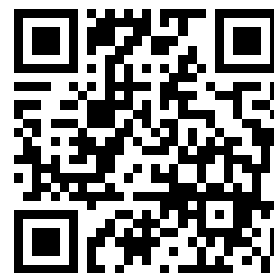


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NRC W-4  
**final**

Has DEIS  
**NUREG-0532**

# **environmental statement**

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**related to operation of**

## **MORTON RANCH URANIUM MILL**

**UNITED NUCLEAR CORPORATION**

**FEBRUARY 1979**

**Docket No. 40-8602**

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NUREG-0532

# FINAL ENVIRONMENTAL STATEMENT

related to the

United Nuclear Corporation

MORTON RANCH, WYOMING URANIUM MILL  
(CONVERSE COUNTY, WYOMING)

prepared by the

U. S. Nuclear Regulatory Commission  
Washington, D. C. 20555

February 1979



## 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 United Nuclear Corporation for the construction and operation of the proposed Morton Ranch Uranium Mill with a product (yellowcake) production limited to 1,008,640 kg (2,400,000 lb) per year.
3. Summary of environmental impacts and adverse effects:
  - a. Impacts to the area due to the operation of the Morton Ranch Uranium Mill will result in:
    - Alterations of up to 110 ha (270 acres) that will be occupied by the mill, mill facilities, tailings areas, and roads.
    - 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 construction and operation.
    - Socioeconomic effects on the towns of Glenrock and Douglas, Wyoming, where the majority of mill workers will be housed during mill construction and operation.
    - Solid waste material (tailings solids) from the mill will be produced at a rate of about 2000 tons ( $1.8 \times 10^6$  kg) per day and will be deposited onsite in exhausted surface mine pits. The excess liquid portion of the tailings will be decanted and pumped to an onsite evaporation pond for disposal.
  - b. Surface water will not be affected by normal milling operations. Mill process water will be taken from mine sumps (at a rate of 390 gpm) and supplemented by recycling from the tailings disposal pits or evaporation pond.
  - 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 individuals at the principal towns near the mill site are presented on the next page. Natural background doses are also presented for comparison. These dose estimates were based on a projected population in the year 2005. The dose commitments from normal operations of the proposed Morton Ranch mill will represent only very small increases in the radiation dose rates from current background radiation sources.
  - d. Construction and operation of the Morton Ranch mill will require the commitment of small amounts of chemicals and fossil fuels relative to their abundance.
  - e. Construction and operation of the Morton Ranch mill will provide employment and induced economic benefits for the region, but may also result in some socioeconomic stress.
  - f. The exhausted mine pits, occupying approximately 55 ha (135 acres) when filled with tailings solids, should be considered 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. The evaporation pond can be reclaimed and returned to productive use shortly after the mill is decommissioned. The reclaimed areas remaining after milling operations cease will modify the area's topography, and, to some onlookers, lessen the area's esthetic appeal.

Annual Population Dose Commitments and Background-Radiation Doses  
(man-rem) to Principal Towns Near the Mill Site  
in the Year 2005

| Location | Whole-Body                             | Bone           | Lung           | Bronchial Epithelium |
|----------|----------------------------------------|----------------|----------------|----------------------|
| Glenrock | 0.226 <sup>a</sup><br>999 <sup>b</sup> | 0.39<br>977    | 0.66<br>1,000  | 6.48<br>1,690        |
| Casper   | 0.770<br>15,400                        | 1.94<br>15,100 | 3.01<br>15,500 | 50.4<br>26,100       |
| Douglas  | 1.68<br>2,610                          | 2.50<br>2,550  | 3.43<br>2,620  | 25.2<br>4,410        |

<sup>a</sup>Values on the top line of each pair give the dose to the whole body or organ from one year of exposure integrated over a 50-year period (i.e., equivalent to the dose received in the 50th year of a continuous, 50-year exposure and multiplied by the projected population of the town).

<sup>b</sup>Values on the bottom line of each pair give the annual dose from background radiation multiplied by the population projected for each town.

4. Principal alternatives considered are:

- 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
- f. Alternative of no licensing action on 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  
Department of Environmental Quality, State of Wyoming  
Board of Commissioners, Converse County, Wyoming

Their comments and those of other agencies and individuals appear in Appendix A of this document.

6. This Final Environmental Statement was made available to the public, to the Environmental Protection Agency, and to other specified agencies in February 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 Morton Ranch mill should be subject to the following conditions for the protection of the environment:

- a. The applicant shall construct a tailings-disposal facility that will incorporate the features considered under Option L of Section 10.4. The evaporation pond dam shall be constructed so as to satisfy the safety criteria of the NRC.
- b. The applicant shall control release of airborne particulates from tailings by use of a water sprinkler system, chemical stabilization, covering with soil, or other equivalent means until reclamation of the tailings is completed. The effectiveness of the control method used shall be evaluated weekly by means of a documented tailings area inspection.

- c. The applicant shall implement the environmental monitoring program described in Table 6.3 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.
- 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. The applicant shall immediately notify the Office of the State Archeologist if bones, firepits, or other artifacts are discovered during construction of the mill bench or tailings-disposal areas and shall have an archeological survey performed prior to disturbing any previously unsurveyed areas.
- f. 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.
- g. The applicant shall provide for stabilization and reclamation of the mill site and tailings-disposal areas and mill decommissioning as described in Sections 3.2.5, 3.2.6, and 10.4 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.

8. Position of the NRC:

The proposed position of the Nuclear Regulatory Commission is that, after weighing the environmental, economic, technical, and other benefits of the operation of the Morton Ranch Uranium Mill against environmental and other costs, and considering available alternatives, the action called for under the National Environmental Policy Act of 1969 and 10 CFR 51 is the issuance of a source material license subject to conditions 7, a through h, 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.

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## FOREWORD

This Final Environmental Statement is issued by the U. S. Nuclear Regulatory Commission (NRC), Office of Nuclear Material Safety and Safeguards, in response to the request by United Nuclear Corporation for the issuance of an NRC Source Material License, authorizing operation of the proposed Morton Ranch Uranium Mill. This Statement has been prepared in accordance with Commission regulation 10 CFR Part 51, which implements requirements of the National Environmental Policy Act of 1969 (NEPA; P.L. 91-190). The mill will be owned and operated by the United Nuclear Corporation (the applicant).

The NEPA states, among other things, that it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may:

- Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
- Assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings.
- Attain the widest range of beneficial uses of the environment without degradation risk to health or safety, or other undesirable and unintended consequences.
- Preserve important historical, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice.
- Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities.
- Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Further, with respect to major Federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of the NEPA calls for preparation of a detailed statement on:

- (i) the environmental impact of the proposed action,
- (ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,
- (iii) alternatives to the proposed action,
- (iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and
- (v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Pursuant to 10 CFR 51, the NRC Division of Fuel Cycle and Material Safety prepares a detailed statement on the foregoing considerations with respect to each application for a source material license for a uranium mill.

In accordance with 10 CFR Part 40, Section 40.31, the applicant submitted an environmental report to the NRC as part of its license application. In conducting the required NEPA review, Commission representatives (the staff) met with the applicant to discuss items of information in the environmental report, to seek additional information that might be needed for an adequate assessment, and generally to ensure that the Commission had a thorough understanding of the project. In addition, the staff sought information from other sources to assist in the evaluation, conducted field inspections of the project site and surrounding area, and met with State and

local officials charged with protecting State and local interests. On the basis of the foregoing activities, and other such activities or inquiries as were deemed useful and appropriate, the staff has made an independent assessment of the considerations specified in Section 102(2)(C) of the NEPA.

That evaluation led to the issuance of a draft environmental statement by the Office of Nuclear Material Safety and Safeguards in April 1978. That statement was distributed to Federal, State, and local governmental agencies, and to other interested parties, for comment. A summary notice was published in the *Federal Register* regarding the availability of the applicant's environmental report and the draft environmental statement.

After comments on the draft statement were received and considered, the staff prepared this Final Environmental Statement, which includes a discussion of questions and comments submitted by reviewing agencies or individuals (App. A). Further environmental considerations were made on the basis of these comments and combined with the previous evaluation; the total environmental costs were then evaluated and weighed against the environmental, economic, technical, and other benefits to be derived from the proposed project. It was concluded (see Sec. 11) that the overall benefit-cost balance for the Morton Ranch mill is favorable, and that the indicated action is that of licensing the Morton Ranch mill.

This Final Environmental Statement was made available to the Environmental Protection Agency, to those agencies commenting on the Draft Environmental Statement, and to the public, in February 1979.

## 1. INTRODUCTION

### 1.1 THE APPLICANT'S PROPOSAL

Pursuant to Title 10, Code of Federal Regulations (CFR), Part 40 and Part 51, an application was filed with the U. S. Nuclear Regulatory Commission (NRC) by United Nuclear Corporation (the applicant) on 1 January 1977 to conduct certain milling operations involving the processing of uranium ore deposits mined in Converse County, Wyoming. The project will consist of removing uranium deposits from local ore bodies by surface and underground mining (discussed in detail in another environmental assessment)<sup>1\*</sup> and construction and operation of a mill with a nominal capacity of 1800 MT (2000 tons) of uranium ore per 24-hour day, 330 days per year, for a projected 20-year mill lifetime. The ore contains the equivalent of about 0.077% uranium oxide ( $U_3O_8$ ). It is estimated that the Morton Ranch deposits contain about 13 million tons of uranium ore. Production of uranium oxide, based on an overall uranium-recovery rate of about 90%, is expected to be about 418 MT/yr.\*\*

Waste materials (tailings) from the mill will be produced at a rate of about 1800 MT (2000 tons) of ore solids per day and stored onsite. The solid portion of the tailings will be stored in exhausted, lined mine pits, and most of the liquid fraction will be evaporated to the atmosphere from a separate, lined evaporation pond constructed specifically for tailings liquid storage and evaporation.

In accordance with NRC Guides 3.5 and 3.8, the applicant has submitted a Source Material License Application (form AEC-2),<sup>2</sup> an Environmental Report,<sup>3†</sup> and supplements to the ER<sup>4,5</sup> in response to questions by the NRC staff.

### 1.2 BACKGROUND INFORMATION

For the mining/milling project, the applicant has leased from various owners approximately 10,500 ha (26,000 acres) of a 101,175-ha (250,000-acre) private property collectively referred to as the Morton Ranch; the leases include fee mineral rights. The leased land (Figs. 1.1 and 1.2) is divided into two large tracts, which are to be used for mining/milling, a 1415-ha (3500-acre) northern and a 8700-ha (21,500-acre) southern tract. Smaller, outlying areas totaling about 405 ha (1000 acres) are used for minerals prospecting. The principal tracts lie in T35 and T36 North, R71-73 West in central Converse County, 105° 31' N. latitude and 43°01' W longitude, about 18 air miles north-northwest of Douglas and about 23 air miles northeast of Glenrock, Wyoming, the nearest incorporated towns. The proposed mill is to be built on Sections 11 and 14 of the southern tract (Fig. 1.3).

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\*"Final Environmental Statement, Morton Ranch Uranium Mining," hereinafter cited as FES-TVA. The Tennessee Valley Authority (TVA) has purchased a 50% undivided interest in the Morton Ranch uranium properties from the United Nuclear Corporation and Teton Exploration and Drilling Company, Incorporated, a subsidiary of United Nuclear Corporation. TVA proposes to participate with United Nuclear Corporation in mining uranium from the Morton Ranch properties. As the details of mining activities are discussed and assessed in the FES-TVA, no assessment of mining is provided in the present document, which is concerned with milling the mined ore.

\*\*Although the applicant's recent estimates are that Morton Ranch ores will contain an average of about 0.077%  $U_3O_8$ , some ores will contain about 0.2%, and the applicant has indicated the possibility of product production equivalent to operating at this higher ore grade. For reasons of conservatism, the impact assessments in this environmental statement are based on the higher value, except where expressly stated to the contrary. For similar reasons, although the mill throughput capacity will initially be 1800 MT (2000 tons) of ore per 24-hour working day, all radiological calculations are based on a throughput of 2700 MT (3000 tons) per day per year, because the applicant has indicated that it may increase the mill processing rate during the term of its license.

†Hereinafter cited as ER.

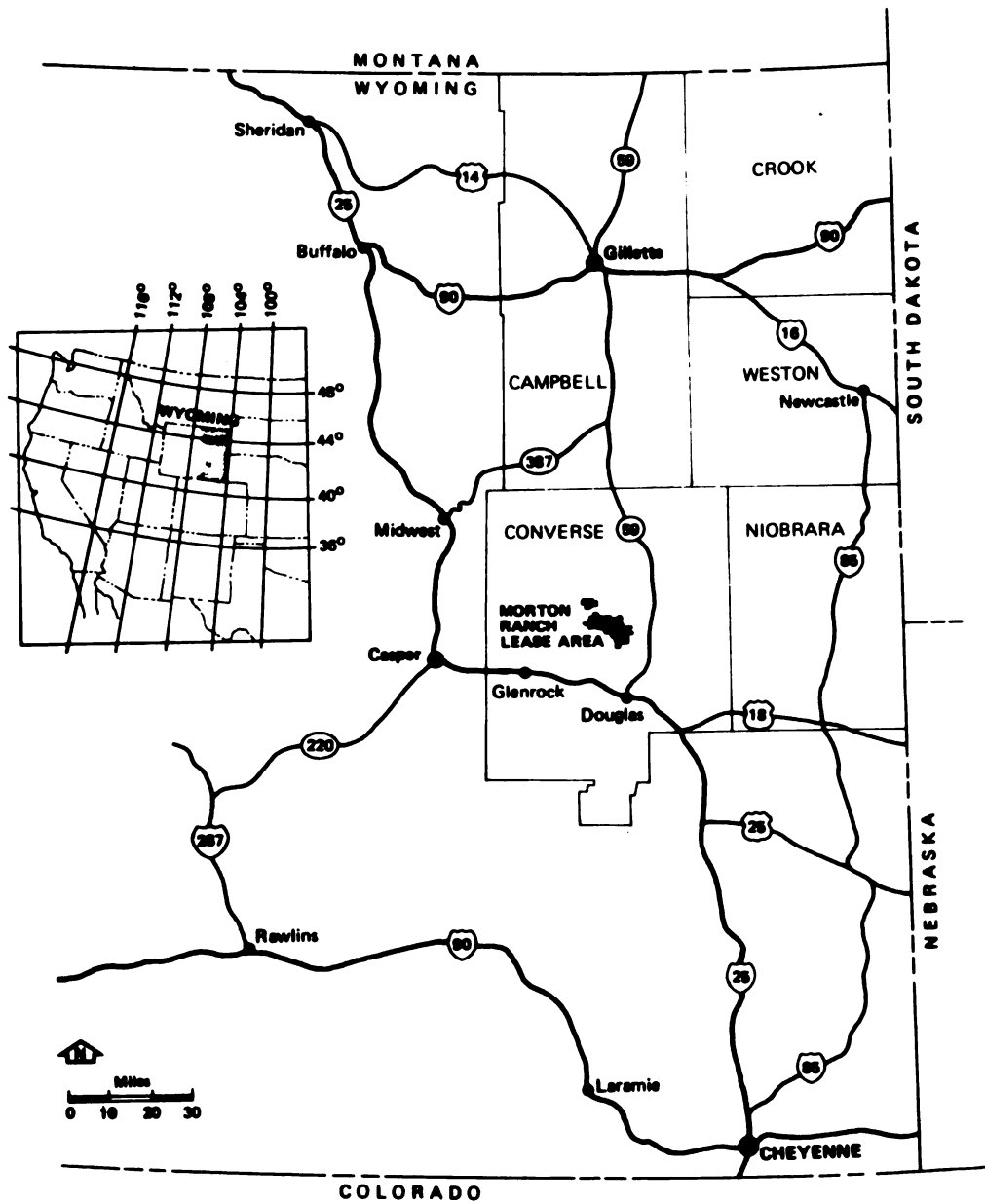


Fig. 1.1. Regional Location of the Morton Ranch Uranium Property (from FES-TVA, Fig. 2.0-1).

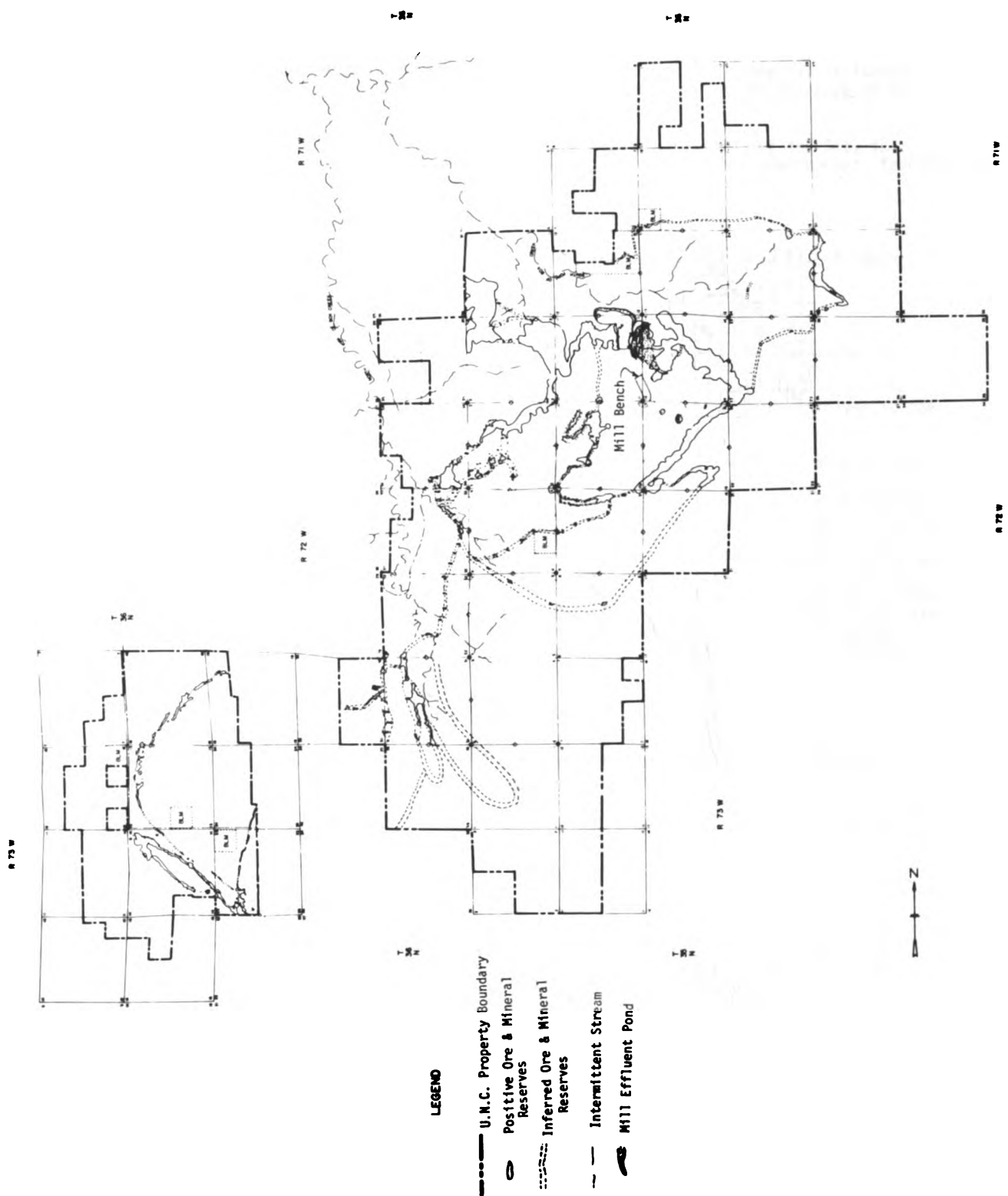


Fig. 1.2. Sectional Map of Leased Areas, Showing Ore Trends (Source: United Nuclear Corp. map of July 1978).

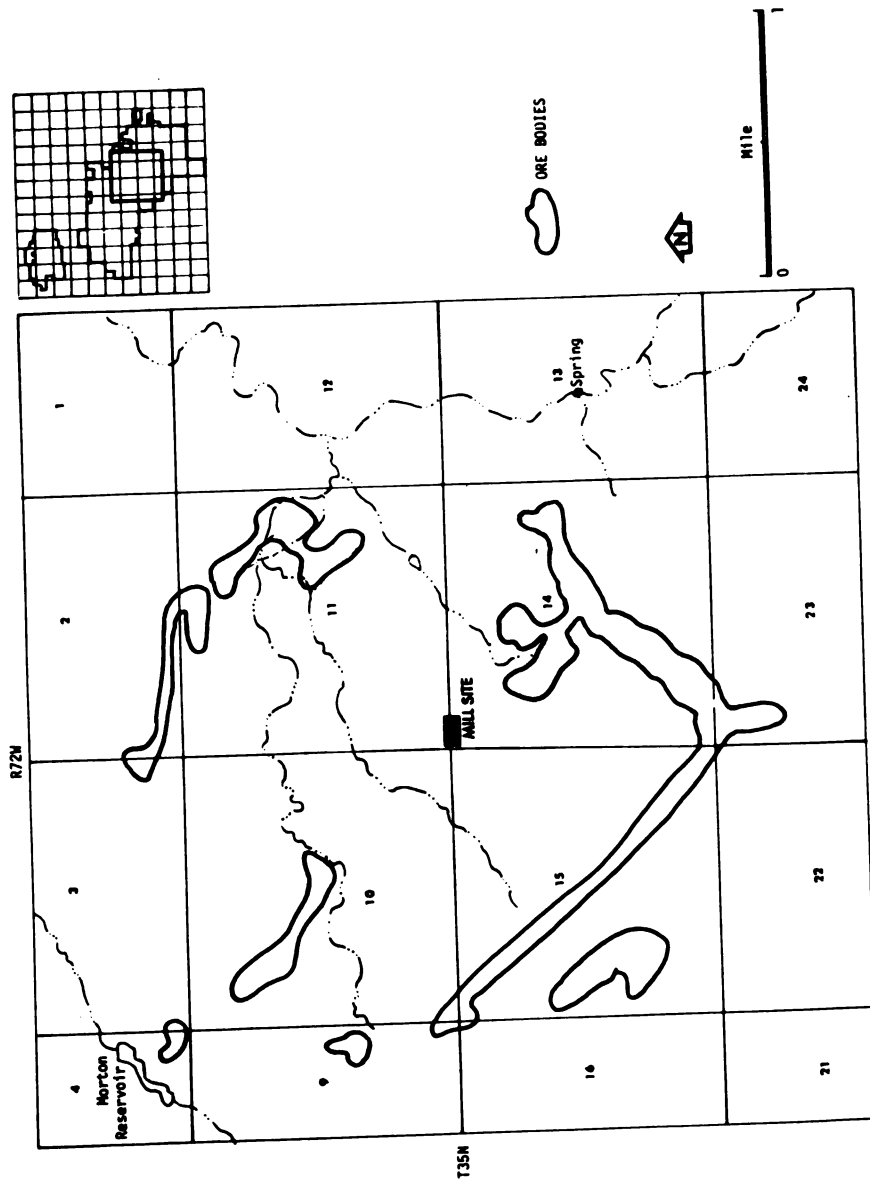


Fig. 1.3. Location of the Proposed Mill Site and Major Ore Bodies (outlined in black) in South Lease Property (modified from ER, Fig. 3.6-2).

### 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., 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 1 January 1970. Pursuant to Section 102(2)(C) of the Act, 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 which 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.
5. Any irreversible and irretrievable commitments of resources which 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 Wyoming Department of Environmental Quality administers the state's Environmental Quality Act of 1973 and implementing rules and regulations. Article 4 of the Act established a permit and licensing scheme which is designed to ensure adequate reclamation of mined lands. The licensing procedure is based on the operator's submission of a detailed reclamation plan to the state. A performance bond is required. According to the state's Land Quality Rules and Regulations (1975),<sup>6</sup> reclamation shall restore the land to a condition equal to or greater than the "highest previous use," and restoration of wildlife habitat is required. The applicant has submitted the required reclamation plan in its application for permit to mine.<sup>1</sup> The Nuclear Regulatory Commission will cooperate with the department and other state agencies in approval actions where both federal and state levels of government have an interest.

### 1.4 STATUS OF REVIEWS AND ACTIONS BY FEDERAL AND STATE AGENCIES

The only federal regulatory approval required for construction and operation of the Morton Ranch mill is a source material license, pending approval by the NRC.

The State of Wyoming requires that permits or licenses be obtained prior to the initiation of various stages of mining and milling operations. The current status (13 January 1978) of these regulatory approvals and permits is given in Table 1.1.

### 1.5 NRC MILL LICENSING ACTIONS

In June 1976, the NRC specified (Fed. Reg. 41 (108), 22430-1, June 3, 1976) 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 1978) 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 Morton Ranch Wyoming Uranium Mill.

