
S	1.02E-6	1.50E-6	1.57E-6	1.61E-6	1.56E-6	1.44E-6	1.15E-6
SSE	5.01E-7	7.99E-7	8.43E-7	8.64E-7	8.33E-7	7.72E-7	6.12E-7
SE	7.49E-7	7.94E-7	8.01E-7	8.03E-7	7.58E-7	6.97E-7	5.48E-7
ESE	4.85E-7	4.12E-7	3.90E-7	3.71E-7	3.29E-7	2.90E-7	2.19E-7
E	7.67E-7	4.69E-7	4.15E-7	3.74E-7	3.11E-7	2.64E-7	1.91E-7
ENE	7.59E-7	4.47E-7	3.82E-7	3.32E-7	2.62E-7	2.12E-7	1.45E-7
NE	2.45E-6	1.12E-6	9.15E-7	7.72E-7	5.83E-7	4.60E-7	3.04E-7
NNE	2.28E-6	9.86E-7	7.96E-7	6.62E-7	4.88E-7	3.78E-7	2.44E-7

REFERENCES FOR APPENDIX H

1. R. E. Moore, *The AIRDOS-II Computer Code for Estimating Radiation Dose to Man from Airborne Radionuclides in Areas Surrounding Nuclear Facilities*, Report ORNL-5425, Oak Ridge National Laboratory, Oak Ridge, Tenn., 1977.

2. Dames and Moore, "Supplemental Report, Meteorology and Air Quality, Environmental Report, White Mesa Uranium Project, San Juan County, Utah, for Energy Fuels Nuclear, Inc." Denver, Sept. 6, 1978.

APPENDIX I

RADON DOSE CONVERSION FACTORS

APPENDIX I. RADON DOSE CONVERSION FACTORS

The basis upon which the NRC staff has relied for its radon daughter inhalation dose conversion factor consists of the following major component parts:

1. The indoor working level (WL) concentration resulting from an outdoor radon-222 concentration of 1 pCi/m^3 is approximately 5.0×10^{-6} WL;

2. The number of cumulative working level months (WLM) exposure per year for an average individual at a constant concentration of one WL is 25 WLM/yr; and

3. The committed dose equivalent to the bronchial epithelium (basal cell nuclei of segmented bronchi) per unit WLM exposure is 5000 mrem (5 rem).

These component parts enter into the following equation which yields the radon-222 inhalation dose conversion factor used by the staff:

$$\frac{5.0 \times 10^{-6}\ \text{WL}}{1\ \text{pCi/m}^3} \times \frac{25\ \text{WLM/yr}}{\text{WL}} \times \frac{5000\ \text{mrem}}{\text{WLM}} = \frac{0.625\ \text{mrem/yr}}{1\ \text{pCi/m}^3}$$

Each of the three components identified above derive from sources and data identified below:

1. 5×10^{-6} WL per pCi/m^3 of radon-222 is established by the assumed indoor air concentration ratios for radon-222, polonium-218, lead-214, and bismuth-214 of 1.0/0.90/0.51/and 0.35. These concentration ratios and the derived conversion factor are representative of conditions in a reasonably well ventilated structure (Refs. 1 and 2).

2. 25 WLM/yr per WL concentration derives from the assumption that an average individual's average breathing rate will be about 50 percent of that of a working miner. A WLM is defined, in terms of exposure to a working miner, as one month's occupational exposure to a one-WL concentration. This assumed breathing rate would result in an average individual receiving about 0.5 WLM as a result of the same length of exposure to air at a one-WL concentration. The following relationship applies:

$$(8760\ \text{hrs/yr}) \times \frac{12\ \text{WLM/yr-WL}}{40\ \text{hrs/wk} \times 52\ \text{wks/yr}} \times 0.5 = 25\ \text{WLM/yr-WL}$$

3. Five rem/WLM is the value derived from applying a quality factor (QF) of 10 for alpha radiation, to convert from rad to rem (Refs. 1, 2, and 3), to the figure of 0.5 rad/WLM as reported in the BEIR Report (Ref. 3, page 148).

The staff considers the above basis for its radon-222 inhalation dose conversion factor to be both sound and reasonable. The staff acknowledges that radon dosimetry is extremely complex and strongly influenced by assumed environmental and biological conditions. In view of the large variations induced by rather small changes in the assumed free-ion fraction, relative equilibrium, thickness of the intervening tissue and mucous layers, etc., the staff has endeavored to use physical, environmental, and other data reasonably representative of average conditions.

References for Appendix I

1. "Potential Radiological Impact of Airborne Releases and Direct Gamma Radiation to Individuals Living Near Inactive Uranium Mill Tailings Piles," U.S. EPA, EPA-520/1-76-001, January 1976.

2. "Environmental Analysis of the Uranium Fuel Cycle, Part I--Fuel Supply," U.S. EPA, EPA-520/9-73-003-B, October 1973.

3. "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," Report of the Advisory Committee on the Biological Effects of Ionizing Radiations (BEIR), National Academy of Sciences - National Research Council, November 1972.

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16. ABSTRACT *(200 words or less)*

A Final Environmental Statement for Energy Fuels Nuclear, Inc. related to issuance of a source material license for the White Mesa Uranium Project to be located in San Juan County, Utah (Docket No. 40-8681) has been prepared by the Office of Nuclear Material Safety and Safeguards. This statement provides (1) a summary of environmental impacts and adverse effects of the proposed action, and (2) a consideration of principal alternatives. Also included are comments of governmental agencies and other organizations on the Draft Environmental Statement for this project and staff responses to these comments. The NRC has concluded that, after weighing the environmental, economic, technical, and other benefits of the White Mesa Uranium Project against environmental and other costs and considering available alternatives, the action called for is issuance of a source material license, subject to stipulated conditions.

17. KEY WORDS AND DOCUMENT ANALYSIS

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