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 Morton Ranch mill in particular. The mill is to be located near the sources of the ore because of the high cost of hauling the ore, which typically contains about one and one-half pounds of uranium per ton. This milling operation, therefore, will be virtually independent of other milling operations; it is customary to erect a mill to process a given ore body and to disassemble the equipment when the uranium resource is depleted. In the case of the Morton Ranch mill, alternative strategies utilizing the nearby Exxon U.S.A. mill and more distant existing mills were considered and rejected because 1) the Exxon mill is operating at design capacity, and 2) the added cost of transportation would be an economic penalty (see Sec. 10.3). Clearly, each

Table 1.1. Status of Regulatory Approvals and Permits Required Prior to Initiation of the Morton Ranch Uranium Project<sup>a</sup>

| Permit or License                                                    | Granting Authority                               | Date of Application                         | Date Granted                 |
|----------------------------------------------------------------------|--------------------------------------------------|---------------------------------------------|------------------------------|
| Permit to Mine - 154                                                 | DEQ-LQD <sup>b</sup>                             | 5-9-73                                      | 5-24-73                      |
| Conversion Permit to Mine - 230C                                     | DEQ-LQD                                          | 12-3-73                                     | 11-26-74                     |
| Transfer of Permit to Mine - 230C<br>(from Teton Exploration to UNC) | DEQ-LQD                                          | 9-2-77                                      | Retroactive to<br>3-2-77     |
| License to Mine - 230C                                               | DEQ-LQD                                          | 8-16-77                                     | 10-27-77                     |
| Air Permit to Construct Mines<br>CT-71                               | DEQ-AQD <sup>c</sup>                             | 9-22-76                                     | 10-29-76                     |
| Air Permit to Operate Mines<br>OP-33                                 | DEQ-AQD                                          |                                             | 6-17-77                      |
| Wastewater Discharge (NPDES)<br>WY-0022098                           | DEQ-WQD <sup>d</sup> -EPA <sup>e</sup>           | 8-13-73                                     | 5-1-75                       |
| WY-0024571                                                           |                                                  | (Renewal) 3-30-78                           | 7-1-78                       |
|                                                                      |                                                  | 5-20-75                                     | 12-8-75                      |
| WY-0024562                                                           |                                                  | (Renewal) 3-30-78                           | 7-1-78                       |
|                                                                      |                                                  | 5-20-75                                     | 3-20-77                      |
|                                                                      |                                                  | (Renewal) 3-30-78                           | 7-1-78                       |
| Sanitary Sewage Disposal<br>75-191 (North Morton)                    | DEQ-WQD                                          | 11-7-75                                     | 11-14-75                     |
| Sanitary Sewage Disposal<br>76-377 (South Morton)                    | DEQ-WQD                                          | 11-29-76                                    | 1-18-77                      |
| Wastewater Treatment Plant<br>Construction - 77-213R                 | DEQ-WQD                                          | 8-1-77                                      | 8-5-77                       |
| Solid Waste Disposal                                                 | DEQ-SWM <sup>f</sup>                             | 8-1-77                                      | 1-10-78                      |
| Water Wells                                                          | SE <sup>g</sup>                                  |                                             |                              |
| 6022 (MX-1)                                                          |                                                  | 6-11-70                                     | 7-21-70                      |
| 6023 (SMX-1)                                                         |                                                  | 6-11-70                                     | 7-21-70                      |
| 6024 (SMX-2)                                                         |                                                  | 6-11-70                                     | 7-21-70                      |
| 29604 (DM-1)                                                         |                                                  | 4-4-75                                      | 4-18-75                      |
| 29605 (DM-3)                                                         |                                                  | 4-4-75                                      | 4-14-75                      |
| 29606 (DM-4)                                                         |                                                  | 4-4-75                                      | 4-14-75                      |
| 29607 (DM-5)                                                         |                                                  | 4-4-75                                      | 4-14-75                      |
| 29608 (DM-6)                                                         |                                                  | 4-4-75                                      | 4-14-75                      |
| 29609 (DM-7)                                                         |                                                  | 4-4-75                                      | 4-14-75                      |
| 29610 (DM-8)                                                         |                                                  | 4-4-75                                      | 4-14-75                      |
| 34330 (UNC No. 2)                                                    |                                                  | 7-20-76                                     | 8-11-76                      |
|                                                                      |                                                  | (Renewal Extension<br>10-11-77)             | (Renewal<br>1-6-78)          |
| 42769 (North Morton Shaft)                                           | SE <sup>g</sup>                                  | 8-19-77                                     | 4-18-78                      |
| Potable Water Supply -<br>30971 (UNC No. 1)                          | SE                                               | 9-5-75                                      | 9-11-75                      |
| Stock Reservoirs -<br>7725 (MX-1)                                    | SE                                               | 6-17-74                                     | 10-28-74                     |
| 7726 (SMX-2)                                                         |                                                  | 6-17-74                                     | 10-28-74                     |
| Rights-of-Way                                                        |                                                  |                                             |                              |
| Access Road & Transmission Lines                                     | Exxon Co., U.S.A.<br>Mortons, Inc.               |                                             | 10-29-69<br>9-23-76          |
| Access Road                                                          | Converse County <sup>h</sup>                     |                                             | 11-13-71                     |
| Gas Line Easement                                                    | Exxon Co., U.S.A.<br>Numrick, et al.             |                                             | 11-10-75<br>1-15-76          |
| Power Line Easement                                                  | Mortons, Inc.<br>Exxon Co., U.S.A.<br>Lee Fowler |                                             | 10-6-75<br>9-8-75<br>9-19-75 |
| Byproduct Material License<br>49-14786-01                            | NRC <sup>i</sup>                                 | 5-19-77                                     | 5-31-77                      |
| Tailings Impoundment                                                 | NRC-SE-DEQ-LQD                                   | 1-14-77 <sup>j</sup><br>(Supplement 7-8-77) | In Review                    |

Table 1.1. Continued

| Permit or License                                                                                                   | Granting Authority                     | Date of Application                         | Date Granted                        |
|---------------------------------------------------------------------------------------------------------------------|----------------------------------------|---------------------------------------------|-------------------------------------|
| Source Material License - SUA-56                                                                                    | NRC                                    | 1-14-77<br>(Revised 11-15-77)               | In Review<br>In Review              |
| BaCl <sub>2</sub> Water Treatment Plant & Flow Measurement Facility (North Morton) - 78-86R                         | DEQ-WQD <sup>d</sup> -LQD <sup>b</sup> | 7-25-78<br>2-22-78<br>(as mod. of #77-213R) | In Review<br>3-23-78<br>(as 78-86R) |
| BaCl <sub>2</sub> Water Treatment, Sedimentation Pond, and Flow Measuring Facility (South Morton) 78-85R<br>78-85RR |                                        | 2-22-78<br>5-24-78                          | 4-3-78<br>6-6-78                    |

<sup>a</sup>Source: United Nuclear Corp., Wyoming Operations, 8 August 1978.

<sup>b</sup>Wyoming Department of Environmental Quality, Land Quality Division.

<sup>c</sup>Wyoming Department of Environmental Quality, Air Quality Division.

<sup>d</sup>Wyoming Department of Environmental Quality, Water Quality Division.

<sup>e</sup>U. S. Environmental Protection Agency.

<sup>f</sup>Wyoming Department of Environmental Quality, Solid Waste Management Division.

<sup>g</sup>Wyoming State Engineer.

<sup>h</sup>Converse County, Wyoming, Board of County Commissioners.

<sup>i</sup>U. S. Nuclear Regulatory Commission.

<sup>j</sup>Dates of Environmental Report and Supplement.

Additional permits from the following agencies will be applied for prior to mill construction and operation of the Morton Ranch Uranium Mill.

1. DEQ-WQD
2. SE
3. DEQ-AQD
4. DEQ-LQD
5. EPA

milling project is to be considered on its own merits; licensing actions with respect to one mill are independent of those applied to other mills, and a cost-benefit analysis can be performed for each licensing action of this type.

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 "yellowcake" from local uranium ore bodies. As pointed out in the response to the first criterion, uranium mills are normally located close to an economically exploitable ore body. The ore body 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 is unique, or in short supply; hence, licensing this mill would not affect any licensing action with respect to other mills. Air, land, and water resources would be used locally, but not to an extent which would preclude the erection and operation of another mill nearby.

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 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 which may arise during review are resolvable within the context 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 3 June 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.*

Some of the pertinent information from the 3 June 1976 statement is paraphrased below:

U.S. uranium mills produced 11,600 tons of yellowcake in 1975, using 70% of stated capacity. The stated capacity, 16,570 standard tons, would be exceeded in 1981, if currently operating and scheduled reactors operated at an 80% plant factor, and in 1983, with a 60% plant factor. It is quite likely that new mills will be needed prior to these dates because most of the current mills have been operating for more than ten years and are facing obsolescence; furthermore, even in a new mill, continuous operation at full capacity is rarely achieved. The entire output is used to fuel nuclear reactors to produce electricity for utility customers.

There is a need for new mill capacity prior to 1981 (probably as early as 1979). The customary interval from the issuance of a source material license for a new mill to the loading of reactor fuel is five years. The Morton Ranch mill is one of a small number of new mills that have been proposed in the last several years; a deferral of its operation could extend the time required for the delivery of needed fuel, and could adversely affect the ability of reactors now operating or under construction to deliver needed electrical power. Such a shortfall of electrical energy is generally construed to be harmful to the public interest.

#### References for Section 1

1. Tennessee Valley Authority, "Final Environmental Statement, Morton Ranch Uranium Mining," Chattanooga, Tennessee, January 20, 1976.
2. "Application for Uranium Milling License on the Morton Ranch, Wyoming Uranium Mill," UNC-LA-2, January 1, 1977, revised November 15, 1977.
3. United Nuclear Corporation, "Applicant's Environmental Report on the Morton Ranch, Wyoming, Uranium Mill," UNC-ER-2 Vols. I and II, 1976.
4. "Supplement to Applicant's Environmental Report on the Morton Ranch, Wyoming, Uranium Mill. Analysis of Alternatives for Mill Tailings Management and Reclamation (Suppl. I)," United Nuclear Corporation, Docket No. 40-8602, July 1977.
5. "Supplement to Applicant's Environmental Report on the Morton Ranch, Wyoming, Uranium Mill. Additional Environmental Information and Mill Design Data (Suppl. II)," United Nuclear Corporation, undated (received September 6, 1977).
6. "Wyoming Land Quality Rules and Regulations," Chapter II, Section 1b(1), 1975.

## 2. THE EXISTING ENVIRONMENT

### 2.1 CLIMATE

#### 2.1.1 General Influences

The climate and weather of central Wyoming are dominated by the low- and high-pressure centers, with attendant frontal systems, that migrate through the area throughout the year. The climate is semiarid, with a mean annual precipitation of 30 cm (12 inches), about half of which occurs during April, May, and June as wet snow and rain. Temperatures vary from summer highs near 100°F (38°C) to winter lows near -40°F (-40°C). The seasons are distinct, with mild summers and harsh winters. Spring and fall are transitional seasons, with warm days and cold nights.<sup>1</sup>

#### 2.1.2 Winds

The prevailing wind direction is westerly to southwesterly (i.e., prevailing winds blow from the west southwest to the east northeast) and the average wind speed is relatively high compared to the natural average. Annual average wind speed and direction for Casper, Wyoming, and the Morton Ranch site are given in Figure 2.1. The two data sets show sufficient similarity for the staff to use the longer-term Casper records for meteorological calculations. Joint distribution of wind speed and direction, abstracted from meteorological records for Casper, are presented in Table 2.1. Strong winds are frequent; the strongest recorded speed was 130 km/hr (81 mph), from the southwest, in March 1962. Monthly mean and maximum wind speeds and directions for Casper are presented in Table 2.2.

The local topography strongly influences the micrometeorological conditions at the site. Dilution of airborne contaminants resulting from normal operating releases will be determined by the small-scale turbulence in the local area in combination with the wind characteristics and the mode of emission release (ground level or elevated).

#### 2.1.3 Precipitation

The average annual precipitation recorded at Bill, Wyoming, approximately 30 km (18 miles) northeast of the site, is 30 cm (12 inches), but relatively large year-to-year variations occur in the monthly and seasonal totals. Late spring and summer precipitation is normally derived from scattered thunderstorms; therefore, the land areas affected and amounts of rainfall are extremely variable. The mean and maximum total monthly precipitation and snowfall for Casper<sup>1</sup> and the monthly total precipitation for Bill,<sup>2</sup> are given in Table 2.3. Potential pond evaporation exceeds precipitation, averaging 110 cm (44 inches) per year.<sup>3</sup>

#### 2.1.4 Storms

Winter storms--with attendant snowfall, low temperatures, and high winds--are common. Summer thunderstorms, occasionally spawning tornadoes, are frequent in spring and summer. These tornadoes tend to be notably less destructive than those occurring farther east. Five tornadoes have been reported within 80 km (50 miles) of the site since 1950.<sup>4</sup>

### 2.2 AIR QUALITY

The Morton Ranch site is included in the Casper Intrastate Air Quality Control Region. The staff considers the present air quality in the area to be good. The current mean suspended particulate concentration is estimated at 13 to 21 micrograms (µg) per cubic meter,<sup>5</sup> whereas the national primary standard is 75 µg/m<sup>3</sup>,<sup>6</sup> and the Wyoming State Standard is 60 µg/m<sup>3</sup>.<sup>7</sup> Data on background levels of sulfur dioxide (SO<sub>2</sub>), hydrocarbons, and oxides of nitrogen (NO<sub>x</sub>) are limited. However, the second-highest 24-hour value for SO<sub>2</sub> recorded during 1977, 45 µg/m<sup>3</sup>, was in Converse County.<sup>2</sup> The U. S. Environmental Protection Agency (EPA) has proposed that the Powder River Basin be classified as an "air quality maintenance area," signifying that EPA considers this region as having the potential for significant decline in ambient air quality due to projected increases in mining and industrial activity.

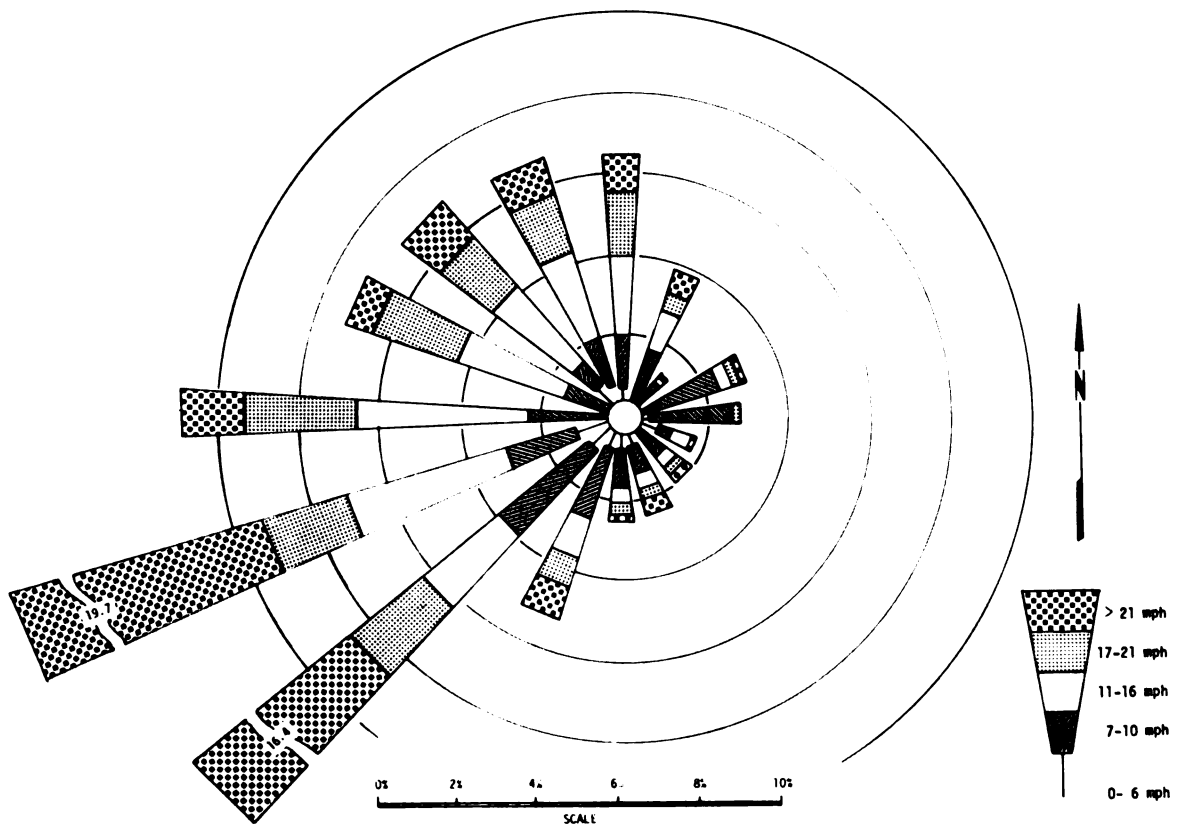
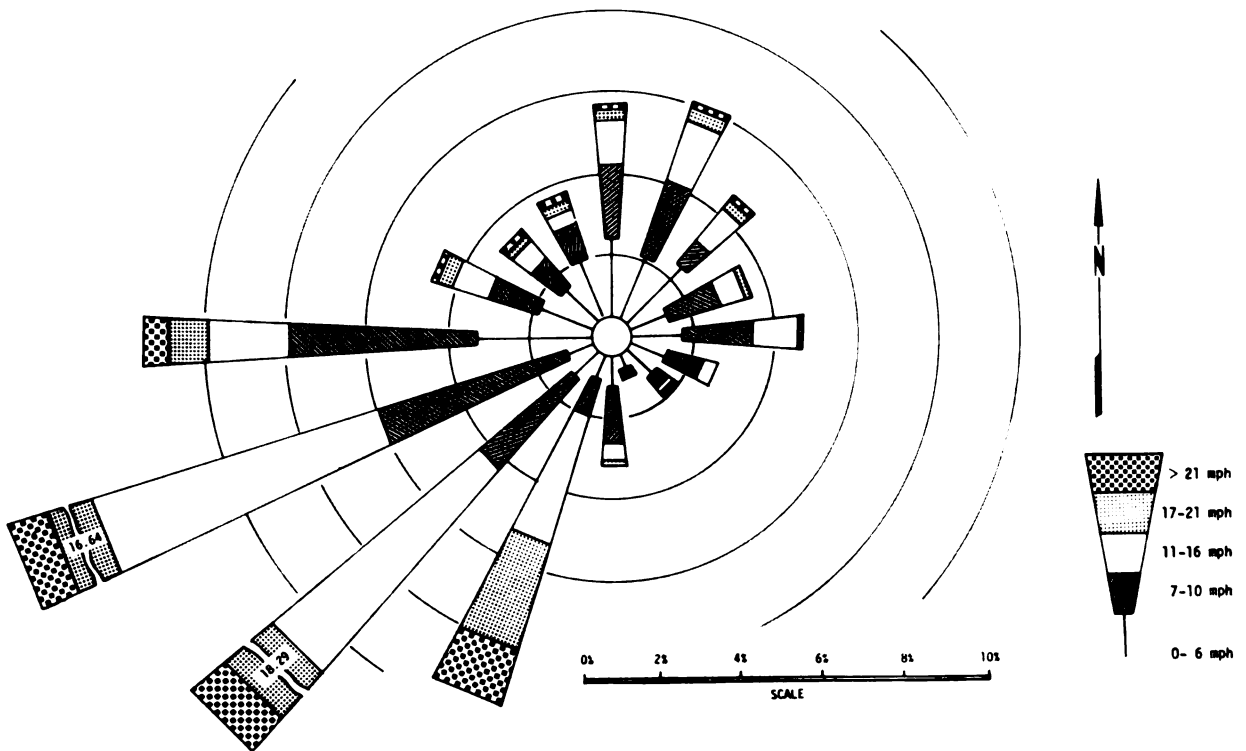


Fig. 2.1. Annual Average Wind Speed and Direction for Casper, Wyoming (top), and the Morton Ranch Site. Flow is from arrows to center. (From ER, Figs. 2.7-1a and 2.7-1b).

Table 2.1. Joint Frequency of Annual Average Wind Speed and Direction for Casper, Wyoming, 1966-1975, with 2.2% Calm Distributed in Table<sup>a</sup>

| Direction | Speed, km/hr |       |       |       |       |      | Total |
|-----------|--------------|-------|-------|-------|-------|------|-------|
|           | 0-5          | 6-10  | 11-16 | 17-26 | 27-34 | >34  |       |
| N         | 0.4%         | 1.5%  | 1.4%  | 0.8%  | 0.3%  | 0.1% | 4.5%  |
| NNE       | 0.4          | 1.9   | 2.2   | 2.1   | 0.6   | 0.1  | 7.3   |
| NE        | 0.2          | 1.0   | 1.4   | 1.0   | 0.2   | 0.1  | 3.9   |
| ENE       | 0.2          | 0.9   | 1.1   | 0.6   | 0.1   | 0.0  | 2.9   |
| E         | 0.4          | 1.3   | 1.7   | 1.2   | 0.2   | 0.1  | 4.9   |
| ESE       | 0.2          | 0.7   | 0.7   | 0.4   | 0.1   | 0.0  | 2.1   |
| SE        | 0.2          | 0.6   | 0.5   | 0.2   | 0.0   | 0.0  | 1.5   |
| SSE       | 0.2          | 0.7   | 0.4   | 0.1   | 0.0   | 0.0  | 1.4   |
| S         | 0.2          | 0.7   | 0.4   | 0.3   | 0.1   | 0.0  | 1.7   |
| SSW       | 0.2          | 0.9   | 1.8   | 4.5   | 4.3   | 2.4  | 14.1  |
| SW        | 0.2          | 0.9   | 2.8   | 6.3   | 4.5   | 2.1  | 16.8  |
| WSW       | 0.4          | 1.7   | 5.2   | 4.8   | 2.0   | 0.9  | 15.0  |
| W         | 0.8          | 2.9   | 4.5   | 2.8   | 1.0   | 0.6  | 12.6  |
| WNW       | 0.3          | 1.3   | 1.0   | 0.9   | 0.3   | 0.1  | 3.9   |
| NW        | 0.2          | 1.1   | 1.0   | 0.5   | 0.2   | 0.0  | 3.0   |
| NNW       | 0.4          | 1.8   | 1.3   | 0.6   | 0.2   | 0.1  | 4.5   |
|           | 4.9%         | 19.9% | 27.4% | 27.1% | 14.1% | 6.6% |       |

<sup>a</sup>Compiled from data in "Wind Distribution at Pasquill Stability Classes--Casper, Wyoming, 1966-1975," U. S. Dept of Commerce, National Climatic Center, Asheville, N. C.

Table 2.2. Mean and Maximum Wind Speeds (km/hr) for Casper, Wyoming, 1941-1970<sup>a</sup>

| Month     | Mean Speed/Direction |     | Maximum Speed/Direction |     |
|-----------|----------------------|-----|-------------------------|-----|
| January   | 27                   | SW  | 93                      | SSW |
| February  | 25                   | SW  | 93                      | SW  |
| March     | 23                   | SW  | 130                     | WSW |
| April     | 21                   | WSW | 87                      | WSW |
| May       | 19                   | WSW | 93                      | NW  |
| June      | 18                   | WSW | 84                      | N   |
| July      | 16                   | WSW | 84                      | WSW |
| August    | 17                   | SW  | 80                      | WSW |
| September | 18                   | WSW | 85                      | NW  |
| October   | 20                   | SW  | 88                      | WSW |
| November  | 23                   | SW  | 79                      | WSW |
| December  | 26                   | SW  | 101                     | SSW |
| Annual    | 21                   |     |                         |     |

<sup>a</sup>Data from "Local Climatological Data, Annual Summary with Comparative Data - 1975, Casper, Wyoming," NOAA, U. S. Dept. of Commerce, National Climatic Center, Asheville, N. C.

Table 2.3. Precipitation Records for Casper, Wyoming (1940-1975)<sup>a</sup>  
and Bill, Wyoming (1948-1960)<sup>b</sup>

| Month     | Casper, Wyoming   |         |                |                | Bill, Wyoming     |
|-----------|-------------------|---------|----------------|----------------|-------------------|
|           | Precipitation, cm |         | Snowfall, cm   |                | Precipitation, cm |
|           | Mean              | Maximum | Mean           | Maximum        | Mean              |
| January   | 1.3               | 2.5     | 23.3           | 99.8           | 1.3               |
| February  | 1.3               | 2.6     | 24.1           | 60.4           | 1.0               |
| March     | 2.3               | 6.2     | 37.5           | 83.5           | 2.1               |
| April     | 4.1               | 9.9     | 35.5           | 55.6           | 3.0               |
| May       | 5.0               | 14.1    | 6.3            | 83.3           | 5.8               |
| June      | 3.3               | 9.5     | 0.8            | 11.4           | 4.3               |
| July      | 2.4               | 7.7     | 0.0            | 0.0            | 3.7               |
| August    | 1.5               | 3.8     | T <sup>c</sup> | T <sup>c</sup> | 2.4               |
| September | 2.3               | 8.3     | 2.5            | 10.4           | 2.2               |
| October   | 2.4               | 6.3     | 12.4           | 56.1           | 1.6               |
| November  | 1.7               | 3.3     | 23.1           | 65.5           | 1.3               |
| December  | 1.2               | 2.6     | 22.6           | 37.3           | 1.8               |
| Annual    | 28.9              |         | 188.5          |                | 30.5              |

<sup>a</sup>From A. R. Lowers, "The Climate of Wyoming," in "Climates of the States," Vol. 2, U. S. Dept. of Commerce, National Oceanic and Atmospheric Administration, 1974.

<sup>b</sup>From "Wind Distribution at Pasquill Stability Classes - Casper, Wyoming, 1966-1975," U. S. Dept. of Commerce, National Climatic Center, Asheville, N. C.

<sup>c</sup>T = trace (amount too small to measure).

Currently, the 750-MW Dave Johnston fossil-fuel-fired electric power plant (see Fig. 2.4), located near Glenrock, Wyoming (about 20 air miles SW), is considered by the staff to be the major emission source in the air quality control region. Other emission sources in the vicinity of the proposed mill are also shown in Figure 2.4.

Some baseline monitoring of air quality has begun at the Morton Ranch site. High-volume samples taken for radiological purposes on 12 and 13 October 1974 showed airborne concentrations of particulates to be  $14 \mu\text{g}/\text{m}^3 \pm 11\%$  to  $41 \mu\text{g}/\text{m}^3 \pm 15\%$ , with the higher value occurring during periods of higher wind speeds (ER, Table 2.9-1). Preoperational monitoring at the nearby Bear Creek site gave an average value of approximately  $13 \mu\text{g}/\text{m}^3$  of airborne particulates.<sup>8</sup>

### 2.3 TOPOGRAPHY

The project site is located in the southern portion of the Powder River Basin, a northwesterly trending structural and topographic depression between the Bighorn Mountains and the Black Hills (Fig. 2.2). Existing topographic expression (Fig. 2.3) is a result of erosion that has incised the sedimentary strata occurring in the basin. The central part of the basin is a broad plateau, the crest of which trends north-south and parallels State Highway 59, east of the site. The regional landscape is dominated by plains, low-lying hills, and tablelands interrupted by stream channelways, flat-topped mesas and buttes, long narrow divides, and rounded ridge crests that range up to 152 m (500 ft) in height above the valley floors.

The project area is characterized by gently rolling uplands and broad stream valleys dissected by numerous dry channelways. The general topographic character is typical of much of the state and of western prairie. No unique topographical features mark the site.

The mill site and most of the mine areas are located in the drainages of the north and south forks of Box Creek (see Fig. 2.7), a tributary of the Cheyenne River drainage system. Part of the northern portion of mine property is drained by Cowell Creek, also part of the Cheyenne River drainage.

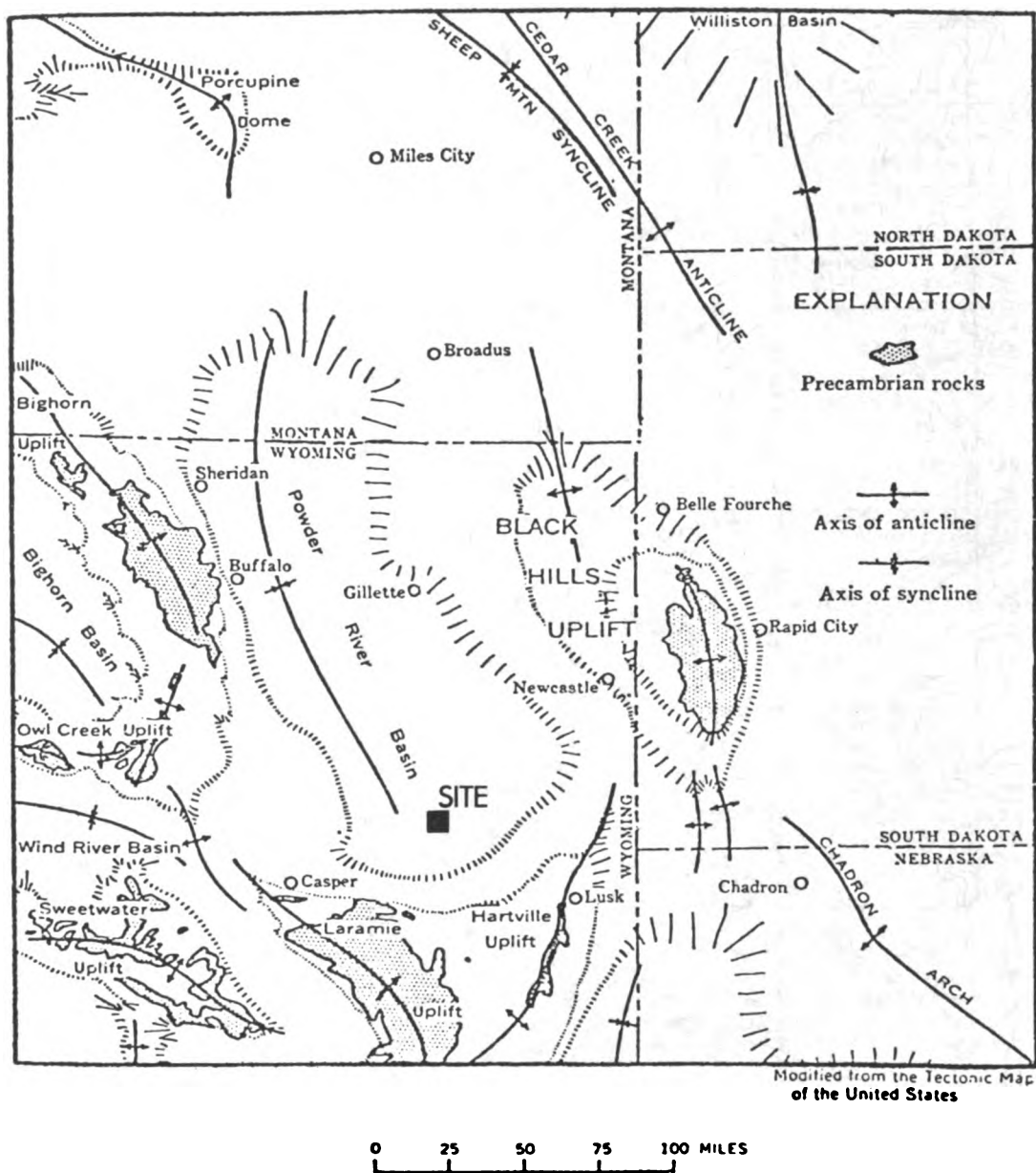


Fig. 2.2. Generalized Map of the Powder River Basin in Relation to Nearby Structural Features (reprinted from "Draft Environmental Impact Statement, Development of Coal Resources in the Eastern Powder River Basin of Wyoming," Vol. 1, U. S. Dept. of the Interior, 1974).



Fig. 2.3. Topography of the Site Area (contour interval 1 inch = 3520 ft).  
(Applicant's figure of 7-17-78.)

The site exhibits a generally northeastward slope somewhat disrupted by the formation of numerous ravines. Maximum relief in the site area is about 168 m (550 ft), with elevations ranging from 1542 to 1712 m (5060 to 5617 ft).

## 2.4 DEMOGRAPHY AND SOCIOECONOMIC PROFILES

### 2.4.1 Demography of the Area

#### 2.4.1.1 Current Population and Distribution

The Morton Ranch site is located in central Converse County, a rural area primarily comprised of cattle and sheep ranches. The towns of Douglas (the county seat) and Glenrock, the trade centers for the county, are approximately 32 km (20 miles) south and 39 km (24 miles) southwest of the site.

The population of Converse County increased slightly between 1950 and 1960, but lost almost all this numerical gain by 1970 (App. B, Table B.1), probably as part of the general decline in U. S. agricultural employment during 1960-1970. Despite this, over half (54.9%) of the county's residents were living in rural areas in 1970. Since then, the development of various energy resources (Fig. 2.4) has produced dynamic population increases throughout the county, and in Glenrock and Douglas (App. B, Table B.1); Douglas has more than doubled its 1970 population. The population concentration has shifted from rural to urban areas because of the settling patterns of the newcomers; 82.8% of county residents are now living in urban areas versus 17.2% in rural areas.

The land surrounding the proposed site is very sparsely populated; the three nearest ranches (App. B, Table B.2) establish a population density of 0.1 to 0.2 persons per square mile within a 16-km (10-mile) radius (ER, Sec. 2.2.4). Morton Ranch Inc. employs an average of 25 persons at the ranch property.<sup>9</sup> The two nearest communities are also small. Orpha, with a population of approximately 20, is 24 km (15 miles) south of the Morton Ranch. Bill, with approximately five people, is 32 km (20 miles) northeast (App. B, Table B.2). Casper, 72 km (45 miles) west, is the only major population center within 80 km (50 miles) of the site. Population estimates for 1976 indicate 47,000 Casper residents (App. B, Table B.5).<sup>10</sup>

#### 2.4.1.2 Projected Population and Distribution

It is likely that a number of other construction and minerals-development activities will occur concurrently with the construction of the Morton Ranch mill. The Converse Area Industrial Association, a group of the largest energy-related companies, has provided semiannual projections of permanent employee and construction-force workers for planned or operational projects of the Association's membership. The projected figures for the next five years, including the Morton Ranch project, are given in Appendix B, Table B.3. The table illustrates the Association's awareness that a large influx is probable.

Immigrant population projections for Glenrock and Douglas (including personnel associated with the Morton Ranch mill) are presented in Appendix B, Table B.4. Three assumptions have been made by the Converse Area Planning Office in determining the figures for this table: 1) all workers will reside in the county, 2) the greatest proportion of the construction work force projected to reside in the county is allocated to the Douglas area on the basis of the project's location and historical settlement trends, and 3) total population increase is based on the Converse Area Industrial Association's job forecasts in Table B.3.

For purposes of radiological dose assessment in this Environmental Statement (see Sec. 4.7), the population of the Glenrock and Douglas areas for the peak years of population influx is projected to remain stable to the year 2005 after a period of rapid growth peaking in 1980 (see App. B, Table B.5). This projection method assumes that the high-growth scenario developed by Wyoming agencies\* will occur for the whole of Converse County. Many lower-growth-rate projections exist, but the use of maximum population estimates ensures that the radiological effects described later show maximum potential impact.

Using these projections and the multiplier impacts estimated previously for Glenrock and Douglas (App. B, Table B.4), it was assumed that neither Glenrock nor Douglas would continue to grow beyond 1980. The projected populations for these communities account for a high proportion of the total expected populations for the entire county. Boom-town effects would be expected to diminish, as most forecasts predict some decline in employment after the 1980s, particularly in

\*The highest reported growth-rate projections in the table are based on the Wyoming Department of Economic Development and Planning's projections for 1979 and the Water Resources Research Institute of the University of Wyoming's projections for the year 2000.

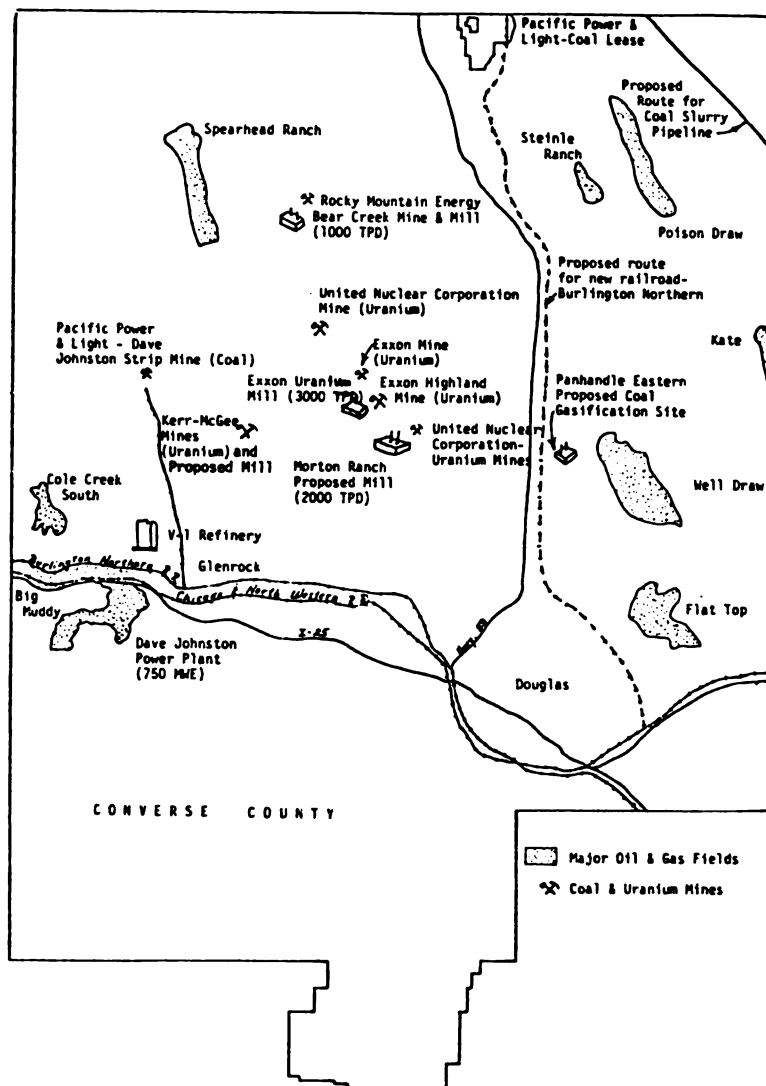


Fig. 2.4. Mineral resource Extraction in Converse County (modified by applicant from "1976 Wyoming Mineral Year Book," Mineral Division of State Dept. of Economic Planning and Development, Cheyenne, Wyoming, November 1976).

construction and construction-related industries. If county-wide projections are reasonable, then Douglas' and Glenrock's share of the incoming population may be high and some population may be expected to be attracted to Casper.

Casper would be expected to grow through the year 2000. The estimated growth rate of 2% is about twice the growth rate of the city's 1960-1970 population increase, but less than the 1960-1970 population growth of Natrona County. Urban-area growth in Casper, Douglas, and Glenrock is expected to exceed growth in rural areas because non-agricultural employment is increasing.

#### 2.4.1.3 Transient Population

The Morton Ranch mill site is located in a rural environment far from major recreational opportunities, and the transient population in the vicinity of the site is extremely small in comparison to the permanent populations at Douglas and Glenrock, 32 and 38 km (20 and 24 miles) away. The closest transient population center (which recorded a maximum of 9000 visitations in 1976)<sup>11</sup> is Fort Fetterman, a state historical site and museum located approximately 24 km (15 miles) southwest of the mill site. The transient populations of the Glendo Reservoir and Medicine Bow National Forest are concentrated in areas greater than 32 km from the mill site, and contribute little to the transient population in the near vicinity of the proposed mill.

### 2.4.2 Socioeconomic Profiles

#### 2.4.2.1 Social Profile

##### Community Characteristics

From the time the early pioneers settled the area, Converse County has remained rural in character. This has affected its social and cultural structure (ER, p. 2-24). However, ranching is now sharing economic prominence with developments related to energy-resource expansion during the past decade. Projections<sup>12,5</sup> of further developments indicate that the county is currently in the midst of rapid expansion and social change. Long-term residents and newcomers are intermixed in the traditionally rural area, with both groups interested in planning and controlling present and future urban growth. The differences between these groups have been illuminated in a study<sup>13</sup> conducted in Campbell County, directly north of Converse County, which explored the attitudes of ranching and mineral-development respondents toward need for improvements in the county (App. B, Table B.6).

The superimposition of new social and cultural systems on indigenous populations has occurred throughout the history of American society. Responses to these systems from the impacted people have been rejection, assimilation, accommodation,<sup>14</sup> or amalgamation. The long-term residents of Converse County have these options available to them at this time.

The current wave of new residents into the county is attempting to adjust to the traditional structure, make appropriate changes in it to accommodate their lifestyles, and to plan for future residents, who are rapidly arriving. In other areas of the U. S., these changes have caused stress for a portion of both old and new residents, which is reflected in an increasing incidence of family discord, adjustment problems, truancy, and alcoholism.<sup>5,14</sup> Whether these social problems will also be manifested in Converse County is difficult to predict, although they usually accompany "boom town" situations. Some indicators that can be identified are changes in the social and cultural structures, polity, and institutions (App. B, Table B.7). It appears that careful planning and a positive attitude toward development and change have prevented many of these stresses elsewhere.<sup>15</sup>

##### Education

Converse County is divided into two school districts: District No. 1 is headquartered in Douglas; District No. 2, in Glenrock. Immigration to the county has affected the school systems (App. B, Table B.8), and both districts are building at a rapid pace to keep abreast of the influx of school-age children into the county.

District No. 1 will open a new elementary school in September 1978 with a capacity for 550 students. A new senior high school with a capacity for 900 students will be completed in 1979. To relieve the current strain on existing facilities, the District will be using a building at the State Fairgrounds for kindergarten. A bus garage has been converted into four new classrooms for the high school students.<sup>16</sup>

"Phase Two" of an elementary school development plan has recently been completed in School District No. 2, providing for an increased capacity of 600 students. Four temporary classrooms

are in use at the Junior-Senior High School. A new building for the rural school has been built, and the District will plan for a third school when enrollment reaches 1000.<sup>17</sup>

### Health Services

A 32-bed hospital, Memorial Hospital of Converse County, is located in Douglas, but has not been accredited by the Joint Commission on Accreditation of Hospitals. In 1976, it had a 48% occupancy rate. Michael Manor, a private nursing and convalescent home in Douglas, has a 59-bed capacity with an occupancy rate of 92%.<sup>18</sup> Four doctors, one dentist, one chiropractor, and one optometrist practice in Douglas.<sup>19</sup>

Glenrock has a Diagnostic and Treatment Center, which recorded 5485 visits in 1976.<sup>18</sup> One doctor and one dentist practice in town.<sup>20</sup>

Additional medical services can be found in Casper. The city provides the Memorial Hospital of Natrona County, eight nursing homes, an allergy clinic, Casper Medical Clinic, and Central Wyoming Counseling and Mental Health Clinic.<sup>21</sup>

### Fire and Police Services

Both Douglas and Glenrock have volunteer fire departments. Each department provides protection to areas outside the city limits.

In 1976, Glenrock had a five-member police force,<sup>20</sup> while Douglas has a department of nine.<sup>15</sup>

Police and fire protection has grown, and will continue to grow, with the rise of population. Protection of areas outside the city limits is provided by the County Sheriff's office.

### Utilities and Services

Mountain springs are the water source for the town of Douglas, which has a source capacity of 3.1 million gallons per day and a storage capacity of 3.8 million gallons.<sup>22</sup> Sewage is handled by a lagoon treatment plant.<sup>19</sup> A separate study was conducted and included in the town's Interim Concept Plan<sup>23</sup> for the expansion of the city's water and sewer systems. These recommendations are now being implemented, and include the construction of two additional water storage tanks. The town has built approximately 15 miles of new paved streets with curbs and gutters.<sup>15</sup>

Glenrock is also developing its municipal services. The town is in the process of a \$2 million project for residential street paving, storm-sewer installation, and the replacement of water and sewer lines.<sup>24</sup> Water for the community is supplied by four wells with a capacity of 1.5 million gallons per day and a storage capacity of 720,000 gallons.<sup>20</sup>

## 2.4.2.2 Economic Profile

### Employment

While the rest of the nation's economy was in a recession during the mid-1970's, Wyoming's economy was growing because of its small manufacturing base and wealth of energy resources. The state's labor force increased over seven percent in each of the years 1974, 1975, and 1976, while its unemployment rate has fallen to about half the national level--around four percent--since 1975.<sup>25</sup>

The size of the labor force in Converse County increased 52% during 1972 to 1976 (App. B, Table B.9). During the same time period, its unemployment rate dropped below three percent. The increase has been in the areas related to energy development: mining, construction, trade, and services. The largest change has been in mining, which showed a 260% increase in five years (Table B.9). This growth in the employment sector has also been accompanied by an approximately \$70 increase in the average weekly wage.<sup>26</sup>

While most of the state experiences a seasonal upswing in employment during the summer months, this trend has been modified in Converse County for the last few years. The large influx of people and the start-up of new projects have caused what is considered seasonal work, such as mining, construction, and retail jobs, to only slightly decrease in winter. This is part of a general pattern of a continual increase over the years (App. B, Table B.10).

## Housing

The housing construction industry has responded to the population changes in the county. As shown in Appendix B, Table B.11, there has been a 34% increase in single-family homes and a 21% increase in multiple-family homes throughout the county over the seven-year period. However, the proportion of single-family homes dropped from 76% to 65% and multiple-family units fell from 11.1% to 8.5% of the housing market over the same time period. This dichotomy is due to the increased use of mobile homes.

The largest share of the 57% increase in housing for the county was in mobile homes. The number of mobile-home units jumped from 296 to 955 (+255%) from 1970 to 1977. While Douglas (+190%) and Glenrock (+54%) showed an increase in mobile-home use, the areas unincorporated of the county experienced the greatest (512%) increase in the use of mobile homes. The development of mobile homes in the two towns will be controlled by their respective zoning laws, whereas unincorporated areas lack such controls and may develop even further. For example, to avoid overcrowding, Glenrock requires a 60-ft minimum lot width for a single mobile home.<sup>27</sup>

The increased use of mobile homes can be explained by the fact that housing construction has lagged behind population growth and mobile homes are often the only housing available to newcomers. Even where other types of housing may be available (e.g., motels and rooming houses), people use mobile homes because of the high cost of these other types of units.

## Recreation

Converse County offers a variety of outdoor recreational activities for both tourists and residents. Hunting, particularly of big game and upland game, has attracted approximately 500 antelope hunters and 650 mule deer hunters per year (five-year average for 1971-1975) to the area surrounding the site (i.e., Sage Creek for antelope and West Bill for mule deer).<sup>28</sup> Residents and others fish in the Platte River or mountain streams in the southern part of the county.

Many visitors are attracted to the county for the annual Wyoming State Fair and to visit the Wyoming Pioneers Memorial Museum, in Douglas. Fort Fetterman, a state historical site and museum located approximately 18 km (11 miles) northwest of Douglas, attracted approximately 9000 people during the summer of 1976.<sup>11</sup>

Although no state parks are located within the county, approximately 25% of Medicine Bow National Forest is situated in the southwest corner. Laramie Peak (located in the National Forest), Ayres Natural Bridge, Jackalope Plunge, and various camping and picnicking sites (App. B, Table B.12) attract many tourists. Glendo State Park is located 40 km (25 miles) southeast of Douglas, at the Glendo Reservoir in Platte County.

In addition to the many city and county parks (App. B, Table B.13), a public golf course, swimming pool, and tennis courts provide a range of recreational activities for residents. A new recreational center in Douglas offers a variety of facilities, from a gymnasium to handball courts.<sup>18</sup> Estimated participation rates for 1970, presented in App. B, Table B.14, show the degree to which recreational facilities will have to be expanded to meet future needs (to 1990).

### 2.4.2.3 Transportation

The Burlington Northern and the Chicago and North Western Railroads each operates an east-west line that serves Douglas and Glenrock (see Fig. 2.4). A 200-km (124-mile) railroad spur is being constructed by the Burlington Northern to connect its lines at Gillette, Wyoming, and Orin Junction, 24 km (15 miles) east of Douglas. The major automobile routes in the county are Interstate 25 and State Route 59. Roads on or adjacent to the site include the Highland Loop Road, Ross Road, and Glenrock-Ross Road. Numerous unimproved dirt roads used in ranching traverse the site.

Commercial air service is located in adjacent Natrona County. The Converse County Airport, situated in southeastern Douglas, provides facilities for private aircraft, with commercial service also available.

## 2.5 LAND USE

### 2.5.1 Land Resources

The project area consists of two major leased tracts and a scattering of outlying areas, totaling approximately 10,500 ha (26,000 acres) or about ten percent of the 100,000-ha (250,000-acre) Morton Ranch property. The ore sources for the proposed project will be within the 1415-ha (3500-acre) northern and 8700-ha (21,500-acre) southern tracts. Uranium exploration is being

conducted on the outlying lands. The proposed mill is to be built on Sections 11 and 14 of the southern tract. Mill tailings will be placed in depleted ore pits, most of which are located within Section 14 (see Fig. 1.2).

#### 2.5.1.1 Land Ownership

Approximately three quarters of Converse County is privately owned (App. B, Table B.15). The Morton Ranch site is almost completely held by private parties except for two full sections and portions of two other sections (approximately 600 ha or 1480 acres) owned by the State of Wyoming. Lease agreements have been obtained from the state for this property. Fee mineral rights, derived from patented and unpatented mining claims, have been obtained from various private parties (Fig. 2.5). Federally owned land parcels (approximately 130 ha or 320 acres) within the mine lease area are identified in Figure 2.5. None of these Federal lands are within the mill or tailings restricted areas.

#### 2.5.1.2 Agriculture

Ranching is the major land use in the county, involving both cattle and sheep production to maximize use of available forage. Some hogs are also raised. The number of sheep and hogs has declined over the past five years, whereas cattle raising has remained fairly stable (App. B, Table B.16). The amount of county land used for growing crops constitutes a small percentage (< 5%) of the total land area (App. B, Table B.17), as the land is too arid for successful small-scale farming. Approximately 30,300 ha (74,870 acres) of the county are in forest land.<sup>22</sup>

The Morton Ranch property currently supports approximately 10,000 sheep and 3000 cattle, and the land surrounding the site is used primarily for sheep grazing. The three ranches nearest the site (Vollman, Fowler, and Box Creek ranches) raise livestock. A limited amount of crops are grown on the Vollman (cattle feed) and Fowler (vegetables) ranches.<sup>9</sup>

#### 2.5.1.3 Esthetics

The site is located in the eastern Powder River Basin, which is generally characterized by open rangeland, i.e., rolling plains lacking distinctive landforms, textures, and colors.<sup>5</sup>

Vegetation is predominantly shrub and/or grass species with few tall plants or trees breaking the pattern of short vegetation. Intrusions into the landscape are primarily man-made, such as strip mines, transmission lines, highways, fences, and oil wells (Fig. 2.6).

Because of the lack of variety in the landscape, large structures such as those used in uranium milling are likely to be visible for several miles from any direction.

### 2.5.2 Historical and Archeological Resources

#### 2.5.2.1 Historic Places

The National Register of Historic Places, as published in *Federal Register* for 7 February 1978<sup>29</sup> and all monthly supplements thereafter, was consulted to identify areas of historical value on or near the proposed site. Two entries were identified: Glenrock Buffalo Jump, approximately 40 km (25 miles) southwest of the site, and Fort Fetterman, approximately 24 km (15 miles) southwest of the site.

#### 2.5.2.2 Archeological Sites

An archeological survey of the proposed mine and mill sites was conducted by the University of Wyoming Department of Anthropology, under the direction of the Assistant State Archeologist (ER, App. A-II). One potentially important find was uncovered during the survey: a large living area, probably a campsite, containing evidence of such activities as stone tool working and manufacture, food procurement, and food preparation. This site, now listed as 40 CO 305, has been nominated to the National Register of Historic Sites and Landmarks by the Wyoming State Archeologist and has been placed on the Wyoming Register of Archeological Sites. The site is several miles from the planned milling activity.

In a later survey by the Associate State Archeologist of areas proposed for the mill bench and tailings disposal, clearance for mining was recommended for those tracts on the basis that evidence of an archeological resource was lacking.<sup>30</sup> In a letter dated 10 January 1978, the applicant committed itself to immediate notification of the Office of the State Archeologist if "bones, firepits, artifacts, etc.," were to be discovered on these tracts.<sup>31</sup>

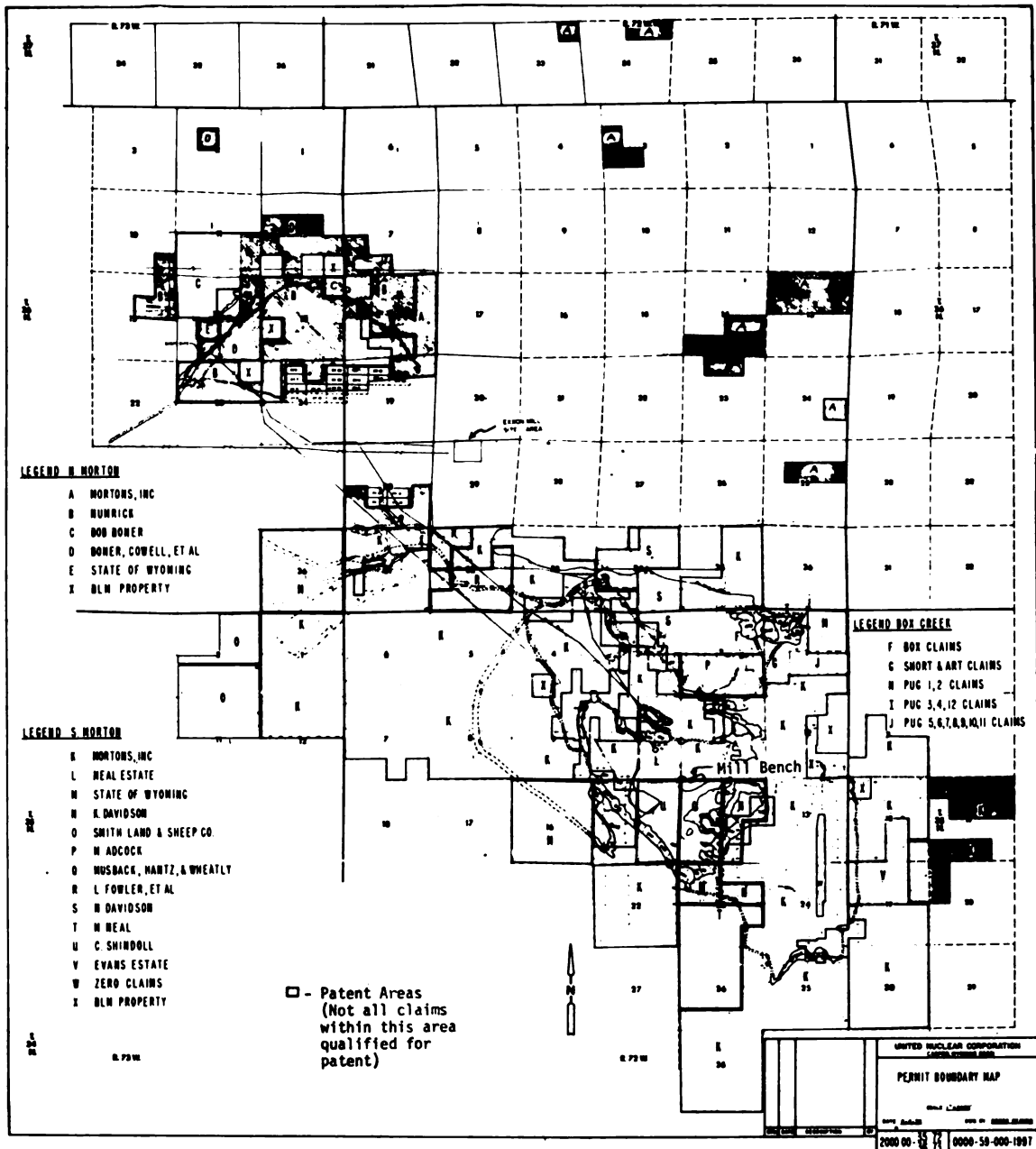


Fig. 2.5. Morton Ranch Leased Tracts, Showing Mineral Rights Ownership (Applicant's figure of 7-17-78.)

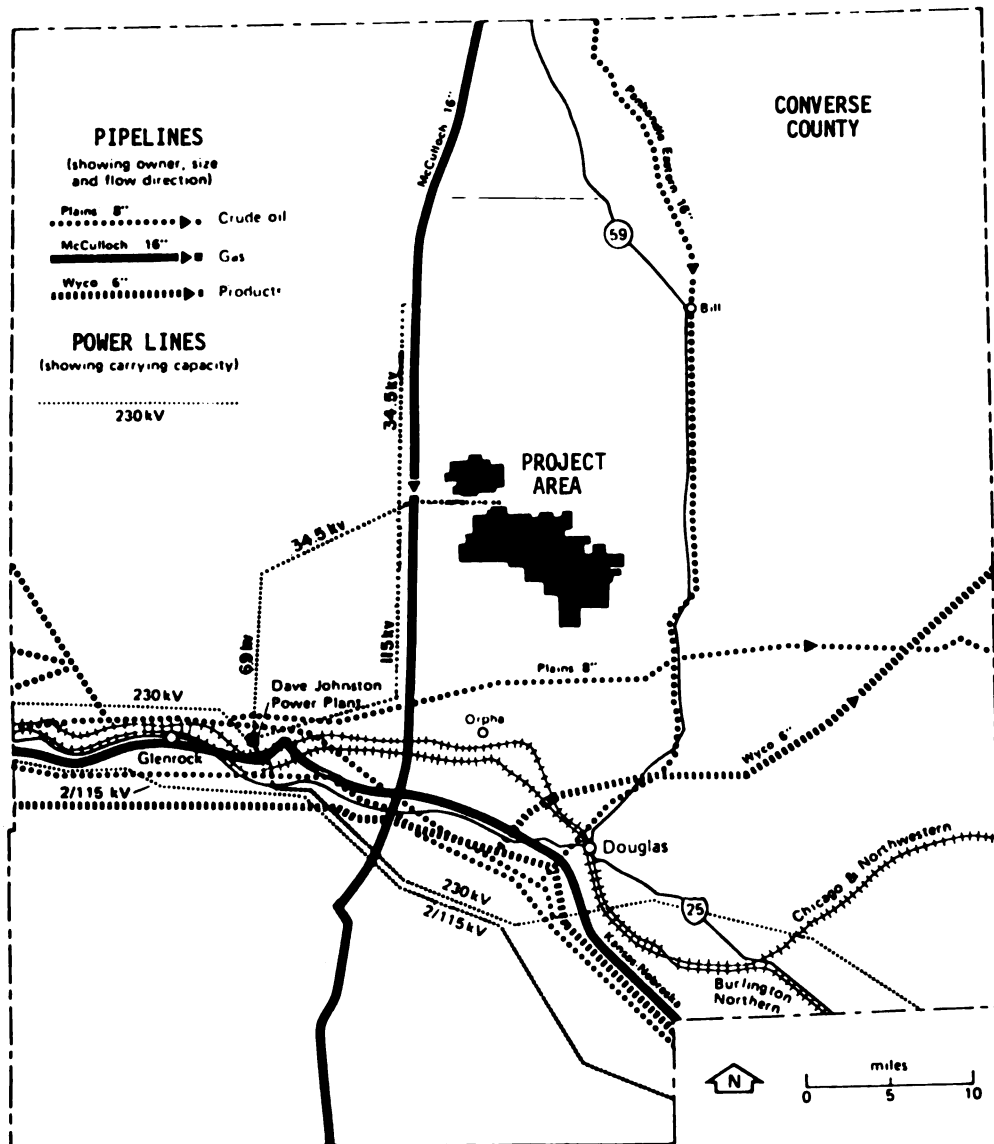


Fig. 2.6. Pipelines and Power Lines in Converse County (from ER, Fig. 2.2-1).

### 2.5.2.3 Natural Landmarks

Although there is no listing of natural landmarks for Converse County in the National Registry of Natural Landmarks,<sup>32</sup> the county does contain segments of Medicine Bow National Forest, Thunder Basin National Grassland, and Ayres Natural Bridge.

## 2.6 WATER

### 2.6.1 Water Sources

#### 2.6.1.1 Surface Water

Most of the site area is drained by the north and south forks of Box Creek and their tributaries (see Fig. 2.7). All are intermittent and discharge into Lance Creek and eventually into the Cheyenne River. A small portion in the southern region of the site drains into the Cheyenne River by way of Lightning Creek. A small portion of the northern lease drains into Cowell Draw and then into the Dry Fork Cheyenne River.

Several small, man-made, stock-watering impoundments are found on the site, the largest of which is Morton Reservoir (Fig. 2.7).

#### 2.6.1.2 Groundwater

Geological formations in the southern portion of the Powder River Basin include, in descending order and increasing age, the 1) alluvium, 2) Wasatch Formation, 3) Fort Union Formation, 4) Lance Formation, 5) Fox Hills Formation, and 6) older rocks too deep to be affected by the proposed uranium mining (see Fig. 2.10). Table 2.4 shows the well depths for each formation, anticipated well yields, and total dissolved solids contents in the vicinity of the Morton Ranch project. The Holocene alluvium in the project area ranges in depth from 0 to about 12 m (40 ft), and consists of unconsolidated and poorly stratified clays, silts, and sands with local gravel lenses. Groundwater is present at or near the surface and fluctuates on an annual cycle. At the low points of drainages, groundwater seepage occurs as ephemeral ponds, contributing to flow only during heavy runoffs. No wells on the property are pumped from the alluvium.

The Wasatch and Fort Union aquifers contain the ore bodies to be mined by the applicant and yield relatively large quantities of water.

The Wasatch Formation, approximately 100 m (328 ft) thick, consists of fine- to coarse-grained lenticular beds of sandstones with interbedded claystone and siltstones. Anticipated yields vary from about 4 Lpm to almost 3000 Lpm (1 to 800 gpm). Groundwater may be confined and under artesian pressure in this formation.

The principal water-producing aquifer near the site is the Fort Union Formation. This formation also consists of fine- to coarse-grained lenticular beds of sandstone with interbedded claystones and siltstones and can be up to 900 m (2950 ft) thick. Wells that tap this aquifer yield from about 4 to 380 Lpm (1 to 100 gpm). This groundwater, also, may be confined and under artesian pressure.

The Lance Formation is not normally tapped as a water supply. It consists of fine- to medium-grained sandstone and interbedded shale and sandy shale. The depth of the aquifer in this formation is between 760 and 910 m (2490 and 2985 ft) in the vicinity of the site.

The Fox Hills Formation consists primarily of fine- to medium-grained sandstone lying at depths of 1670 to 1820 m (5480 to 5970 ft). It is used as a municipal and domestic water source in areas where suitable water is unavailable from shallower sources. However, it is not expected to be tapped for Morton Ranch milling operations.

Fig. 2.8 shows the piezometric contours and the direction of the groundwater flow in the vicinity of the Morton Ranch property. Although groundwater movement in the area is normally from south to north, the staff believes that dewatering wells at Exxon's Highland uranium mine have affected the direction of flow on the north lease.

The groundwater table in the mill tailings area of the site is depicted in Figure 2.9. The water table depth has been interpreted by the applicant as the average depth of the top of the upper aquifer sand unit penetrated (the upper ore sands in the Wasatch Formation). Long range effects of mining on surface water flow should be negligible, although treated water being pumped from pits during mining operations into the south fork Box Creek drainage will increase its flow intermittently. Because of the lenticular character of the aquifers of the Wasatch Formation and of

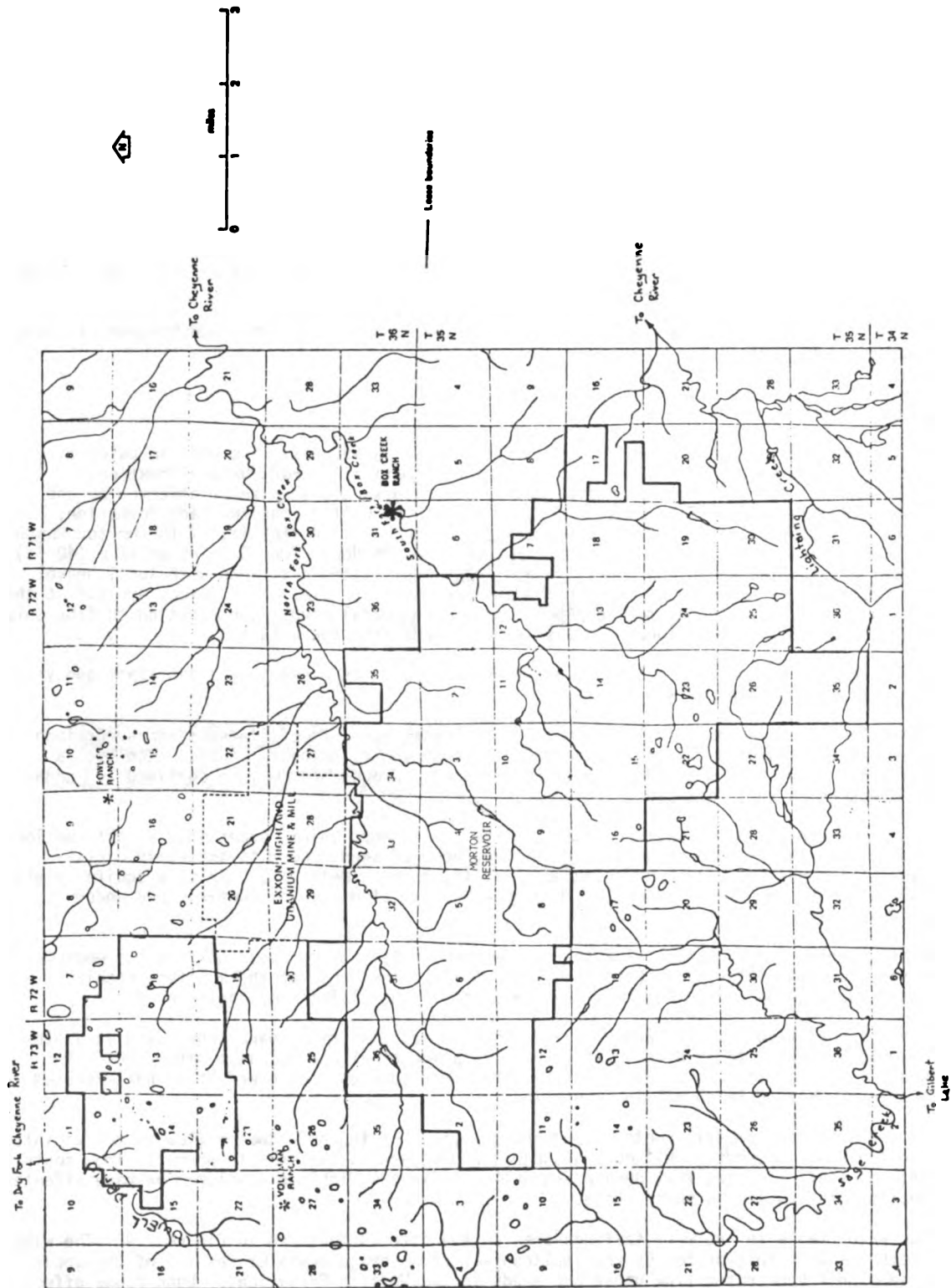


Fig. 2.7. Surface Drainage of the Morton Ranch Lease Areas (from ER, Fig. 2.6-2).

Table 2.4. Northeastern Wyoming Groundwater Sources<sup>a</sup>

| Geologic Period | Aquifer    | Depth Range of Wells, m | Anticipated Well Yield, Lpm |               | Total Dissolved Solids, ppm |
|-----------------|------------|-------------------------|-----------------------------|---------------|-----------------------------|
|                 |            |                         | Common                      | High          |                             |
| Quaternary      | Alluvium   | 3-30                    | 20-945                      | 1140-2270     | 106-7340                    |
| Tertiary        | Wasatch    | 12-300                  | 4-150                       | 380-2370      | 160-6620                    |
|                 | Fort Union | 45-180                  | 4-110                       | 380           | 484-3250                    |
| Cretaceous      | Lance      | 45-365                  | 4-190                       | 1900          | 450-3060                    |
|                 | Fox Hills  | 210-700                 | 75-260                      | 760-1900      | 1240-3290                   |
|                 | Mesaverde  | 12-915                  | 57-150                      | 225-265       | 550-1360                    |
|                 | Cody       | 30-335                  | 4-20                        | 380-760       | 6392-12,380                 |
|                 | Frontier   | 20-610                  | 4-20                        | 380-1135      | 390-2360                    |
|                 | Dakota     | 75-1830                 | 95-380                      | 760-3410      | 218-1820                    |
| Jurassic        | Sundance   | 120-210                 | 4-20                        | 95            | 894-2310                    |
| Triassic        | Spearfish  | 6-275+                  | 4-115                       | 380-760       | 2590                        |
| Pennsylvanian   | Minnelusa  | 75-1980                 | 95-950                      | 1890-7470     | 255-3620                    |
| Mississippian   | Pahasapa   | 150-2320                | 380-9460                    | 26,500-35,600 | 290-3290                    |
| Ordovician      | Bighorn    | 0-60                    | 3785                        | 3785          | 427-3219                    |
| Cambrian        | Flathead   | 20-1800                 | 760                         |               | 124                         |

<sup>a</sup>Adapted from ER, Table 2.6-1.

the alluvial deposits, mining should have negligible effect on alluvial groundwater, and its contributions to the south fork Box Creek drainage.

Groundwater usage is limited primarily to rural domestic and livestock needs. Such water comes mainly from low-yield wells that tap the Wasatch and Fort Union Formations. There are 20 wells on the Morton Ranch property and 111 wells within 10 km (6 miles) of the site (ER, Table 2.6-2).

Recharge to the Wasatch and Fort Union aquifers occurs from precipitation percolating downward through the overlying formations throughout the basin. Recharge to the deeper aquifers occurs principally by infiltration of precipitation in the outcrop of the aquifers in the Big Horn Mountains, the Black Hills, and the low-lying hills along the Cheyenne River Divide and the Hartville uplift.

## 2.6.2 Water Quality

### 2.6.2.1 Surface Water

Samples of Morton Ranch surface water were collected by the applicant for the TVA in October and December of 1974 and were analyzed for radioactive and nonradioactive constituents (FES-TVA, Sec. 3.4). The applicant analyzed water samples from natural springs and ponds, and from ponds created as part of mine-development activities. Results from the applicant's sampling program are given in Appendix C, Table C.1 and C.2 and Figures C.1 and C.2.

The concentrations of dissolved Ra-226, natural uranium, and Th-230 were below EPA drinking-water standards in most samples. Iron, in a few samples, exceeded U.S. Public Health Service drinking water recommendations (FES-TVA, Sec. 3.4). Discharge from the mine dewatering holding ponds is done in accordance with NPDES permit requirements (ER, Sec. 4.1).

### 2.6.2.2 Groundwater

Samples of Morton Ranch groundwater were collected by the applicant as part of its mine-water analysis in October and December of 1974 and analyzed for radioactive and nonradioactive constituents (FES-TVA, Sec. 3.4). Staff evaluation of water samples from wells drilled as part of the TVA's mine-development activities indicate that the water quality is acceptable for most uses. Groundwater analyses, exclusive of radioactivity, are summarized in Appendix C, Table C.3

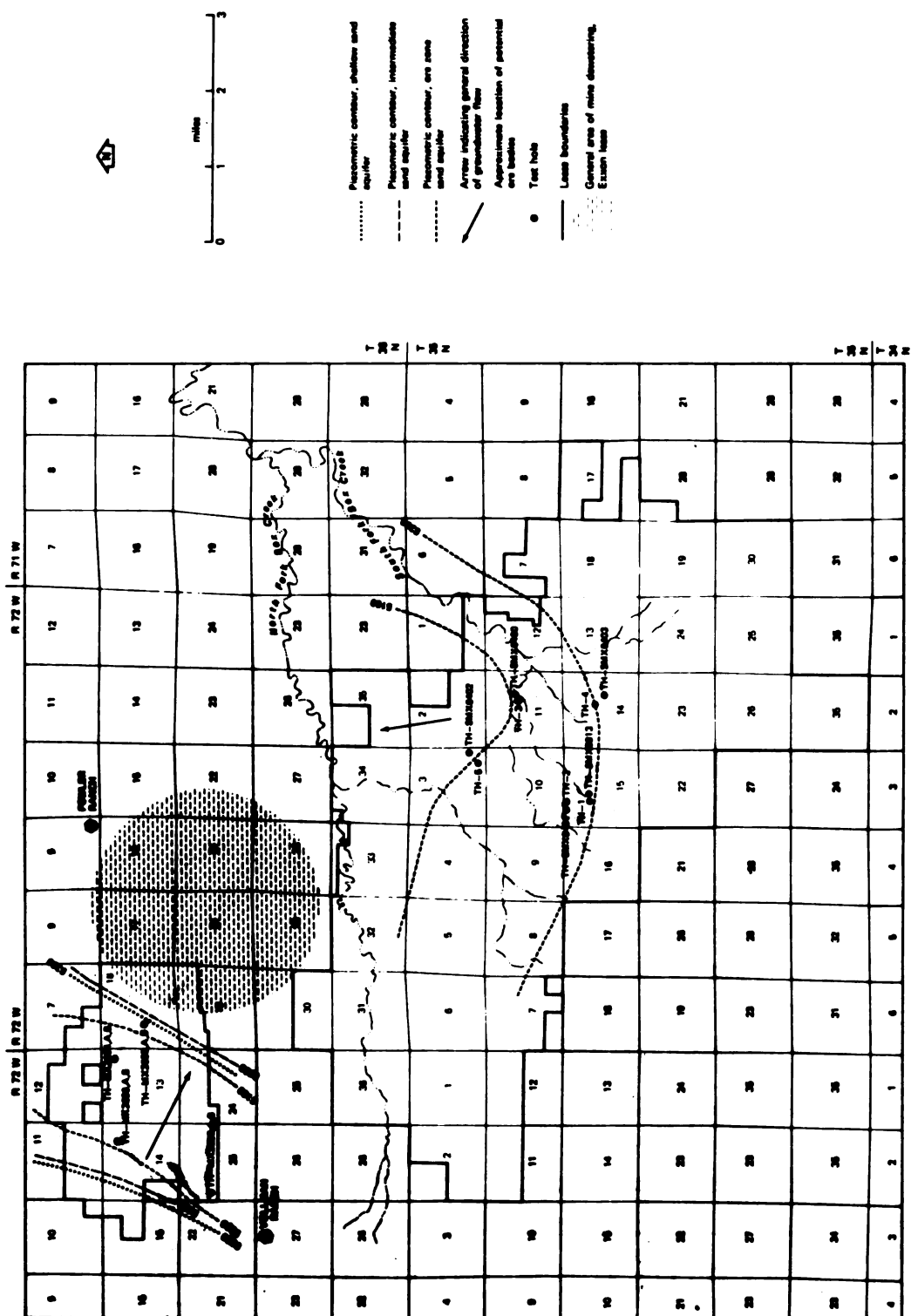


Fig. 2.8. Piezometric Gradient in the Vicinity of the Morton Ranch Property (from FES-TVA, Fig. 3.4-6).

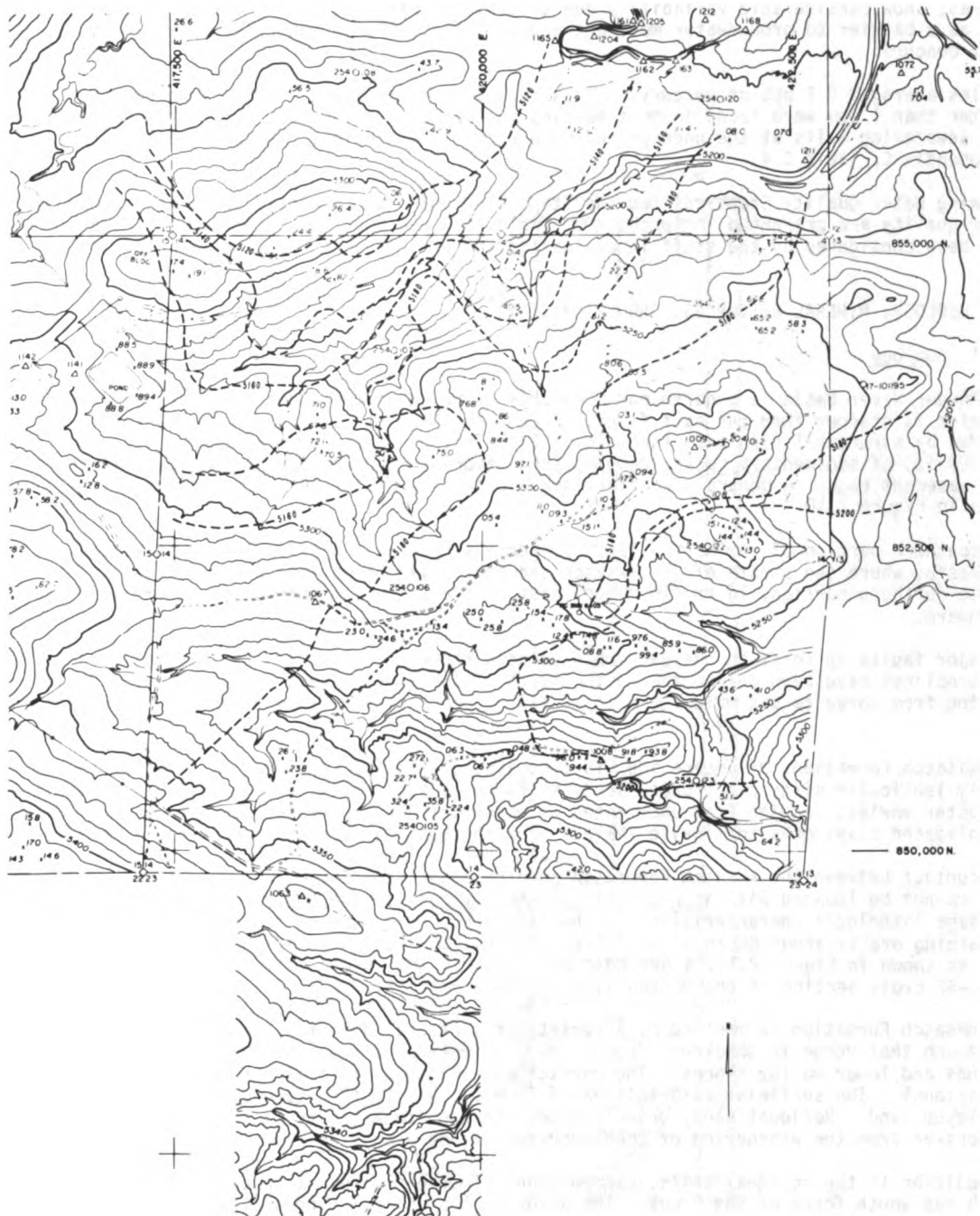


Fig. 2.9. Mill Tailings Groundwater Contour Map Water Table

and Figures C.1 and C.3. The TVA concluded that element distributions, as presented in these figures, show considerable variability due to clay-material lensing in the sandy units, which acts as a barrier to groundwater movement and preferentially concentrates some elements. The staff concurs.

Samples averaged 0.1 ppb of mercury, with a recorded maximum of 0.7 ppb. Iron concentrations greater than 1 ppm were found in most samples analyzed. Further sampling of groundwater pumped from dewatering wells at the underground mine site is continuing. Current results are summarized in Appendix C, Table C.4.

Drinking Water Quality Standards for the State of Wyoming and proposed EPA criteria for Wyoming water quality are presented in Appendix C, Tables C.5 and C.6, for comparison. These standards have been considered by the staff in evaluating the existing water quality at the site.

## 2.7 GEOLOGY, MINERAL RESOURCES, AND SEISMICITY

### 2.7.1 Geology

The Powder River Basin is a north-northwesterly trending asymmetrical syncline, the west flank of which is steeper than the east flank. Except on the north, the basin is completely surrounded by structural highlands (see Fig. 2.2). In the deepest part of the basin, about 5500 m (18,000 ft) of sedimentary rocks, ranging from Cambrian to Oligocene in age, overlie the crystalline basement rock. A generalized stratigraphic section of the southern portion of the basin is shown in Figure 2.10.

The southern portion of the Morton Ranch property straddles a section of the structural axis of the basin, where the strata of the Wasatch and Fort Union Formations are essentially flat-lying. At the northern portion, 16 km (10 miles) east of the axis, the strata dip generally 2° to 5° northward.

No major faults or folds in the bedrock have been reported. A series of subparallel anticlines and synclines have been delineated to the north of the site. These structures have reliefs ranging from three to six meters (10 to 20 ft). Such structures may extend to the Morton Ranch site.

The Wasatch Formation, of Eocene age, is comprised of fluvial sediments of interbedded and highly lenticular silty claystones, sandy siltstones, sandstones, and claystones. Lithologic character varies, ranging from uncemented to moderately well-cemented sandstone, and from weakly consolidated claystones to fissile shales. For the most part, these beds exhibit massive jointing.

The contact between the Wasatch Formation and the underlying Fort Union Formation, of Paleocene age, cannot be located with accuracy lithologically because the two formations have essentially the same lithologic characteristics in the site area. The base of the lowermost sandstone-containing ore is about 60 to 90 m (200 to 300 ft) above the base of the Wasatch Formation. This is shown in Figure 2.11, a geologic map of the Powder River Basin, and in Figure 2.12, a NW-to-SE cross section of the Morton Ranch project property.

The Wasatch Formation is mantled by a variety of surficial deposits, including residual soil and slope wash that range in thickness from a few centimeters on steep slopes to over 3 m (10 ft) on uplands and lower valley slopes. The contact between the surficial material and the bedrock is gradational. The surficial materials range from sandy silt to clayey silt, and from silty clay to clayey sand. Residual sandy gravels appear to cap ridge crests in the area. The gravels may be derived from the weathering of conglomerates of the overlying White River and Wasatch Formations.

In addition to the residual soils, narrow bands of stream alluvium underlie Cowell Draw and the north and south forks of Box Creek. The alluvium typically includes clays, silts, and sands with some gravel lenses. The material is unconsolidated, poorly stratified, and commonly 1.5 to 4.5 m (5 to 15 ft) thick. Locally, the alluvium may be as much as 14 m (48 ft) thick.

### 2.7.2 Mineral Resources

#### 2.7.2.1 Uranium

Uranium has been mined in the area since the early 1950s, initially from small, shallow deposits in the Wasatch Formation. Since the mid-1960s, when ore was discovered at depth, exploration by drilling has proved the existence of many large uranium deposits in the southern part of the basin. No precise data are available concerning the total tonnage discovered to date. There are at least ten deposits that contain more than one million tons of ore each and probably as many as 100 deposits containing from a few tons to one million tons.<sup>33</sup> Continuing exploration will probably reveal the presence of additional deposits. More than 90% of the known ore reserves

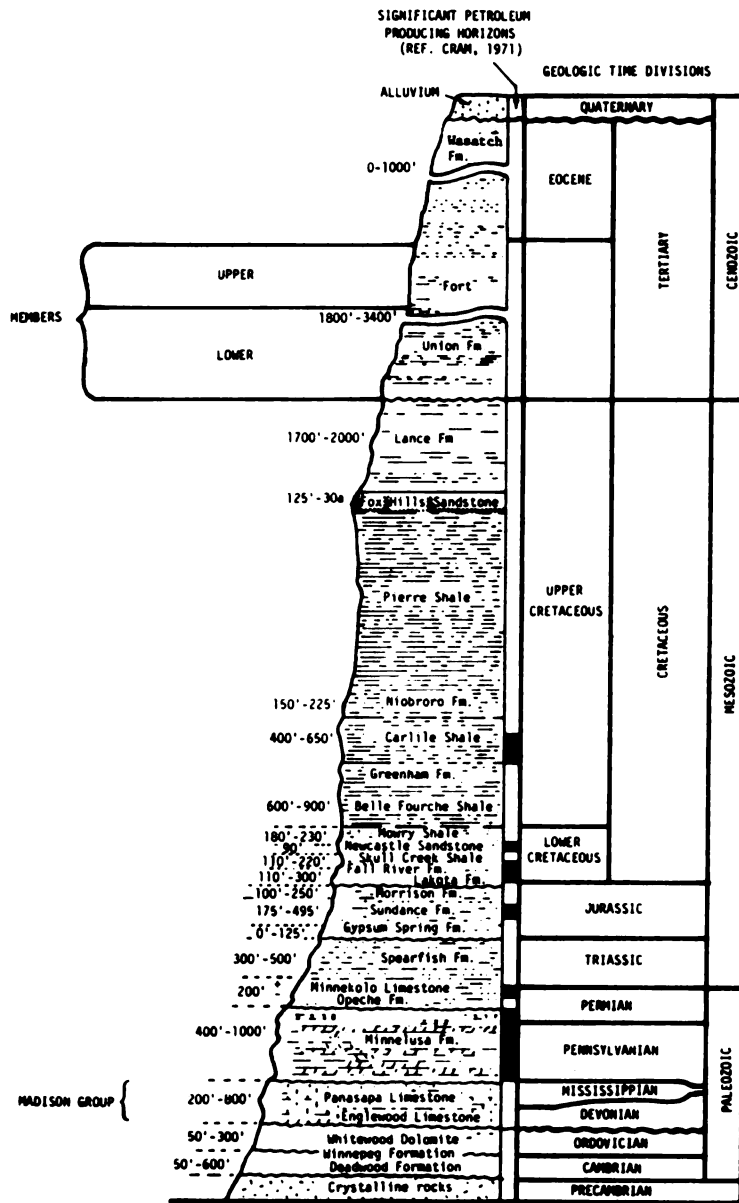


Fig. 2.10. General Stratigraphic Section, Southern Powder River Basin (from ER, Fig. 2.4-3).

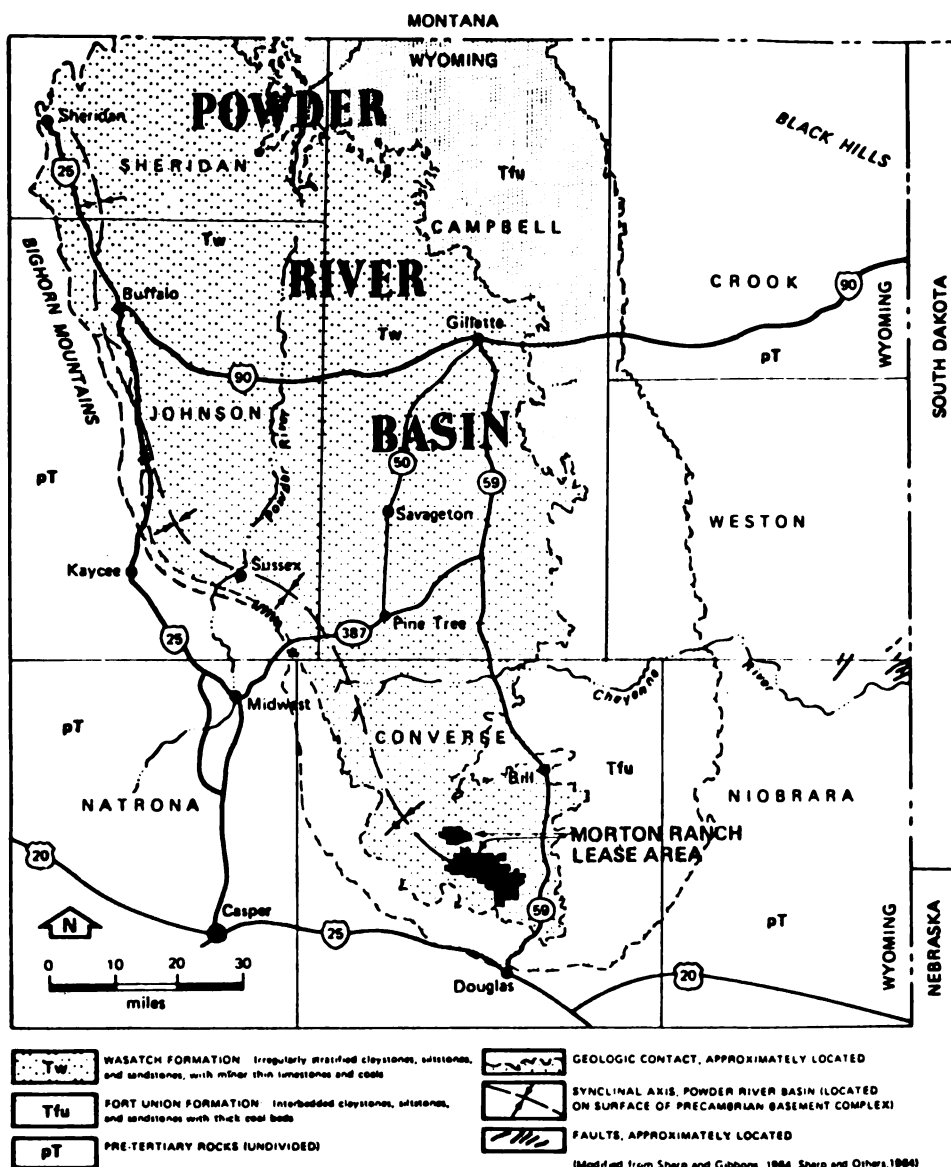


Fig. 2.11. Regional Geology of the Powder River Basin (from ER, Fig. 2.4-1).

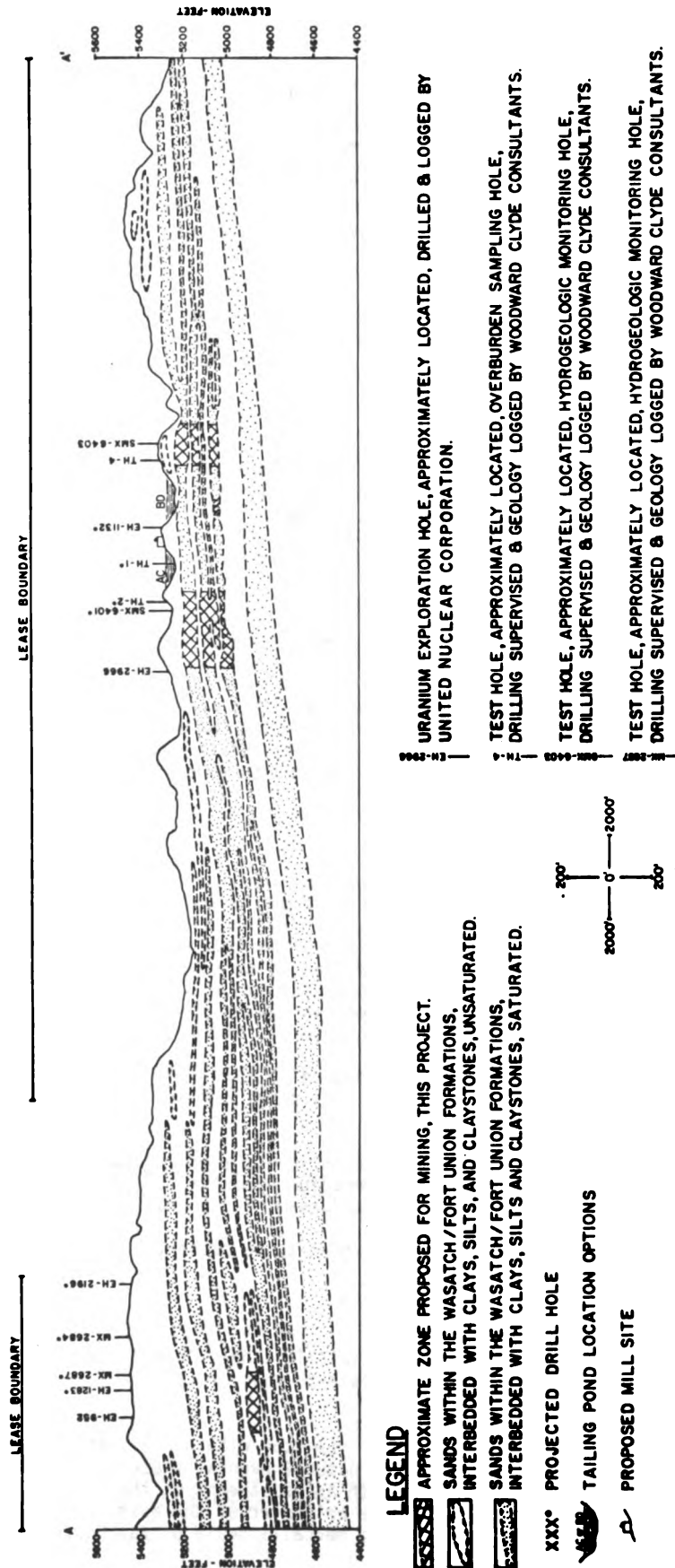


Fig. 2.12. Geologic Cross Section of the Morton Ranch Property (from ER, Fig. 2.4-5).

occur in the Fort Union and Wasatch Formations, of early Tertiary age; a few deposits occur in the Lance and Fox Hills Formations, of Cretaceous age.

Typically, the uranium deposits in the Fort Union and Wasatch Formations occur at a boundary between oxidized yellow or reddish and unoxidized gray sandstone and are known as "roll front" deposits. The boundaries, as viewed in plan, are generally very sinuous, occur at different stratigraphic horizons, and display no consistent trend. Ore grade is not continuous along the boundaries but occurs in local concentrations connected by thin, low-grade mineralized sandstone.

Three uranium minerals--coffinite, zippeite, and liebigite--have been identified in rock core samples, occurring primarily as coatings on the individual grains of the sandstone host rocks. It is believed that parts of the deposits have migrated within the sandstone units in conjunction with the down-dip movements of reduction-oxidation contacts.

The ore-bearing interval (Fig. 2.12) ranges from 15 to 30 m (50 to 100 ft) in thickness and consists of fine-, medium-, and coarse-grained sandstones that are poorly indurated. Some well-indurated, calcite-cemented sandstone may be found in and near the ore.<sup>33</sup>

#### 2.7.2.2 Oil and Gas

The Powder River Basin has been an important source of oil and gas since the early 1900s. Total production to date has been approximately 1.3 billion barrels of oil, and the ultimate yield of the more than 100 active fields is estimated to exceed two billion barrels.<sup>34</sup> Production and estimated reserves of natural gas are also substantial. Oil and gas occur in 20 or more geologic formations under various conditions of entrapment, and it is likely that new discoveries will be made in the yet unexplored parts of the region.

The nearest oil- and gas-producing area--the Well Draw field--is about 26 km (16 miles) east of the site. Production is from Cretaceous formations several thousand feet below the Wasatch Formation.

Oil production in Converse County has doubled since 1974 and tripled since 1973.<sup>35</sup> Natural gas production in the county in 1975 was three times that of 1974 and was 13 times that of 1972.<sup>35</sup> No major discoveries have been made in the last two years, and it has been predicted that production will soon reach a maximum (peaking about 1978) and then begin to decline.<sup>35</sup>

#### 2.7.2.3 Coal

Coal beds, principally in the lower part of the Wasatch Formation and upper part of the underlying Fort Union Formation, are present throughout most of the Powder River Basin. Precise information concerning total quantities of coal is not available for the entire basin, but the staff believes that the presence of several hundred billion tons would be a realistic estimate. Individual coal beds range in thickness from a few feet to more than 30 m (100 feet); many of the beds are 15 to 30 m (50 to 100 ft) thick. Deposits occur at the surface in many places, particularly near the basin margins, but are as deep as 1800 m (6000 ft) in the interior of the basin. Coal is currently being produced from nine open-pit mines.

In Converse County, 3 million tons of coal was produced in 1975<sup>35</sup> for use in the Dave Johnston mine-mouth power plant. Tonnage mined to support this plant was expected to stabilize at about 3.4 million tons during 1977.<sup>35</sup>

In the area of the Morton Ranch project, thin, discontinuous seams of subbituminous coal are interspersed throughout the overburden above the uranium deposits. This coal is uneconomical to mine, and is usually removed as overburden from surface-mining operations.

No other mineral resources of economic value are known to be present near the project area.

#### 2.7.3 Seismicity

The Morton Ranch site is located in a minor-risk seismic zone<sup>36</sup> that extends over much of the Middle Western States. The nearest area of moderate-to-major risk is 400 km (250 miles) west, along the Wyoming-Idaho border.

Twenty-three seismic events have been detected or reported within a 160-km (100-mile) radius of the site.<sup>37</sup> Of these, only 12 are thought to be natural events related to faulting. The nearest mapped faults are more than 40 km (25 miles) south and southeast of the site. They are associated with the Laramie and Hartville uplifts. The epicenter of the most intense event (near Casper, Wyoming, estimated at VII on the Modified Mercalli Scale of Earthquake Intensities) is

72 km (44 miles) from the Morton Ranch site. Of the other 11 events, two were of an intensity of VI; eight, of V; and one, IV.

## 2.8 SOILS

The soils of the Morton Ranch lease sites have been surveyed by the U.S. Soil Conservation Service. All of the soil complexes are either neutral or alkaline in pH. Although they are low in organic content, phosphorus, and nitrogen, they are said to be adequate in both quantity and quality to support revegetation of all areas to be affected by the milling operations (FES-TVA, p. 3.3-1).

Analyses of core samples made by the Colorado School of Mines Research Institute (ER, Vol. 2, App. A-VI, part II, p. A-55) show that toxic elements in the topsoil, subsoil, and overburden were not found in concentrations high enough to create toxicity problems in plants growing on them nor in livestock feeding on such plants.

## 2.9 BIOTA

### 2.9.1 Terrestrial

#### 2.9.1.1 Vegetation

The vegetation of the Morton Ranch area is generally sparse and is typical of the western edge of the North American prairie. It is characterized by the presence of various short grasses and sagebrush and by the near absence of tall plants and trees--a vegetation pattern that largely results from lack of precipitation combined with high evaporation and transpiration rates.

The composition of grass-sagebrush associations vary from area to area, depending primarily on available moisture, the ability of the plant species to withstand drought, and the current and past grazing practices. The results of the applicant's quantitative survey of the area's vegetation, made in 1974 (ER, Table 2.8.2, and ER Suppl. II, response to Q. 20), are given in Table 2.5; the types and distribution of vegetation in the proposed mill and tailings areas are shown in Figure 2.13. Big sagebrush is the dominant shrub of the overstory; blue grama grass, of the understory. Forbs are virtually absent (0.2% of the ground cover). Such vegetation is important as forage for range livestock and as food and cover for many species of wildlife. In the past, the range was overgrazed, first by bison and later by sheep and cattle; but it is now classified as "good" (FES-TVA, p. 3.1-1 and Ref. 38).

Table 2.5. Vegetation in the Vicinity of the Morton Ranch Mill Site

|                                                 | Percent<br>Ground Cover | Percent<br>Composition |
|-------------------------------------------------|-------------------------|------------------------|
| <u>Grasses</u>                                  |                         |                        |
| Western wheatgrass ( <i>Agropyron smithii</i> ) | 1.2                     | 4.7                    |
| Blue grama ( <i>Bouteloua gracilis</i> )        | 12.4                    | 46.3                   |
| Threadleaf sedge ( <i>Carex filifolia</i> )     | 0.3                     | 1.0                    |
| Junegrass ( <i>Koeleria cristata</i> )          | 0.2                     | 0.8                    |
| Dropseed ( <i>Poa</i> )                         | 0.4                     | 1.7                    |
| Needle-and-thread grass ( <i>Stipa comata</i> ) | 0.2                     | 0.6                    |
| <u>Forbs</u>                                    |                         |                        |
| Phlox ( <i>Phlox</i> )                          | 0.2                     | 0.9                    |
| <u>Shrubs</u>                                   |                         |                        |
| Big sagebrush ( <i>Artemisia tridentata</i> )   | 9.4                     | 35.0                   |
| Prickly pear ( <i>Opuntia polyacantha</i> )     | 1.6                     | 5.8                    |
| <u>Lichens</u>                                  |                         |                        |
| Lichens (Crustaceous)                           | 0.9                     | 3.2                    |
|                                                 | 26.8                    | 100.0                  |

Source: ER Suppl. II, response to Q. 20, Table 1.

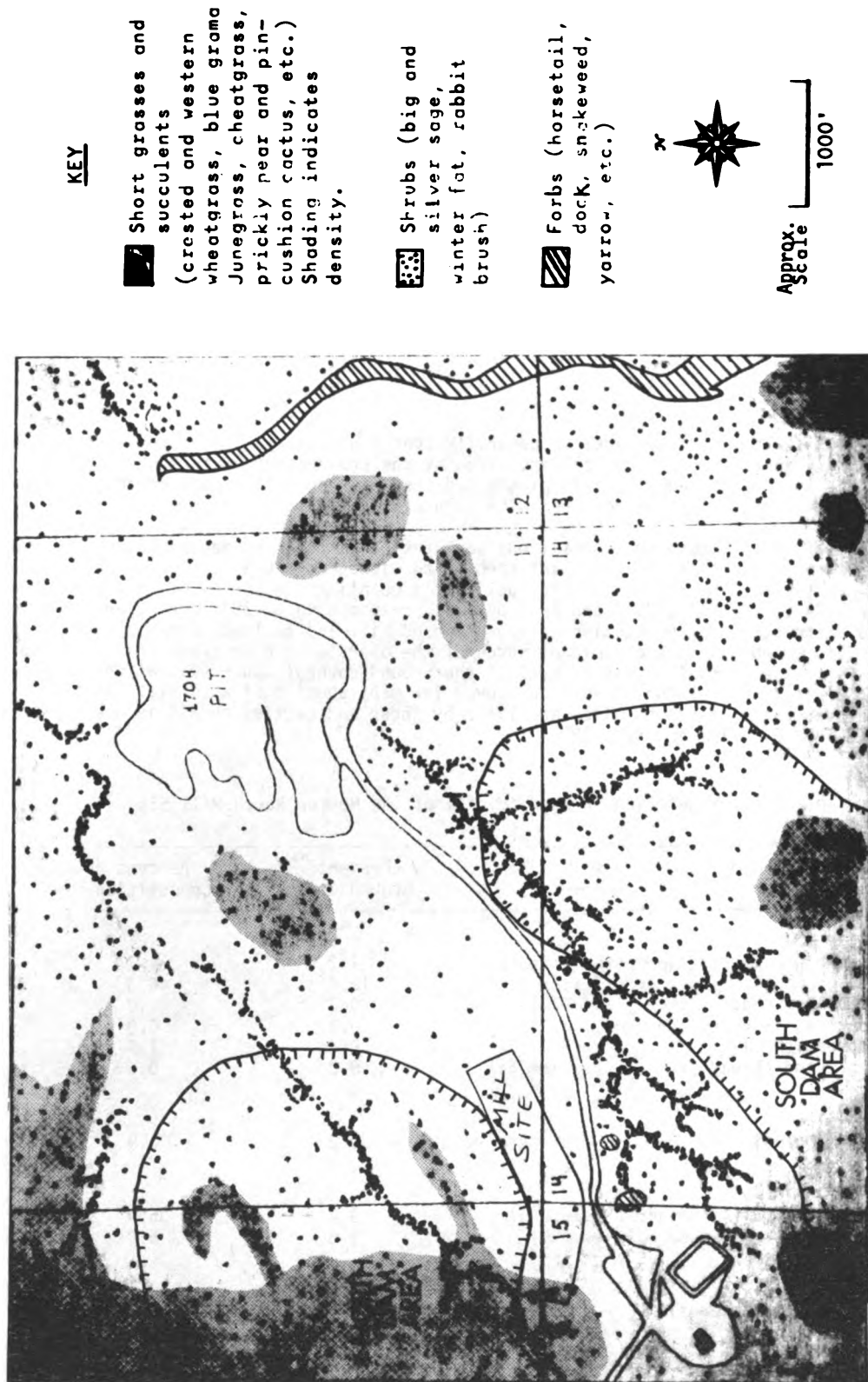


Fig. 2.13. Vegetation in the Vicinity of the Mill Site (modified from ER Suppl. II, response to Q.21).

A small amount of aquatic and riparian vegetation occurs on the Morton Ranch property, principally in the low-lying areas along the north fork of the intermittent Box Creek. These consist primarily of algae, buttercups, water hyacinths, horsetails, and rushes (FES-TVA, p. 3.6-1). A few trees also grow along the lower drainage. No aquatic or riparian vegetation occurs in the proposed mill and tailings areas (ER Suppl. II, response to Q. 21).

No rare, threatened, or endangered plant species have been observed on the Morton Ranch site by the applicant (FES-TVA, p. 3.6-4 and Ref. 39), nor were such species identified by staff biologists during a site inspection in June 1977.

#### 2.9.1.2 Wildlife

The sagebrush-grass prairie habitat of the Morton Ranch area supports a diverse fauna. Several species are important as game animals.

#### Vertebrates

Ninety-eight species of terrestrial vertebrates have been observed or are thought to occur in the Morton Ranch mine and mill area (ER, Table 2.8-3). Birds are the most diverse group (52 species), followed by mammals (26 species), and by reptiles and amphibians (20 species).

The pronghorn antelope is the most important big-game animal on the mine/mill site. It prefers the open expanses of grasslands and sagebrush typical of the site, and is a permanent resident of the area.<sup>40</sup> It feeds mostly on shrubs, but does eat lesser amounts of forbs and grasses. Sagebrush, the dominant shrub on the site, is especially important as winter forage. Present range conditions and the Wyoming Game and Fish Department's management practices maintain the resident herd (Sage Creek Herd Unit) at an average density of approximately two individuals per square kilometer (five per square mile), with an annual harvest of 0.6 per square kilometer (1.5 per square mile).

Mule deer also occur in the mine/mill area, but in fewer numbers. They prefer more rugged terrain and cover than is available on most of the site. Population densities have been estimated at 0.8 individuals per square kilometer (2.0 per square mile),<sup>41</sup> but the exact density is unknown.<sup>42</sup> Mule deer on the Morton Ranch site are found mostly along the north<sup>41</sup> and south (ER, p. 2-71) forks of Box Creek.

Other mammals observed or expected to occur on the site include the black-tailed jackrabbit, white-tailed jackrabbit, desert cottontail, coyote, red fox, badger, striped skunk, and raccoon (ER, Table 2.8-3). Some are of economic importance as game animals and furbearers.

Rodents, as a group, are by far the most abundant mammals on the site. Functionally they are important in the ecosystem as herbivores and as prey for larger, predaceous mammals and for raptors. On-site live-trapping studies (ER Suppl. II, response to Q. 20, Table IV) in the vicinity of the proposed mill have indicated that the deer mouse and the thirteen-lined ground squirrel are the most plentiful rodents. The Wyoming pocket mouse and Ord's kangaroo rat were also observed, but in fewer numbers.

Although little is known of the abundance or specific habits of bats in eastern Wyoming, several species are believed to occur in the vicinity of the site (ER Suppl. II, response to Q. 20, Table VIII). The small-footed myotis has been observed at the Bear Creek mill site [32 km (20 miles) north-northwest];<sup>2</sup> but in surveys of the Morton Ranch property during 1975 (FES-TVA), none was found.

A variety of birds use the project site for a permanent or seasonal residence or as a temporary resting place during migration. Thirty-one of the 52 species listed in Table 2.8-3 of the applicant's Environmental Report were actually observed in a survey made during July-August 1974 (FES-TVA); the remaining 21 species are known to occur in the area.

The sage grouse is the most important upland game bird that occurs in the area. It is relatively plentiful on the Morton Ranch property because of the abundance of big sagebrush for food and cover, and because water in ponds in low-lying areas along the north fork of Box Creek is available for watering and brood rearing (ER, p. 2-70). The annual harvest is uncertain, but is estimated to range from 500 to 650 individuals in Converse County (ER, p. 2-70; ER Suppl. II, response to Q. 20),<sup>41</sup> an area of 11,040 sq km (4265 sq miles).

Mourning doves are also found throughout the project site (ER Suppl. II, response to Q. 20). They consume mostly forb and grass seeds and build their nests in the few trees along Box Creek, and in sagebrush and other shrubs where trees are not available.

Many species of waterfowl live on the Morton Ranch either permanently or seasonally (ER, Table 2.8-3). Several ponds in low-lying areas along the north fork of Box Creek provide suitable habitat for ducks. The mallard is the most plentiful.

Several species of raptors range over the mine-mill site (ER, Table 2.8-3); however, none is abundant. Those species observed during the July-August 1974 survey include the golden eagle, ferruginous hawk, marsh hawk, Swainson's hawk, and rough-legged hawk (FES-TVA, Table 3.6-3).

Reptiles and amphibians are not numerous in eastern Wyoming; however, some are relatively abundant on the Morton Ranch site (ER Suppl. II, response to Q. 20, Table X). In the 1974 survey (FES-TVA, p. 3.6-4 and Ref. 43), the northern prairie lizard, sagebrush lizard, eastern short-horned lizard, frog, and bullfrog were observed. The leopard frog, the most common amphibian in the area, is found around most ponds during spring and summer.

### Invertebrates

The most abundant terrestrial fauna on the Morton Ranch site, in terms of both species and total numbers, are the arthropods (grasshoppers, bugs, beetles, flies, wasps, spiders, mites) (FES-TVA, p. 3.6-4). These invertebrates are extremely important to the stability of the ecosystem, as they occupy practically all levels in the food chain, functioning as herbivores, predators, and scavengers. Many are food sources for higher orders of animals. They may also compete with other animals by feeding on sagebrush and grasses. Arthropods may reduce plant reproduction by consuming seeds and, at the same time, interact with the ecosystem as plant pollinators, disease vectors, and decomposers.

### Endangered Species

Of the species classified by federal statute<sup>43,44</sup> as endangered or threatened, only the American peregrine falcon (*Falco peregrinus anatum*) and the black-footed ferret (*Mustela nigripes*) have ranges that include the Morton Ranch.<sup>45</sup>

The American peregrine falcon has never been common in Wyoming. It has been seen migrating through the state in spring and fall, and is a rare summer resident. In western North America, the peregrine falcon typically chooses rocky cliffs and rimrocks near water for its nesting sites. In Wyoming, the preferred nesting and feeding sites are along the major rivers. Recent sightings in the state (during the past ten years) have been along the Green River in western Wyoming, and in Hoback Canyon and Douglas Creek Canyon.<sup>45</sup> It is doubtful that this bird would occur in the vicinity of the Morton Ranch mill, except possibly during its spring and fall migrations, as there is no suitable nesting habitat on or in the vicinity of the mill.

The black-footed ferret is found only in association with prairie dogs and prairie dog towns.<sup>45</sup> Thus, the critical habitat includes either a large prairie dog town or several smaller ones in close proximity which provide a year-round supply of food.<sup>45</sup> Prairie dog towns are usually found in sagebrush-grassland areas, the type of vegetation that occurs on the Morton Ranch and in the surrounding area. Four prairie dog towns have been identified in Converse County within 65 km (40 miles) of the site, but there have been no reports of sightings of the black-footed ferret near these towns.<sup>46</sup> No prairie dog towns or black-footed ferret were observed on the project site during the 1974 survey (FES-TVA), nor has the Wyoming Game and Fish Department recorded the presence of prairie dog towns.<sup>47</sup> No prairie dog towns or black-footed ferrets were identified by staff biologists, during a site visit in June 1977. For these reasons it is unlikely that there are any black-footed ferrets inhabiting the mill site.

Of the species classified as rare in Wyoming by the State Game and Fish Department,<sup>45</sup> only the spotted bat (*Euderma maculata*), the burrowing owl (*Speotyto cunicularis*), and the meadow jumping mouse (*Zapus hudsonius*) have geographic ranges that include or might include the Morton Ranch.

The spotted bat is apparently very selective in its roosting site location, preferring high cliffs and canyons of sedimentary origin.<sup>45,48</sup> In Wyoming, this bat is known only in the Big Horn Basin.<sup>45</sup> Because there are no high cliffs or canyons on the Morton Ranch property or nearby, it is unlikely that there are any spotted bats on the mill site.

The burrowing owl usually nests in prairie dog towns and is seldom found in the absence of colonies of burrowing mammals.<sup>45</sup> Successful reproduction requires burrows started by prairie dogs, mice, or ground squirrels and modified by the owl. Although prairie dog towns have not been sighted on the Morton Ranch, ground squirrels are relatively plentiful (ER Suppl. II, response to Q. 20). Therefore, burrowing owls may inhabit the mill site, even though none was observed during the 1974 survey (FES-TVA, p. 3.6-5) or the June 1977 site visit.

The meadow jumping mouse is known to occur in eastern and southeastern Wyoming.<sup>45</sup> However, it is unlikely to occur on the Morton Ranch because of the absence of its preferred habitat: low, grassy meadows near streams.

### 2.9.2 Aquatic

The principal streams of the Morton Ranch property are the north and south forks of Box Creek. Both are intermittent and contain water only during the spring months. The nearest permanent stream is the Cheyenne River, about 100 km (62 miles) northeast.

In the 1974 survey, three fish species were found in ponds associated with the north fork of Box Creek (about 6 km or 3.7 miles northeast of the mill) (FES-TVA, Table 3.6-4 and ER Suppl. II, response to Q. 20, Table V). The fathead minnow was abundant in one pond, and the flathead chub and white sucker were present, but in lesser numbers, in another pond. The ponds associated with the intermittent north fork of Box Creek are not suitable habitats for any species of game fishes because they are either dry part of the year or they are eutrophic (FES-TVA and ER Suppl. II, response to Q. 20). There are no natural ponds in the immediate area of the mill site.

Invertebrates also occur in the riparian and aquatic habitats on the Morton Ranch site. Arthropods (flies, bugs, scuds, mites), annelids (worms, leeches), and mollusks (snails, clams) were identified during the 1974 survey (FES-TVA, Table 3.6-5).

## 2.10 NATURAL RADIATION ENVIRONMENT

The existing radiation environment at the Morton Ranch site is a composite of the natural radiation environment (primary and secondary cosmic radiation, cosmogenic radioactivity, and terrestrial radioactivity) and radiation from offsite sources such as other mining and milling operations. The background doses are given to provide the reader with a perspective on the doses involved.

The intensity of cosmic radiation is a function of altitude and latitude. In the region of the Morton Ranch, the dose equivalent from cosmic radiation is about 77 mrem/yr to the whole body.<sup>49-56</sup> Cosmogenic radiation is responsible for about 1 mrem/yr to the whole body.<sup>55-58</sup>

Dosage from external terrestrial radiation is primarily from the radionuclides K-40 and Rb-87, and from the decay series of U-238 and of Th-232. The concentration of these radionuclides in the soil is dependent on the epigenesis of the area.<sup>59,60</sup> Calculated and measured values for inhabitants of Wyoming indicate an average (outdoor) annual dose equivalent of about 88 mrem/yr<sup>54,61</sup> from external terrestrial sources. Internally deposited radionuclides contribute about 20 mrem/yr to the whole body.<sup>58,62,63</sup>

The maximum value for radon flux to the atmosphere from a dry, sandy soil containing 1 pCi Ra-226 per gram of soil is estimated to be 1.6 pCi/m<sup>2</sup>-sec.<sup>61,64</sup> The concentration of Ra-226 in sedimentary soil, the soil type found in the Morton Ranch region,<sup>65</sup> is about 1 pCi/g,<sup>55</sup> and the radon flux may be an order of magnitude less than that from the dry sandy soil. Calculations that assume secular equilibrium between U-238 and its daughters yield an estimated Rn-222 flux of 0.9 to 1.5 pCi/m<sup>2</sup>-sec. Radon concentrations in the range of 0.5 to 1.0 pCi/L are believed by the staff to be representative of natural background in a mineralized region such as the Powder River Basin. This range of concentrations is supported by background measurements made at other uranium mining and milling sites<sup>66-70</sup> and by the applicant's measurements which show a mean concentration of 0.6 pCi/L. Exposure to a radon concentration of 0.5 pCi/L on a continuous basis would result in a dose of 313 mrem/yr to the bronchial epithelium (App. D, page D-19).

The average concentration of suspended particulates in Wyoming air has been measured at about 40 µg/m<sup>3</sup>.<sup>71</sup> This is equivalent to an activity concentration of about  $4 \times 10^{-5}$  pCi/m<sup>3</sup> each of U-238, U-234, Th-230, Ra-226, and Th-232. The U. S. average for the concentration of these nuclides has been estimated at  $2 \times 10^{-4}$  pCi/m<sup>3</sup>.<sup>55</sup> Using the lower value of  $4 \times 10^{-5}$  pCi/m<sup>3</sup>, the dose to lung would be less than one mrem/yr.

Table 2.6 summarizes the estimated doses to various organs from the natural background of the region. For Wyoming, the radiation dose equivalent rate from the natural environment is estimated to be about 185 mrem/yr per person. More data must be accumulated by the applicant, especially concerning the area's radon levels, before a site-specific background radiation level can be determined for the Morton Ranch project. Site-specific data are discussed in Section 6.6.

Table 2.6. Summary of Typical Radiation Dose Rates from the Natural Environment in the Wyoming Area<sup>a</sup>

| Source of Exposure                     | Dose, mrem/yr |      |                    |                      |
|----------------------------------------|---------------|------|--------------------|----------------------|
|                                        | Whole-Body    | Bone | Lung               | Bronchial Epithelium |
| Cosmic radiation                       |               |      |                    |                      |
| Direct                                 | 77            | 77   | 77                 | -                    |
| Cosmogenic                             | 1             | 1    | 1                  | -                    |
| Terrestrial radiation <sup>b</sup>     | 88            | 70   | 88                 | -                    |
| Internally deposited radionuclides     | 20            | 45   | 20                 | -                    |
| Inhaled radionuclides (chiefly Rn-222) | -             | -    | < 1.0 <sup>c</sup> | 313                  |
| Total Dose Rate                        | 186           | 193  | 187                | 313                  |

<sup>a</sup>These doses are typical of the general region; exposure levels fluctuate from area to area, and other data may vary because of this.

<sup>b</sup>Outdoor dose equivalent rates; shielding from building structures is not accounted for.

<sup>c</sup>Inhalation dose due to radon daughters is expressed as dose to the bronchial epithelium.

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### 3. OPERATIONS

#### 3.1 MINING OPERATIONS

Current estimates indicate that 13,000,000 tons of uranium ore underlie the north and south Morton Ranch leased tracts. This total represents a 170% increase in the estimate provided in the applicant's Environmental Report, and is the result of continued exploration findings. The main ore bodies on the two properties are about eight miles apart. The average grade of the identified uranium ore that would be extracted is about 0.077%  $U_3O_8$ , with the highest grade about 0.2%  $U_3O_8$ . For reasons of conservatism, the 0.2% value will be assumed for all calculations except where noted otherwise.

Figure 1.3 shows the locations of the south lease area ore bodies with respect to the proposed mill site. Because of the depth (550 to 700 feet below ground surface) and relatively small size of the northern-lease ore body, the applicant has chosen underground mining as the most economically feasible method for extracting this ore. The lower-grade, larger quantities of ore in the south area will be extracted by open-pit mining.

When the proposed mill becomes operational, mine water removed by sump pumps in the pit bottoms will be used in the mill process. Approximately 24 Lps (390 gpm) of mine water will be used for this purpose.

A detailed description of the proposed mining operation can be found in the applicant's Final Environmental Statement on uranium mining.<sup>1</sup>

#### 3.2 THE MILL

The Morton Ranch mill will use a conventional acid-leach, solvent-extraction (SX) process to extract the uranium from the host ores and concentrate it to a semirefined product (referred to as "yellowcake") that is principally (~ 95%)  $U_3O_8$ , but can be any of several uranium compounds.

A simplified diagram of the milling operation is given in Figure 3.1. More detailed information concerning the extraction and purification steps may be found in the applicant's Environmental Report and in Reference 2. The milling operation will consist of a series of unit processes. The ore will be crushed and wet-ground prior to the first uranium-recovery process, i.e., sulfuric acid leaching. The leach liquors will then be purified and concentrated by solvent extraction, after which the uranium will be precipitated as an ammonium diuranate (ADU) slurry by the addition of ammonia. The slurry will then be filtered, dried, sintered, ground, and drummed for shipment as "yellowcake."

##### 3.2.1 External Appearance of the Mill

The mill buildings will be located on a 9-ha (22-acre) site in the southern leased tract. The prominent features will be the main process building, a warehouse, a maintenance shop, the ore storage pad, an administration building, a parking area, and roadways. The proposed layout of the physical plant (Fig. 3.2) has been arranged to minimize the exposure of mill personnel to ore dust. The architectural design and color scheme of the mill were chosen to be harmonious with the environment. Cuts and embankments will be landscaped, and shrubs planted, to improve the appearance of the mill complex and to minimize erosion. A 1.8-m (six-foot) cyclone fence topped with barbed wire strands surrounding the mill complex will prevent the entrance of animals or of unauthorized persons.

##### 3.2.2 The Mill Circuit

The maximum design capacity of the Morton Ranch mill is 1800 MT/day (2000 tpd) of ore. The quantitative material balance, input, and output values are found in Figure 3.3. These values may change as the mill design is developed, to minimize energy use and chemical consumption and to maximize yellowcake production.

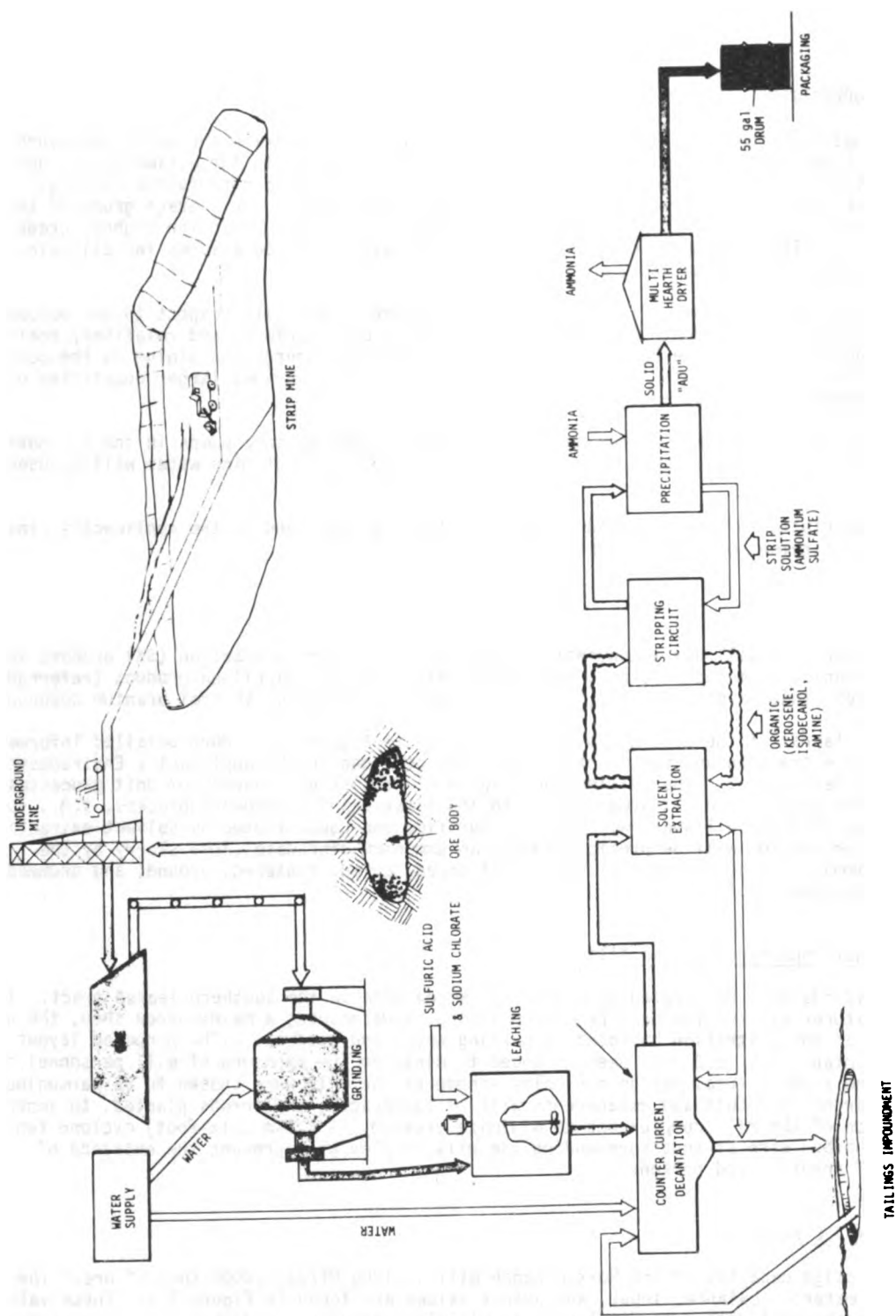


Fig. 3.1. Simplified Flow Diagram of the Uranium Milling Process (ER, Fig. 3.2-1)

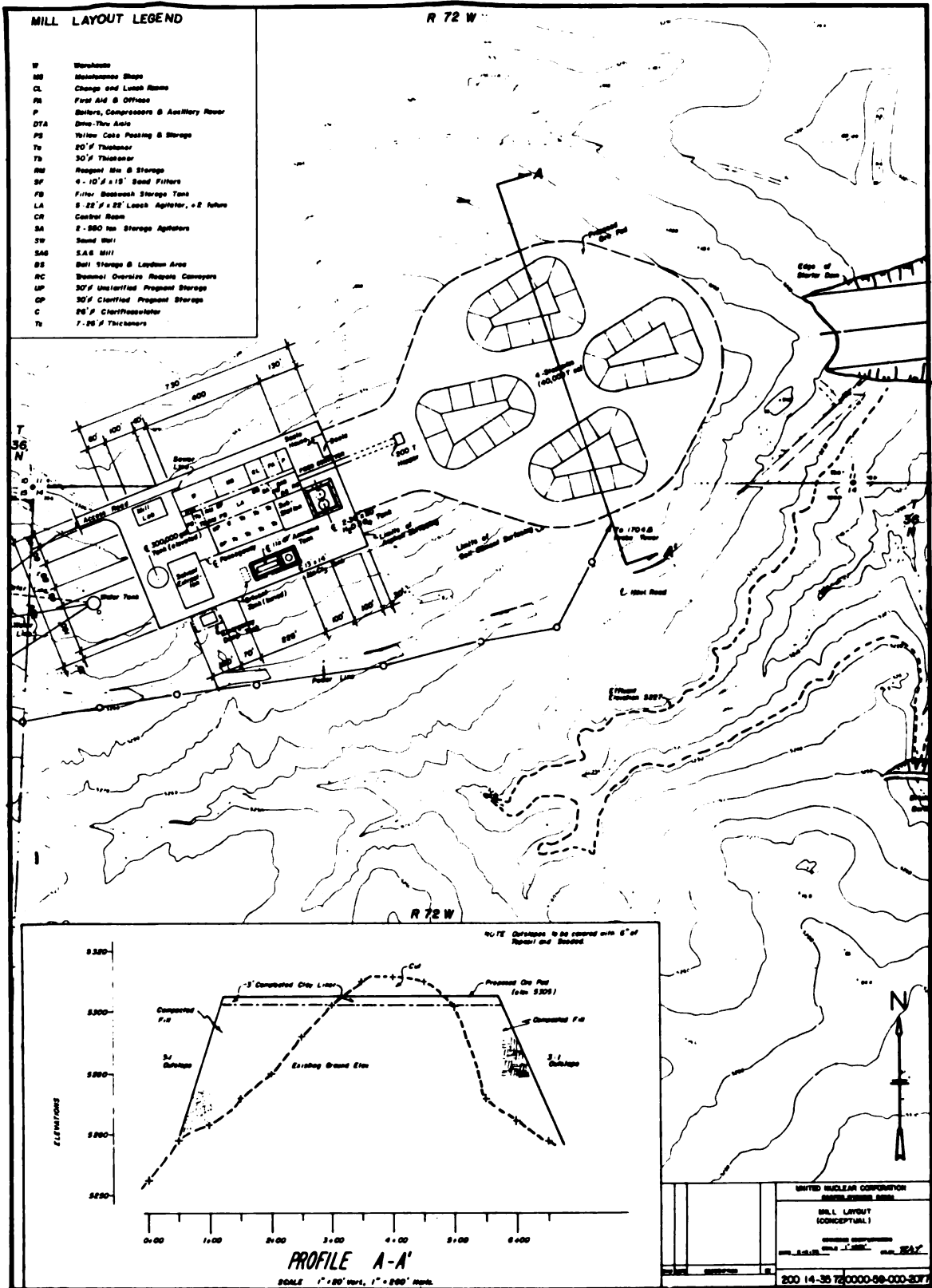


Fig. 3.2. Proposed General Layout of the Morton Ranch Mill  
(Applicant's figure of 7-17-78). (Not to scale.)

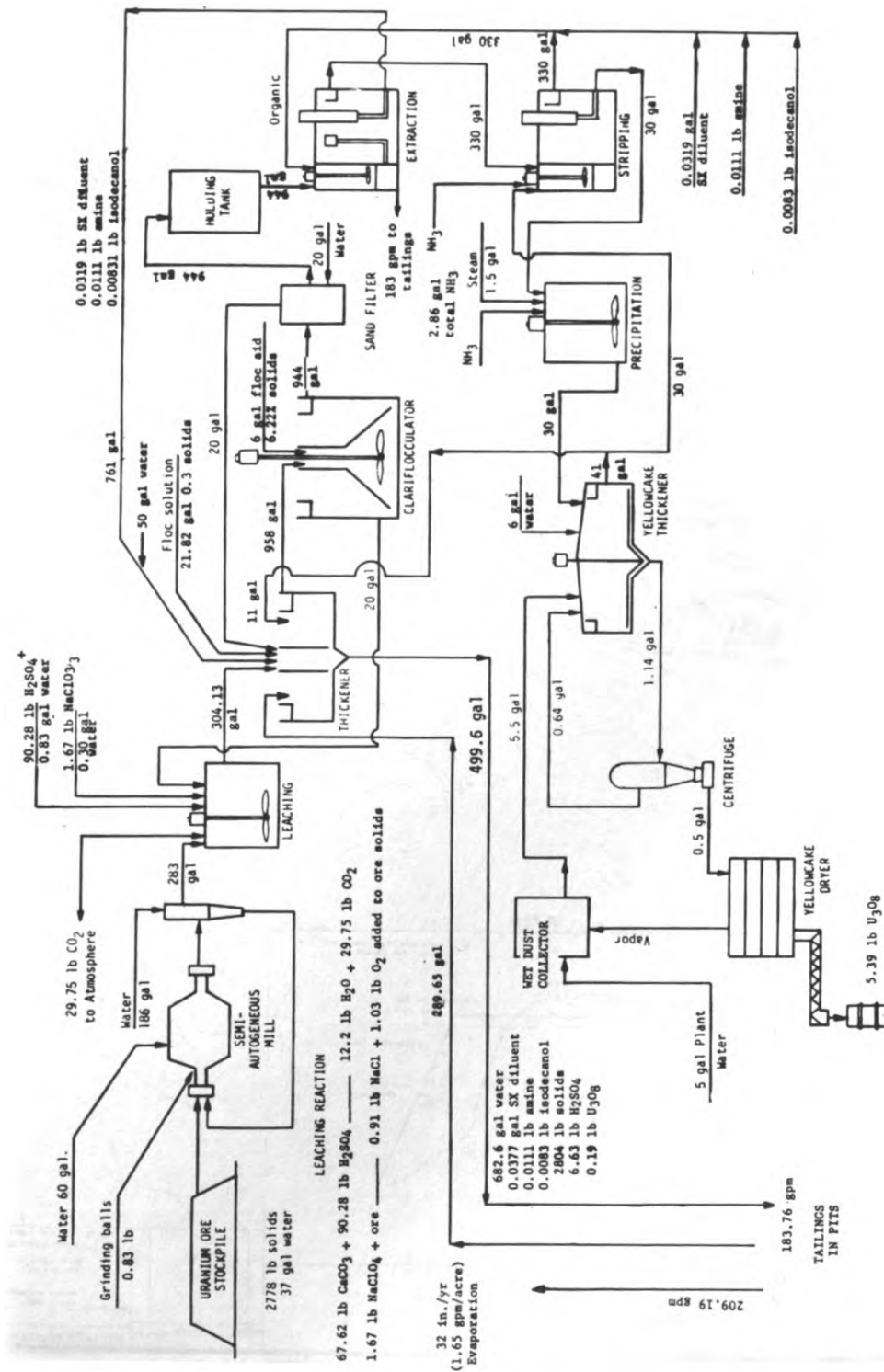


Fig. 3.3. Quantitative Material Flow per Minute in the Proposed Morton Ranch Mill (modified from ER, Fig. 3.2-2, and revised UNC-LA-2).

Prior to milling, the ore from the mining operations will be stored in one of four 36,290-MT (40,000-ton) capacity stockpiles. Loaded ore trucks from the mines will be weighed and the ore dumped onto a 145,150-MT (160,000-ton) capacity ore pad. A front-end loader will transfer the ore to a semiautogenous grinding mill 4.7 m (15.5 ft) in diameter and 1.8 m (6 ft) long, where the ore will be wet-ground to expose the uranium minerals in uniformly sized particles. The grinding-mill discharge will be directed to a cyclone separator from which the denser material will be returned to the grinder, and the slurry, containing 60 to 62% finely ground solids, will be routed to the leaching section. There the slurry is mixed with sulfuric acid, sodium chlorate, and treated with steam to dissolve the uranium from the ore. About 30 kg (66 lbs) of sulfuric acid and 0.45 to 0.86 kg (1.0 to 1.9 lb) of sodium chlorate will be required for complete dissolution of uranium per ton of ore.

After the slurry has passed through the series of five leaching tanks in a ten-hour period, the discharge will contain 58 to 60% solids at a pH of about 1.2. The uranium-bearing solution will be separated from the barren sand in a series of seven countercurrent decantation tanks (thickeners), utilizing a coagulant aid or flocculant to accelerate solids settling. The partially clarified liquid will then pass through a clariflocculator and three sand filters for further solids removal prior to uranium extraction in the solvent extraction section. The concentration of uranium in this decanted leach solution is expected to be  $\approx 0.55$  g/L (4.6 lb/1000 gal). The barren waste will be directed to the tailings disposal area.

In the first step of the solvent extraction process, dissolved uranium will be removed from the feed solution (or aqueous phase) and transferred into the organic or solvent phase. The organic phase will consist of solvent extraction diluent, which is a petroleum distillate solution containing about 3.5% organic amine, and 2.5% isodecanol. Most impurities will remain in the aqueous phase and the uranium will thus be substantially concentrated in the organic phase. In the Morton Ranch mill this extraction will take place in four sets of mixing and settling tanks with organic liquid and water moving in opposite direction (countercurrent) through the various tanks. It is estimated that, after four stages, the organic phase will contain about 1.6 to 2.5 grams of  $U_3O_8$  per liter. The barren aqueous solution, called raffinate, will be recycled to the countercurrent decantation circuit for reuse. In the second step of the solvent extraction process (called "stripping"), the "pregnant" (uranium-bearing) organic solvent will be cycled to another set of tanks where the uranium is to be extracted from the organic phase into water by contact with aqueous ammonium sulfate. The barren organic phase will be returned to the solvent extraction tanks, and the enriched solution, containing between 18 and 27 grams  $U_3O_8$  per liter, will be heated to between 60° and 71°C (140° and 160°F), then neutralized with ammonia to precipitate ammonium diuranate. The precipitated concentrate will be partially dewatered in a primary and secondary (washing) thickener.

The thickened yellowcake slurry will be further dewatered in a centrifuge, which will reduce the water content to about 40%. This slurry is then pumped to a 2.4-m (8-ft) diameter multihearth dryer fired by natural gas, fuel oil, or propane to approximately 540°C (1000°F). The drying process will remove the remaining ammonia and most of the water to convert the ammonium diuranate to yellowcake (95%  $U_3O_8$ ). At an estimated maximum concentration of 0.2%  $U_3O_8$  in the ore, and a daily 1800 MT (2000 ton) input, about 3600 kg (8000 lb) of yellowcake containing about 3400 kg (7600 lb) of  $U_3O_8$  will be produced daily. The yellowcake will be crushed as it comes from the dryer and stored for subsequent packaging in 210-L (55-gal) steel drums.

### 3.2.3 Non-radioactive Mill Wastes and Effluents

#### 3.2.3.1 Airborne Effluents

Non-radioactive effluents will be released to the atmosphere during the processing of the ore (Table 3.1). The leaching process will release minute quantities of  $SO_2$  and chlorine vapors\* and approximately 30 lb of carbon dioxide per minute (Fig. 3.3 and Table 3.2). The solvent extraction process will release trace quantities of organic (petroleum distillate) vapor. The concentrate-drying operations will release water vapor and combustion products, the nature and quantities of which will depend on whether natural gas or fuel oil is used to fire the multi-hearth dryer. Choice of fuel will be dependent on the availability and cost of natural gas.

\*It is estimated that at the Bear Creek uranium mill, located 28 km (18 miles) from Morton Ranch's main ore bodies and expected to process 1000 tons of ore per day, the maximum rates of release of  $SO_2$  and chlorine vapors will be 0.01 lb/hr for each.<sup>3</sup> The staff expects that the releases of these gases from Morton Ranch will also be insignificant.

Table 3.1. Sources of Air-Pollution Emissions, Morton Ranch Mill

| Pollutant              | Sources             | Emission Rate, g/sec |                   |
|------------------------|---------------------|----------------------|-------------------|
| Suspended particulates | Crusher and grinder | 0.0016 <sup>d</sup>  |                   |
|                        | Yellowcake dryer    | 0.014 <sup>a</sup>   |                   |
|                        | Boilers             | 0.04 <sup>b</sup>    | 0.47 <sup>c</sup> |
| Hydrocarbons           | Tailings piles      | 2.0                  |                   |
|                        | Boilers             | 0.009 <sup>b</sup>   | 0.06 <sup>c</sup> |
| Sulfur oxides          | Leach circuit       | 0.004 <sup>e</sup>   |                   |
|                        | Boilers             | 0.002 <sup>b</sup>   | 4.8 <sup>c</sup>  |
| Nitrogen oxides        | Boilers             | 0.67 <sup>b</sup>    | 1.61 <sup>c</sup> |

<sup>a</sup>Estimated.<sup>d</sup>Appendix D.<sup>b</sup>Natural gas-fired boiler.<sup>e</sup>See footnote on page 3-5.<sup>c</sup>Oil-fired boiler.

The gaseous effluents from each process step will be treated as necessary to meet the Wyoming Air Quality Standards (see Sec. 4.1) prior to being discharged from the process stacks. The locations of gaseous-release points are indicated on Table 3.2, which also summarizes stack heights, expected flow rates, equipment serviced, and controls employed.

### 3.2.3.2 Liquid Effluents

The proposed mill facilities have been designed to contain or recycle virtually all process wastes and any spilled or leaked process reagents. Most of the waste will leave the mill circuit from the countercurrent decantation section (CCD). The tailings slurry will contain  $\approx 0.043$  m<sup>3</sup>/sec (680 gpm) of water, about 0.018 m<sup>3</sup>/sec (290 gpm) of which will be recycled to the mill. The net liquid effluent will therefore be  $\approx 0.025$  m<sup>3</sup>/sec (390 gpm). The slurry will also contain  $\approx 1300$  kg/min (2800 lb/min) of solids from the ore, and various chemicals originating from the mill process. Approximately  $1.7 \times 10^{-6}$  m<sup>3</sup>/sec (0.027 gal/min) of SX diluent,  $7.5 \times 10^{-6}$  kg/sec (0.0010 lb/min) of amine, and  $5.2 \times 10^{-6}$  kg/sec (0.007 lb/min) of isodecanol will be discharged in the liquid waste stream. A brief description of the fate of these chemicals is given in Table 3.3. The seepage of effluents from the tailings disposal pits and the evaporation pond is expected to be low and the effects very small in relation to the concentration of such ions in the aquifer (see Sec. 4.3).

### 3.2.3.3 Solid Effluents

Essentially all of the milled ore solids plus chemicals added in the milling process are released in the form of a tailings slurry. At an 1800 MT/day (2000 tpd) ore processing rate, it is estimated that the mill will produce  $\approx 1830$  MT (2020 tons) per day or 1300 kg/min (2800 lb/min) of solid tailings effluents. This includes most of the solids contained in the ore plus additions of process chemicals. The dusts arising from various mill operations are listed in Table 3.2. The exhaust gases from the drying operation will be scrubbed to remove solid uranium concentrate from the stream; with 99.8% scrubbing efficiency, the maximum total U<sub>3</sub>O<sub>8</sub> discharge rate would be about 1.2 kg (2.6 lb) per day, assuming 24 hr/day dryer operation.

### 3.2.3.4 Sanitary and Other Mill-Waste Systems

Sewage treatment will be carried out in conformance with the requirements of the Wyoming Department of Environmental Quality, Water Quality Division, and the State Engineer's Office. Sanitary wastes from the mill, shop, and office areas will be treated by digestion in an underground, anaerobic septic tank and then discharged to a sewage lagoon having a surface area of one ha (2.47 acres). A similar sewage system has been approved and constructed at the underground mine site. Assuming that about 57 L (15 gal) of wastewater per office person per day and 132 L (35 gal) of wastewater per mill/shop person per day would be generated by project activities,

Table 3.2. Mill Stack Non-radioactive Process Airborne Effluents<sup>a</sup>

| Release Location      | Anticipated Height Above Ground, m | Anticipated Flow Rate, ft <sup>3</sup> /min | Equipment Serviced                         | Control Employed                    | Anticipated Efficiency              | Potential Contaminant               | Annual Quantity |
|-----------------------|------------------------------------|---------------------------------------------|--------------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|-----------------|
| Stack 1               | 6                                  | 10,000                                      | Grinding circuit                           | Wet scrubber and wet grinder        | 95% for particulates                | Nuisance dust                       | <0.05 tons      |
| Stack 2               | 6                                  | 6,000                                       | Leach circuit and surge tanks              | Wet scrubber                        | 99.5% for 1 to 2 $\mu$ particulates | ClO <sub>2</sub><br>Cl <sub>2</sub> | Trace<br>Trace  |
| Stack 3               | 9                                  | 4,500                                       | Yellowcake thickeners; precipitation tanks | Wet scrubber                        | 95% for particulates                | NH <sub>3</sub>                     | Trace           |
| Stack 4               | 9                                  | 4,000                                       | Yellowcake dryer and packaging             | Wet scrubber and bag dust collector | 99.8% for 1 to 2 $\mu$ particulates | NH <sub>3</sub>                     | Trace           |
| No. 1 laboratory hood | 6                                  | 3,000                                       | Chemical laboratory                        | Wet scrubber                        |                                     | Perchloric acid fumes               | Trace           |
| No. 2 laboratory hood | 6                                  | 2,000                                       | Chemical laboratory                        | HEPA filter                         | 99.93%                              | Misc. chemicals                     | Trace           |

<sup>a</sup>Modified from UNC-LA-2, p. 4.2.

Table 3.3. Exit Form and Terminus of Principal Process Effluents

| Chemical                                | Effluent Terminus                                                                                                                                                                                                                                                                                   |
|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sulfuric acid                           | A small percentage of the total effluent will be dissipated to the atmosphere during the leaching process and the concentrate drying process. Most of the sulfuric acid will end up in the process liquid waste stream in the form of hydrogen and sulfate ions.                                    |
| Sodium chlorate                         | Sodium chlorate, an oxidizing agent, will be reduced in the process to sodium chloride, which will be contained within the process liquid waste stream. Some sodium chlorate may not be completely reduced and may be released as chlorine dioxide or chlorine gas.                                 |
| Ammonia                                 | Most of the ammonia in the final product (uranium diuranate) will be driven off in the drying process, but scrubbed prior to stack exit. Ammonia discharged to the tailings-disposal area will combine with sulfuric acid to form ammonium sulfate.                                                 |
| Polyacrylamide (flocculating agent)     | Polyacrylamide will enter the tailings pond in its original chemical form and is expected to decompose.                                                                                                                                                                                             |
| Petroleum distillate, amine, isodecanol | These chemicals will be recycled in the mill process. Some loss of these materials is expected because of their emulsification and dissolution in the aqueous solutions that will be discharged to the tailings pond. Most will be retained in the tails as a film attached to the solid particles. |

approximately 24,000 L (6300 gal) of wastewater would be discharged to the sewage lagoon per day. The expected quantities of pollutants contained in the untreated wastewater are shown in Table 3.4. The staff believes that a 0.99-ha (2.47-acre) lagoon is statistically of sufficient size to support the expected number of personnel in the proposed south Morton shop (68 employees), office (80 employees), and mill (79 employees) areas.

Table 3.4. Staff-Estimated Pollutant Loading of Untreated Sanitary-Wastewater Discharges<sup>a</sup>

| Pollutant                              | Concentration, mg/L | Discharge Rate, kg/day <sup>b</sup> |
|----------------------------------------|---------------------|-------------------------------------|
| Suspended solids <sup>c</sup>          | 150                 | 3.6                                 |
| Dissolved solids <sup>c</sup>          | 200                 | 4.8                                 |
| Biochemical oxygen demand <sup>c</sup> | 130                 | 3.1                                 |
| Total nitrogen <sup>c</sup>            | 50                  | 1.1                                 |
| Phosphates <sup>d</sup>                | 10                  | 0.2                                 |
| Chlorides <sup>c</sup>                 | 100                 | 2.4                                 |

<sup>a</sup>Assuming primary settlement treatment before disposal.

<sup>b</sup>Based on liquid discharge of 24,000 L/day.

<sup>c</sup>P. H. McGauley, "Engineering Management of Water Quality," McGraw-Hill, New York, 1968.

<sup>d</sup>"Process Design Manual for Phosphorus Removal," U. S. Environmental Protection Agency, Washington, D. C., 1971.

Water used to launder protective clothing worn for yellowcake-handling operations will be returned to the mill circuit for uranium reclamation or discharged to the tailings pond.

Wastes from the supporting chemical laboratory, containing small amounts of laboratory reagents, will be discharged into the tailings pond.

Non-radioactive solid wastes such as construction debris, office and lunchroom wastes, and packaging materials, will be disposed of in an approved sanitary landfill near the proposed site.

The acids used in cleaning unsalvageable process machinery will be recycled to the mill process.

#### 3.2.3.5 Control of Non-radioactive Mill Wastes and Effluents

The applicant states (ER, Sec. 3.4) that the effluents released from the proposed mill will be minimized to the extent reasonably achievable and that the "better features of current practices" as designated by the Environmental Protection Agency,<sup>4</sup> have been incorporated in the design of the mill.

Gaseous effluents and dust arising from each process will be treated and discharged from the stacks (see Sec. 3.2.3.1) so as to promote rapid dilution and dispersion. The controls to be employed and the anticipated efficiencies are shown in Table 3.2. Emissions from the grinding circuit, the precipitators, yellowcake thickeners, and yellowcake handling areas will be processed with scrubbing equipment designed with a minimum collection efficiency of 95%. The leach circuit and surge tanks, and the yellowcake dryer exhaust will each be serviced by separate wet venturi scrubbers and will have a minimum collection efficiency of 99.8% for particles in the  $1\mu$  to  $2\mu$  range and a higher efficiency for larger particles. To control perchloric acid fumes in the chemical laboratory, a wet scrubber will be employed as an integral part of the perchloric acid hood. The other laboratory hood will be serviced by a prefilter and high-efficiency particulate air filter, with a rated collection efficiency of 99.3% for  $0.3\mu$  particles. Sanitary wastes will be discharged to a sewage lagoon (see Sec. 3.2.3.4). In addition to the controls described above, several unit operations will be carried out within enclosed isolated structures (e.g., the solvent extraction circuit). Graded surfaces, the ore stockpiles and ore handling conveyors, and the tailings dam will be sprayed with water as necessary to minimize dust. The addition of mine water to the ore in the grinding process will practically eliminate dust release from this operation.

#### 3.2.4 Radioactive Mill Effluents

Potential sources of radioactive effluents from the mill will be ore transportation, the stored ore, the ore crusher and grinder, the yellowcake dryer stack, the yellowcake packaging area, and the tailings-disposal area. Figure 3.4 depicts the pathways by which radioactivity from mining and milling operations would enter the air and groundwater. There is no direct pathway into surface water from normal mill operations. The analysis of release rates is based on available data, staff site inspections, and measurements recorded at similar mills currently in operation.

U-238 and U-235 are the principal natural long-lived isotopes of uranium and exhibit separate decay series. For radiological conservatism, the staff assumes that the Morton Ranch mine ores will contain 0.2%  $U_3O_8$ ; under secular equilibrium conditions the processed ore thus would contain 563 pCi each of U-238, U-234, Th-230, Ra-226, and Pb-210 per gram of ore. The concentration of U-235 in natural uranium is 0.72%, and its activity is approximately 26 pCi per gram of ore. In the U-235 series the only long-lived daughter radionuclide is Pa-231 (half-life:  $3.43 \times 10^4$  years). The quantity of radioactivity associated with the U-235 series is small in comparison with amounts from the U-238 series.

##### 3.2.4.1 Transportation of Ore to Mill

The ore will be transported by truck from the mine sites to the mill. The average haul distance will be about 6 km (3.7 miles). Ore spilled enroute to the mill will be a potential source of road contamination. The applicant will, as necessary, either spray these roads with water or use a chemical stabilizer to control dusting (ER Suppl. II, response to Q. 4); therefore, this type of release is expected to contribute very little to the overall radioactivity emissions.

##### 3.2.4.2 Ore Storage, Feed, and Grinding

At the mill, a 50-day inventory of ore is stored outdoors to provide a continuous supply of raw material for processing. The capacity of the ore pad is  $1.45 \times 10^5$  MT ( $1.6 \times 10^5$  tons) (ER Suppl. II, p. 3-8). The decay of Ra-226 in the ore produces Rn-222 (radon gas), which would be released during the storage period (App. D-1, Part D-1.1). Storage for 50 days would result in the production of greater than 99% of the secular equilibrium activity of Rn-222, which would be partially released to the atmosphere. Subsequent ore feeding and crushing operations would release the remaining radon. The ore grinding process and the close interface maintained between liquid and solid phases during the leaching process would increase the radon release from the ore, but simultaneously decrease the diffusion coefficient for radon. The staff

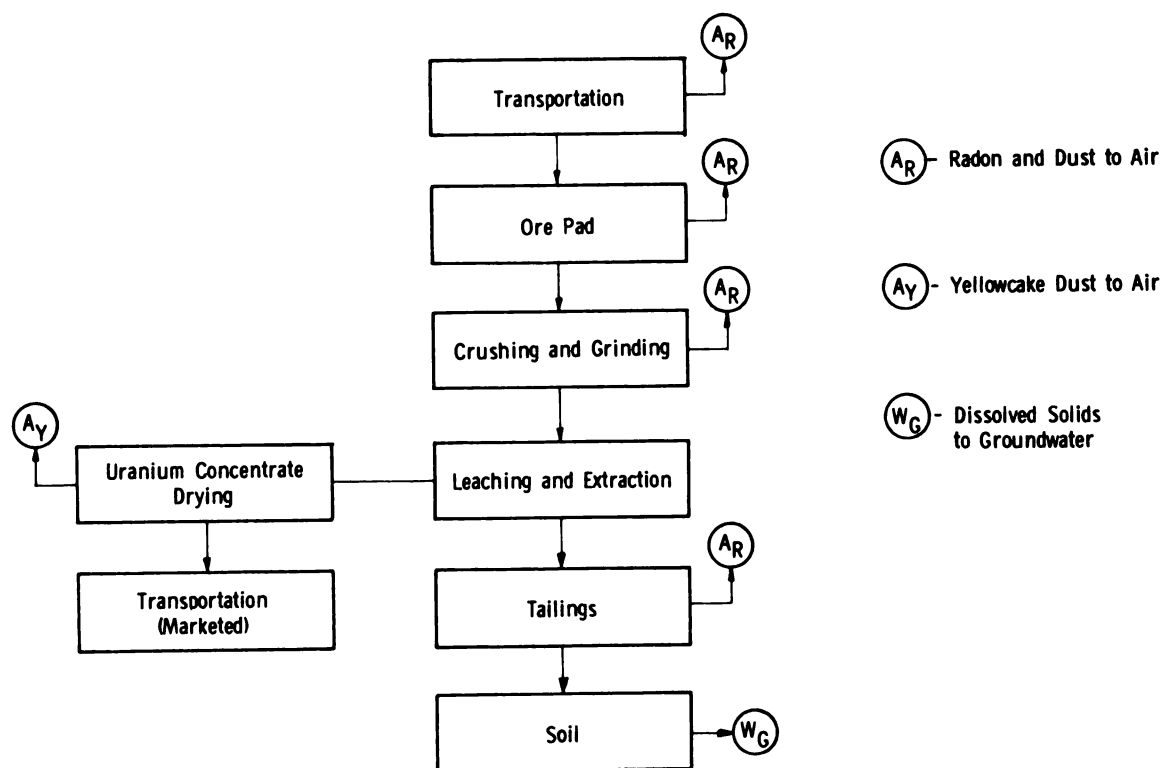


Fig. 3.4. Radionuclide Dispersion Pathways from Various Uranium Mill Operations.

estimates that the total radon released from the combined operations of ore storage, feed, and grinding would be about 112 Ci/yr (App. D-1, Part D-1.1). Almost all radon is released during storage; only a negligible fraction of the total comes from the feeding and grinding operations due to the short period of time these involve.

Although the ore has a high moisture content, >10% (ER Suppl. II, response to Q. 4), stored ores are readily dehydrated in dry seasons, and surfaces exposed to wind action will be a source of dust. To minimize dust emission, the applicant will use the driest ore of a particular type first. If ore must be stored for a long period of time, a chemical sealant will be used to reduce dust emission (ER Suppl. II, response to Q. 4). The releases of particulates from ore storage areas and ore-feeding operations are expected to be negligible. Grinding of the ore is expected to produce some fugitive dust. The average annual release from ore storage, feeding, and grinding is computed to be 0.06 mCi each of Pb-210, Ra-226, Th-230, U-234, and U-238 (App. D-1, Part D-1.1).

### 3.2.4.3 Leaching

Ore leaching is a wet process that does not contribute to the emission of particulates. Because of the short transit time (less than one day) of the ore through the mill circuit, this process releases little radon to the environment.

### 3.2.4.4 Uranium Concentrate Drying and Packaging

After uranium precipitation and extraction, the uranium concentrate is washed, dewatered, calcined, hammermilled to granules about 0.64 cm (0.25 inch) in size, and packaged for shipping. The product (yellowcake) would be about 95%  $U_3O_8$  (ER, p. 1-2) and contain an estimated 5% of the Th-230, 0.2% of the Ra-226, and 0.2% of the Pb-210 originally in the ore. Emission of particulates to the air during uranium concentrate drying and packaging will be controlled by a wet scrubber with a minimum efficiency of 99.8% (ER Suppl. II, response to Q. 4). The estimated release of radioactive dust is calculated to be  $5.08 \times 10^{-2}$  kg/hr (App. D-1, Part D-1.2).

The yellowcake will be packaged in 360-kg-capacity (55-gallon) metal drums that will be vibrated to ensure complete filling. This packaging terminates the potential for uncontrolled release of radioactivity under normal operating conditions.

### 3.2.4.5 Process Liquid Waste

The water used in mill processes will be supplied by water from the Morton Ranch mine, and will be used at a rate of  $\approx 0.025$  m<sup>3</sup>/sec (390 gpm). Wastewater will be discharged to the tailings impoundment with the spent ore, as a slurry. The slurry would be deposited in exhausted mine pits and the water decanted--some to be recycled, the rest sent to an evaporation pond. Seepage of radionuclides from the pond is expected to be negligible because it will be lined with clay. At the end of the milling operations, any solids from the bottom of the evaporation pond would be removed and placed in one of the pits, prior to stabilization and reclamation.

Seepage through the dam will be prevented from entering natural water channels, where it could be washed downchannel during periods of precipitation. Collection ditches will carry seepage to a sump, from which it will be pumped back to the pond (ER Suppl. II, p. 3-14). No water will be intentionally released to downstream drainage unless it meets water discharge permit requirements.<sup>5</sup>

### 3.2.4.6 Tailings

The applicant has proposed a number of options [ER Suppl. I, Sec. 3.2 (summarized in Sec. 10.4.2 of this Statement) and Ref. 6] for the disposal of process tailings, stating its preference for Option L.\* The staff concurs that Option L, which involves the use of abandoned mine pits for tailings solids disposal, plus an evaporation pond for decanted tailings liquids (see Sec. 3.2.5), offers a viable plan for tailings management operations.

\*First referred to by the applicant as "modified Option E" (Ref. 6), but now termed Option L (as stated in the signed notes of a meeting between the applicant and representatives of the NRC held on 20 January 1978 at Argonne National Laboratory, Argonne, Illinois). The term Option L will be used in this Environmental Statement.

The tailings slurry would be pumped to various pit areas (Figs. 3.5 and 3.6) and, as the tailings settled, the water would be decanted and pumped to an evaporation pond (Fig. 3.7). Particulate emissions from the evaporation pond are expected to be small because the slimes left after evaporation would be suspended in a sulfuric acid solution. The decanted water would not convey radioactivity to the atmosphere as it evaporated, and because the tailings pits and the evaporation pond would be lined with clays (Fig. 3.6) having high ion-exchange capacities, the escape of radionuclides to the environment through seepage is expected to be negligible. The staff notes that the tailings solids can never become completely dry while in the pits because of the sulfuric acid content of the tailings liquids mixed with them. However, the solids need only dry to the extent necessary to support the weight of heavy construction equipment used on the surface of the pond and pits during stabilization and reclamation procedures.

The applicant shall be required to control the release of airborne particulates from the tailings until reclamation is completed; nevertheless, particulate release from ten percent of the dry tailings area is assumed. Under these conditions, the release of radioactivity from the tailings pits would be 3 mCi U-238/yr, 52 mCi Th-230/yr, 55 mCi Ra-226/yr, and 55 mCi Pb-210/yr. The expected annual Rn-222 effluent would be  $8.51 \times 10^3$  Ci from the tailings pits (App. D, Table D-1.2). The predicted annual dose equivalent rates for U-238, U-234, Th-230, Ra-226, and Pb-210 from Option L are given in Appendix D, Table D-1.3.

The evaporation pond may be used as a tailing slurry surge pond during those times when pit disposal is not feasible (e.g., if tailings lines were to freeze). The applicant is committed to keep wet or immersed all tailings placed in the pond. Therefore, no addition to the predicted source terms will occur if the evaporation pond must serve to hold tailings. The initial area of the pond would be  $\approx 14$  ha (37 acres); the staff calculates that the pond would cover 44 ha (110 acres) at maximum usage.

### 3.2.5 Stabilization and Reclamation of the Mill Tailings Area

In accordance with the Wyoming Environmental Quality Act of 1973 (as amended) and the requirements of the U. S. Nuclear Regulatory Commission, the applicant has proposed several tailings stabilization alternatives (Options A-L, described in Section 10.4, in ER Suppl. I, pp. 3-7 through 3-16, and in Ref. 6) from which it has chosen a preferred alternative, Option L, described below.

The purpose of the applicant's plan is 1) to contain, as far as possible, all radionuclides, spent reagents, and other noxious materials that will have been deposited in the tailings area as a result of the milling process, and 2) to return the land surface to its former use as grazing and pastureland, and wildlife habitat.

The general objective of the plan is to stabilize the tailings by onsite burial. Specific objectives are: 1) to dry the tailings; 2) to reduce airborne emanations by covering or burying the tailings; 3) to protect groundwater by placing the tailings above the water table, with an impervious liner or suitable soil layer between the tailings and water table; 4) to protect surface water by establishing proper drainage patterns; 5) to reestablish normal ground contours; and 6) to return the land to unrestricted use.

Option L would involve the use of clay-lined, depleted mine pits for tailings disposal (Figs. 3.5 and 3.6) and a clay-lined pond south of the proposed mill site for the evaporation of liquids (Fig. 3.7). The tailings would be conveyed to the pits for burial and excess water would be decanted to the pond for evaporation. Pipelines would be used to transport the tailings slurry and decanted liquid.

During mill operation, after each pit would become filled to design capacity with tailings solids, the upper layer of the solids would be permitted to dry, so that heavy construction machinery could operate on the surface of the pit. Then, about 1.2 m (4 ft) of mine overburden, a minimum of 0.61 m (2 ft) of compacted clay, another 1.2 m (4 ft) of overburden, and 15 cm (6 in) of topsoil would be emplaced, in that order, on top of the dried tailings. The topsoil would be planted with vegetation for its stabilization, and to aid the eventual reclamation of the affected land areas.

After the active lifetime of the mill, the evaporation pond would be permitted to dry. However, the residue left on the bottom of the evaporation pond may never become completely dry because of the sulfuric acid content. If this is the case, the applicant may find it necessary to consider additional methods of stabilization such as neutralization with limestone or caustic to form a salt cake or use of absorbent materials (overburden), in order to facilitate transport of pond bottom residues to the pits for ultimate disposal. Solids containing radioactive or

other contaminants, and any contaminated clay liner or underlying soil, would be scraped from the bottom of the pond for deposition in a vacant, lined, mine pit. The stripped pond area may be left to provide a water impoundment, otherwise the applicant will be required to reclaim the pond area.

Stabilization and reclamation are discussed in greater detail in Section 10.4.

Fencing of the mill site and tailings area would be completed prior to operations, and would be maintained until the original surface use of the land has been acceptably restored (ER Suppl. II, response to Q. 28). All fencing will be in accordance with the specifications of the Wyoming Game and Fish Department and the Bureau of Land Management (ER Suppl. II). Appropriate warning signs will be posted on the fences (ER, p. 9-3).

The applicant's plans for revegetating the stabilized tailings are oriented to returning the land to its present agricultural use, the production of sheep and cattle (ER Vol. II, App. A-VI, p. A-1). In addition, it is likely that the land would be recolonized by wildlife. The plant species used by the applicant for revegetation will be selected primarily to enhance forage production for livestock, and secondarily to provide food and cover for native wildlife, for esthetics, for soil stability, and for surface and subsurface water conservation. Modifications in species used and relative ratios may be made based on results obtained with onsite test plots.

The staff agrees with the applicant that on the basis of currently available information, the below-grade burial approach to tailings stabilization is the appropriate choice at this site.

The staff notes also that information developed in the Generic Environmental Impact Statement on uranium milling being written by NRC (see Sec. 1.5) could be used to modify or change the applicant's approach to stabilization, if so indicated. That Statement, which will probably be completed in the first quarter of 1979, will contain the results of research already begun to assess the impacts of uranium mill tailings ponds and piles, and the means for mitigating any adverse impacts.

The current NRC licensing action will be subject to express conditions that approved waste-generating processes and mill tailings management practices will be subject to revision in accordance with 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 surety arrangements to cover the costs of reclaiming the tailings disposal area and of decommissioning the mill site.

At the time of termination of the Source Material License, the NRC will require that the land on which the tailings are stored be subject to the following specific restrictions:

- The holder of the possessory interest will not permit the exposure and release of tailings material to the surrounding area.
- The holder of the possessory interest will prohibit erection of any structures for occupancy by man or animals.
- Subdivision of the covered surface will be prohibited.
- No private roads, trails, or rights-of-way may be established across the covered surface.

### 3.2.6 Mill Decommissioning

In addition to the stabilization plan (Sec. 3.2.5), the applicant has submitted a general plan for decommissioning of the processing facilities and ancillary structures (ER Sec. 5.8 and ER Suppl. II). The plan includes decontamination of the facilities in accordance with NRC guidelines and regulations; disposal of all fuels and chemicals by an acceptable method suited to the nature of the materials and their potential for environmental damage; and dismantling and removal or burial of all buildings and other structures. Foundations will be buried under 1.5 to 2 m (5 to 6 ft) of overburden and soil, and the area will be graded, covered with topsoil, and revegetated.

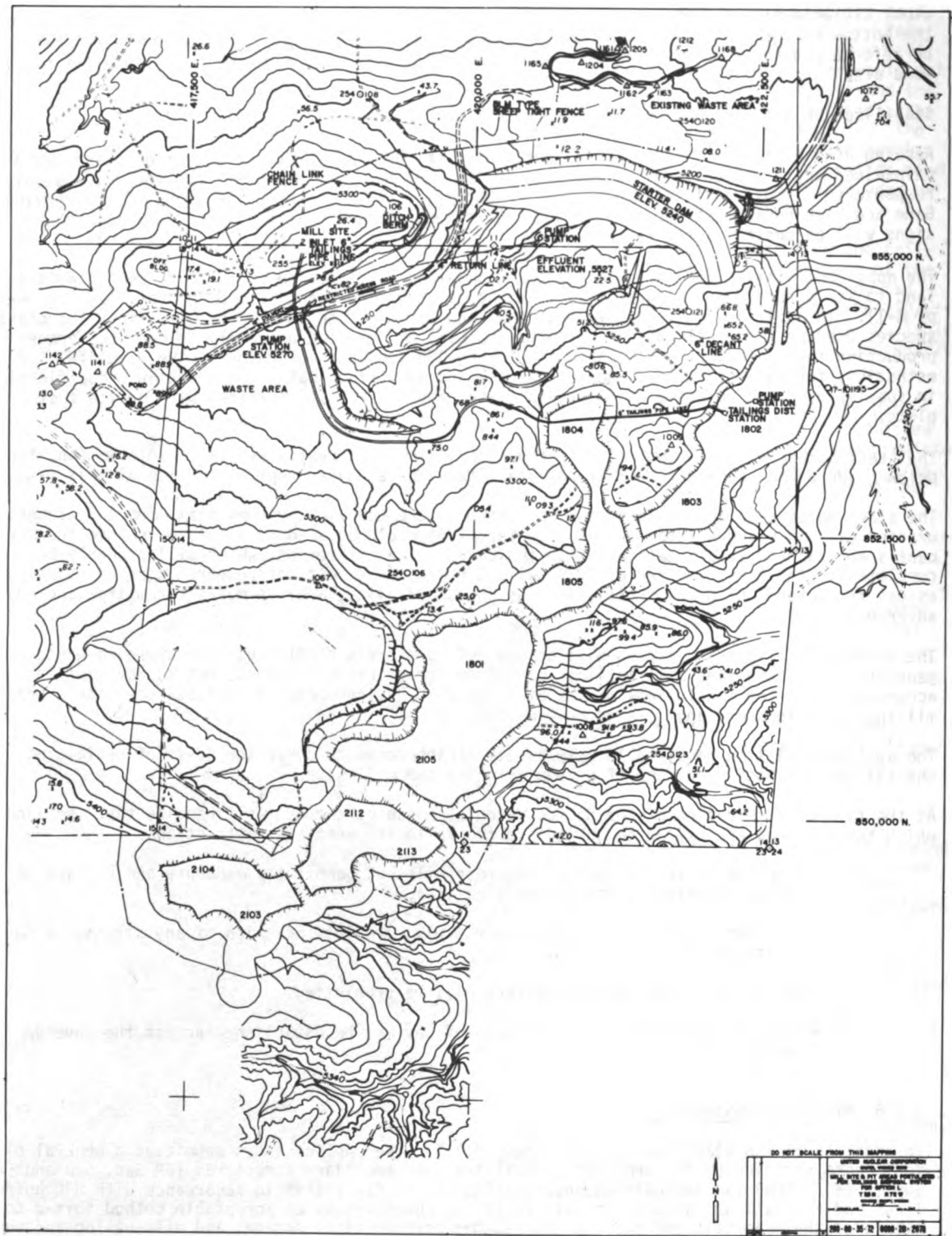


**Fig. 3.5. Pit Areas Postulated for Tailings Solids Retention in Option L**

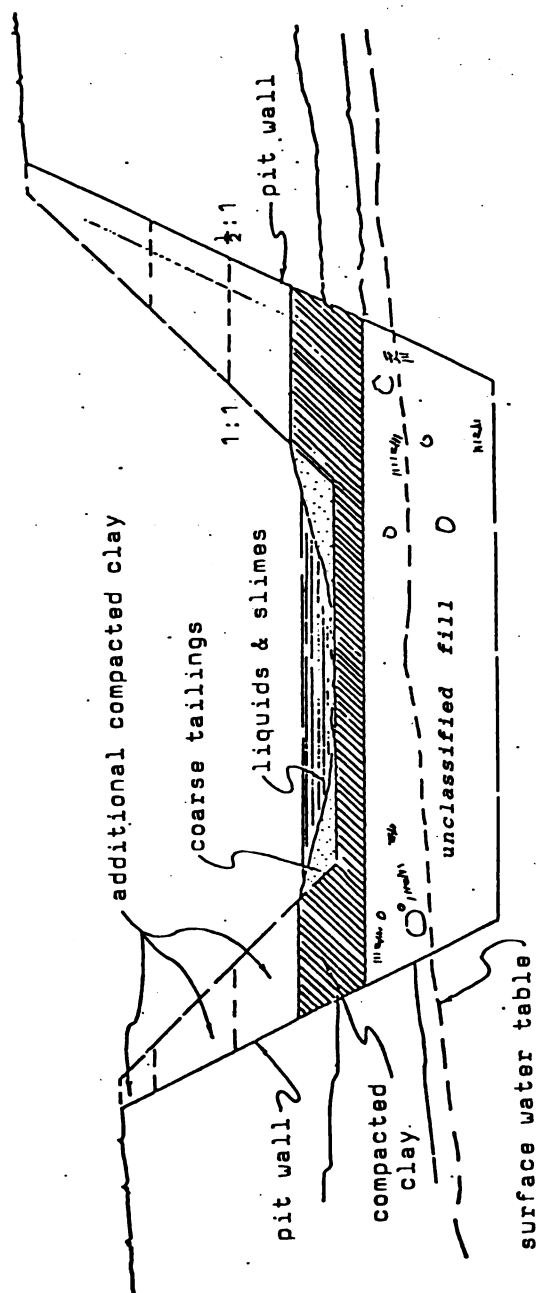


Fig. 3.6. Conceptual Design of a Clay-lined Pit Used for Tailings Retention (from ER Suppl. I, Fig. 3.2-6).

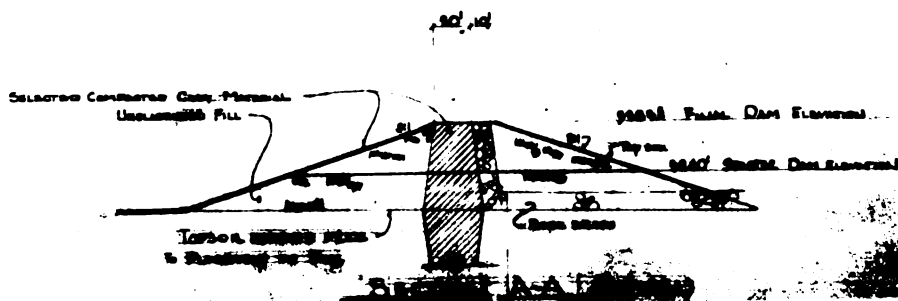
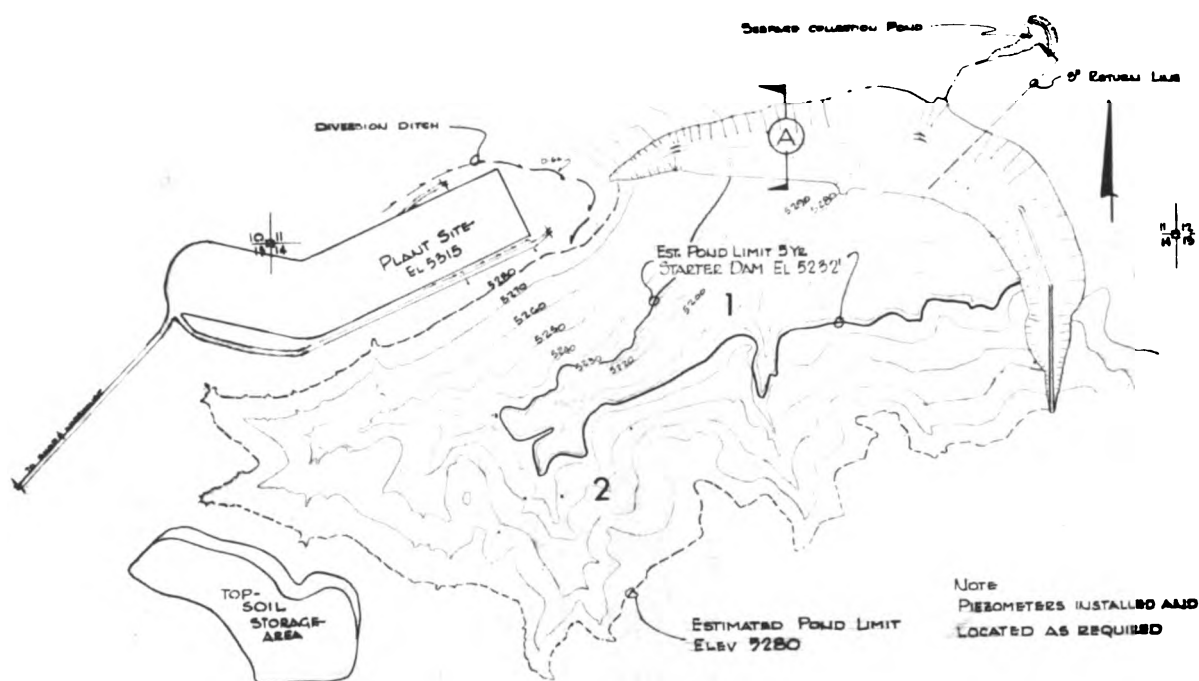


Fig. 3.7. Location of Proposed Evaporation Pond in Relation to the Mill Site (not to scale). Area marked 1 shows the first dam lift, equivalent to 214 ha (37 acres) of liquid effluent evaporation area (applicant's estimation). Area marked 2 shows maximum liquid effluent evaporation area (44 ha or 110 acres) at end of the mill lifetime (staff estimate; see Sec. 4.2.1). (Modified from ER Suppl. II, Fig. 3.4.2-1.)

The NRC does not require submission of detailed decommissioning plans until near the end of the useful life of a project. Prior to termination of the license, the applicant will be required to submit additional detailed information. This additional information will include data from radiation surveys taken at the site and plans for any mitigating measures that may be required as a result of the radiation surveys and NRC inspection. 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 the NRC and the then-current regulations. Depending on the circumstances, the NRC may require that, prior to termination of the license, the applicant must submit an environmental report on proposed decommissioning operations.

As previously stated, the applicant will be required to make surety arrangements to cover the costs of decommissioning the mill site.

#### References for Section 3

1. "Final Environmental Statement, Morton Ranch Uranium Mining," Tennessee Valley Authority, Chattanooga, Tenn., 20 January 1976.
2. R. C. Merritt, "The Extractive Metallurgy of Uranium," Colorado School of Mines Research Institute, 1971.
3. "Final Environmental Statement Related to Operation of Bear Creek Project, Rocky Mountain Energy Co.," NUREG-0129, Docket No. 40-8452, June 1977.
4. "Environmental Analysis of the Uranium Fuel Cycle. Part 1 - Fuel Supply," EPA 520/9-73-003-B, U. S. Environmental Protection Agency, Office of Radiation Programs, Washington, D.C., October 1973.
5. United Nuclear Corporation, "Morton Ranch Uranium Mill License Application," UNC-LA-2, September 1977.
6. Letter of Vice President, Mining and Milling Division, Wyoming Operations, United Nuclear Corporation, to U. S. Nuclear Regulatory Commission, 13 January 1978.



## 4. ENVIRONMENTAL IMPACTS

### 4.1 AIR QUALITY

The principal impact on air quality resulting from mill operations will be an increase in suspended particulate matter. The applicable Wyoming standard permits a maximum annual average ambient suspended particulate concentration of  $60 \mu\text{g}/\text{m}^3$ .<sup>1</sup> The measured background concentration near the mill area is  $13\text{--}21 \mu\text{g}/\text{m}^3$ .<sup>2</sup> In the mill area, fugitive dust from desiccated tailings could be removed and dispersed by the prevailing winds. Other potential sources of dust would include the yellowcake dryer stack and the ore crushing and grinding stacks. Because most material would become suspended during periods of higher wind speeds, the staff selected slightly unstable conditions and 5 m/sec (11 mph) winds as the minimum conditions for dust suspension, and 5 m/sec and faster wind speeds were used to calculate average release estimates. Dust release under these conditions is discussed in Section 4.7.4.2 and App. D-1. With these assumptions, the average annual suspended particulate concentration from all sources other than road dust is calculated to be  $11 \mu\text{g}/\text{m}^3$  which, with the present estimated background, is below the applicable standard. During periods of high wind speeds, dry roads, and dry tailings, the short-term concentrations of suspended particulates may exceed state limits.

Additional possible sources of air-quality impact are gaseous effluents from the leaching process and the tailings disposal areas. A summary of the principal mill effluents was given in Tables 3.1 and 3.2; Table 4.1 is a comparison of the calculated annual airborne concentrations of effluents, 1500 m (4900 ft) from the mill, with the applicable Wyoming standards. All concentrations were calculated using a Gaussian diffusion model,<sup>3</sup> and Casper, Wyoming, meteorological data, and assumed constant emission rates and ground-level releases.

Table 4.1. Calculated Maximum Annual Average Emissions  
Concentrations from All Mill Air-Pollutant Sources

| Pollutant              | Calculated Concentration from Mill, $\mu\text{g}/\text{m}^3$ <sup>a</sup> |            | Applicable<br>Wyoming Standard, $\mu\text{g}/\text{m}^3$ <sup>b</sup> |
|------------------------|---------------------------------------------------------------------------|------------|-----------------------------------------------------------------------|
|                        | Natural Gas Boiler                                                        | Oil Boiler |                                                                       |
| Suspended particulates | 10                                                                        | 11         | 60                                                                    |
| Hydrocarbons           | 8                                                                         | 8          | 160 <sup>c</sup>                                                      |
| Sulfur oxides          | 0.1                                                                       | 19         | 60                                                                    |
| Nitrogen oxides        | 3                                                                         | 7          | 100                                                                   |

<sup>a</sup>1500 m downwind from mill center.

<sup>b</sup>Source: "Wyoming Air Quality Standards of Regulations, 1975." Wyoming Department of Environmental Quality.

<sup>c</sup>Three-hour maximum, not to be exceeded more than once per year.

Using the foregoing data, the staff concludes that the construction and operation of the mill will have negligible impact on the air quality of the region.

### 4.2 LAND USE

#### 4.2.1 Land Resources

The depleted ore pits left from surface mining will be used for the disposal of the mill tailings solids. Up to 110 ha (270 acres) of land could be disturbed as a result of mill construction

and operation, including the tailings disposal areas and evaporation pond.\* Land disturbance will involve the alteration of the topography of the project area by the creation of water ponds, spoil piles, and the evaporation pond embankment, resulting in changes in the local drainage pattern and slopes. It is currently not possible to calculate how much land will be in a disturbed condition at any one time because mining, reclamation, and milling activities will occur concurrently, and mining and reclamation schedules are not available.

#### 4.2.1.1 Agriculture

Milling activities will disturb up to 110 ha (270 acres) of the site, depending on which tailings-disposal option is employed. The applicant has stated that the project will not change the principal usage of the property: i.e., livestock grazing (ER, Sec. 4.1.1). The staff believes, however, that the combination of mill construction, roads, and utility lines will disrupt grazing patterns and decrease available rangeland by up to 109 ha (270 acres) during mill operation. Fences have been and will be constructed to exclude grazing animals from the construction site, access roads, and tailings area.

#### 4.2.1.2 Transportation

Numerous dirt roads and trails have already been constructed on the site for the current uranium mining activities. In the future, access roads to the proposed evaporation pond area will also have to be constructed. Environmental impacts to the site area from the paving or upgrading of major roads have already occurred in connection with the construction and operation of the Exxon and the Rocky Mountain Energy Company mine/mill complexes. Thus, no additional impacts from major road construction work are expected in connection with the Morton Ranch project. There will be an increase in traffic on State Highway 93 because of construction trucks and the cars of construction workers.

#### 4.2.1.3 Recreation

Hunting of game animals will be banned on the site, thus slightly curtailing the hunting range in the area. However, in view of the large area that will remain open to hunting in Converse County, the general impact on the hunter will be very small. No other recreational opportunities of the area will be affected by the construction and operation of the facility.

#### 4.2.1.4 Esthetics

Construction of the facility will alter the form, line, colors, and textures that now characterize the landscape. Deep pits, banks of spoil, and stored topsoil will contrast sharply with the existing landscape, which has a smooth, rolling character. The elevated mill structures will create a focal point in the landscape, and activities of personnel and machinery will attract attention. Changes in the landscape caused by mill structures will be mitigated to some extent by the applicant's choice of an architectural design and color scheme, which are intended to be in harmony with the natural environment (ER, p. 3-1).

### 4.2.2 Historical and Archeological Resources

As discussed in Section 2.5.2.2, one potentially important archeological site is located on Morton Ranch. However, the site is several kilometers from the proposed facilities, and projected milling activities will have no impact on that site. Identification and determination of effect on historic and archeological resources was done in consultation with the State Historic Preservation Officer.<sup>29-31</sup> Protection of archeological site 40 CO 305 from mining activities is addressed in FES-TVA.

Any undiscovered artifacts that may exist at the mill site and tailings area could be disturbed and/or destroyed by project development if care is not taken to be alert to, and report, such a discovery. The applicant has agreed to report the discovery of archeological artifacts to the State of Wyoming, as discussed in Section 2.5.2.2.

After an initial survey of the proposed mill site, archeological clearance was recommended by the state archeologist. Following a recent survey of additional lands for proposed inclusion

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\*The evaporation pond would [initially] cover 15 ha (37 acres). The staff has calculated that the area covered by ponded liquids will continuously expand to cover 44 ha (110 acres) by the time milling operations cease. The 110-acre figure has been used in all calculations and assessments, to ensure conservative numerical values.<sup>4</sup>

in the mill site, the state archeologist again recommended the giving of an archeological clearance for the site. The state historic preservation officer has granted clearance for these surveyed areas (see App. H).

#### 4.3 WATER

For a mill throughput of  $1.82 \times 10^6$  kg/day of ore (2000 tons/day), approximately 43.1 Lps (683 gpm) of water is expected to be required (see Fig. 4.1). This water will be supplied by the dewatering stream from the open-pit mines, from the mill feed, and from recirculation of evaporation pond liquids. No groundwater or surface water from the area will be required except a maximum of less than 0.3 Lps (5.0 gpm) for human consumption. The net liquid discharge from the mill will be about 24.8 Lps (390 gpm), contained in the tailings slurry.

The tailings slurry capacity planned in Option L, which would include the use of all available pits for tailings solids plus an evaporation pond for decanted tailings liquids (see Secs. 10.3.2 and 10.3.3), would be sufficiently large to contain all tailings solids and excess liquid produced during the life of the mill. Maximum seepage from the pits would be 1.5 Lps (24 gpm) with the 0.9 m (3 ft) thickness required by the staff.<sup>5</sup> The staff expects that thorium and radium would be retained in the liner. However, common anions such as sulfate and chloride would probably reach the water table; in spite of this, because of the low seepage rate, the amount of contamination would be very small in relation to the concentration of such ions in the aquifer. Seepage from the evaporation pond would be about 1 Lps (15 gpm). The staff expects that thorium and radium would be retained in a 0.9-m clay liner, but sulfate and chloride ions would slowly seep through and the potential exists for these contaminants to reach the water table. However, because the seepage rate is so small, the amount of contamination is expected to be very small even when combined with the impacts from the pit seepage.

#### 4.4 MINERAL RESOURCES

As indicated in Section 2.7.2.3, coal seams in the vicinity of the proposed site are discontinuous and dispersed throughout the subsoils. Thus, the staff expects that any coal found on the site would be uneconomical to mine. However, if the coal stripped along with the overburden is found to be of sufficient quality and quantity to warrant separation, it could be salvaged. Any oil and gas present under the site would be thousands of feet below mining depths and could not be affected by the proposed mining and milling operations.

Minerals other than uranium that occur in the ore may become valuable in the future. Should this occur, minerals retained (except for minor seepage losses) in the tailings and overburden piles could be mined if economics warrant. These resources would be less accessible at this future date, however, due to belowgrade disposal of the tailings solids.

#### 4.5 SOILS

##### 4.5.1 Physical Impacts

Mill construction and operation will decrease the quantity and quality of existing soils. The impacts include loss of soil quantity as a result of preconstruction site preparation, erosion, mixing, and spills (see Sec. 4.5.2), and loss of soil quality as a result of compaction and storage.

Of the twelve tailings-disposal alternatives discussed by the applicant (Options A-L; see Sec. 10.4), Option L, the preferred choice of the applicant and the staff, is discussed below.

##### 4.5.1.1 Area Affected

Option L involves a retention dam and evaporation pond in the drainage area south of the mill site and the use of depleted mine pits. The disturbance associated with this option will involve up to 110 ha (270 acres). Some of area that would be disturbed as a result of the mill project would be shared with mining operations. These include the sewage lagoon (1 ha, or 2.5 acres), the access roads (20 ha, or 49 acres), the shop/warehouse (2 ha, or 5 acres), the power lines (16 ha, or 41 acres), and the gas and telephone lines (1.3 ha, or 3 acres) (ER, p. 4-1; App. VI, pp. A-32, A-33). Some of these facilities are already in existence, but their use and maintenance could result in small additional soil disturbance.

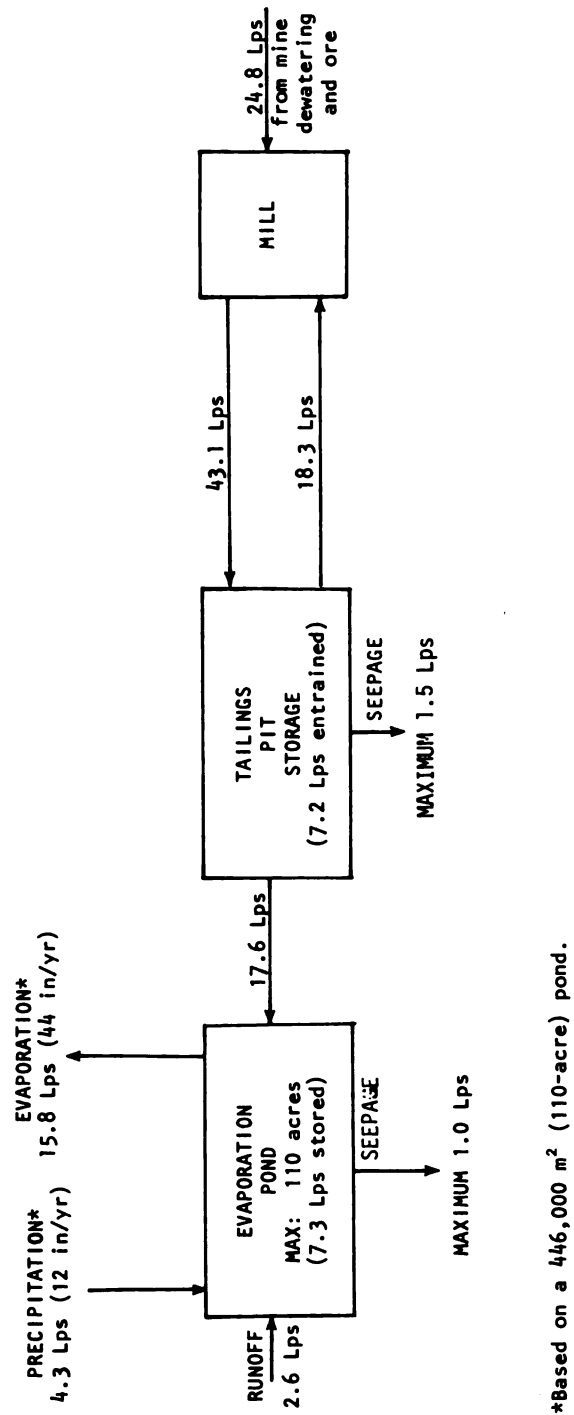


Fig. 4.1. Mill Water-Balance Diagram for  $1.82 \times 10^6$  kg/day (2000 tons/day) Ore Throughput (adapted from "Application for Uranium Mill License," revised 11-15-77, Fig. 3.1-4).

#### 4.5.1.2 Impacts

##### Soil Quantity

Topsoils and subsoils will be displaced during site preparation. Soils will be stripped to a depth of 60 cm (24 inches) (ER Suppl. I, p. 5-1). Even with great care, some topsoils [average depth 10 to 12 cm (4 to 5 inches)]<sup>6</sup> will be mixed with subsoils and downgraded to subsoil classification, and some subsoils [average depth 27 cm (11 inches)] will be mixed with other substances and downgraded to unclassified fill.

Removal of vegetation from the mill site and tailings area will expose the underlying surface materials to increased wind and water erosion. Topsoil and subsoil stockpiles will also be subjected to wind and water erosion. The rate of erosion will be reduced when the piles are covered with vegetation.

To counteract these anticipated impacts, topsoil and subsoil stockpiles will be protected from wind and water erosion by: 1) locating the piles away from existing drainages and on the leeward slopes of existing hills or ridges; 2) surrounding the piles with runoff intercept and drainage ditches; 3) seeding the piles with cover vegetation; and 4) keeping the surface of the piles moist until covered with vegetation (ER, pp. 4-2, 9-1, 9-2; ER App. VI, p. A-25).

To minimize water erosion, all affected lands will be graded and contoured to blend with the undisturbed topography. During periods of the year when a permanent cover cannot be seeded, annuals such as wheat or oats may be seeded to provide temporary cover. During periods when neither permanent nor temporary cover can be established, the topsoil will be laid so that it has a rough surface, to minimize both wind and water erosion. Seed drills will be used for planting, and the staff recommends that all drilling be on the contour unless specific conditions dictate otherwise. In especially critical areas, straw or other mulch will be used. For at least two growing seasons after seeding, livestock will not be permitted to graze on the newly vegetated areas (ER App. VI, pp. A-2, A-5, A-6, A-12, A-13).

Because the reclaimed areas of the pits would be constructed level with reference to the surrounding terrain, the staff expects that the rate of erosion of the pit cover would be similar to that of the terrain. If subsidence of the pit cover would eventually occur, the cover would be lower than the surrounding terrain and the depressed areas would gradually fill with erosion products from elsewhere. However, since the reclaimed piles will be slightly domed the effects of subsidence will be minimized.

Despite efforts to minimize losses of soil, the available 10 to 12 cm of topsoil (4 to 5 inches) will be insufficient to provide the 15 to 22 cm (6 to 9 inches) proposed by the applicant (ER App. VI, p. A-5) for reclamation of the tailings-filled mine pits and the evaporation pond area, and some subsoil will have to be substituted.

##### Soil Quality

Compaction of soil by heavy construction equipment and ore trucks will lower its potential for reclamation. Areas under roads and heavy-traffic areas near the mill will be most affected. Compaction restricts plant root development;<sup>7</sup> it also prevents normal water percolation, thereby inhibiting plant growth and increasing runoff and erosion.

The applicant has stated that the amount of soil compaction from vehicles will be minimized by limiting the number of roads in the mill/tailings area and restricting travel on these roads (ER App. VI, p. A-29).

Wherever heavy traffic has compacted the soil (including unpaved roads, filled mine pits undergoing reclamation, the reclaimed pond area, and other areas to be reclaimed), the adverse effects of compaction will be mitigated by deep ripping. This will be done before topsoil is in place. Heavily compacted soils will be ripped to depth of about 60 to 75 cm (24 to 30 inches) below the surface (both topsoil and subsoil). Less heavily compacted soils will be ripped to 15 to 30 cm (6 to 12 inches). No ripping will be done when the soil is wet, and soils will not be moved when wet (ER App. VI, pp. A-4 to A-6).

Storage of topsoils and subsoils in stockpiles will reduce their productivity.<sup>8</sup> Anaerobic reactions in the pile will disrupt the normal biotic environment; leaching will remove water-soluble nutrients. Both soil flora and fauna will be affected, but most affected will be the micro-organisms that convert organic material and other substances to plant nutrients. The result will be a general lowering of soil productivity. In the opinion of the staff, many years will have to elapse before the land will be as productive (in terms of vegetative ground cover) as it was before disturbance.

No toxic materials were disclosed in preoperational analyses of core samples of topsoil, subsoil, or overburden; however, should any such materials be encountered during the life of the project, the applicant states that they will be buried at a depth of at least 2 m (6 ft) below the surface (ER App. VI, p. A-26).

#### 4.5.2 Non-radioactive Chemical Impacts

Some spillage of chemicals (including petroleum products) is likely to occur in the mill area and on soils around the mill, tailings area, and shop/warehouse. Spillage of tailings, which contain non-radioactive as well as radioactive chemical substances, between the mill and tailings-disposal area is also likely. Such spills will be mitigated by removing the affected layers of soil and discarding them in the tailings area (ER Suppl. I, p. 3-36), decreasing soil quantity in these locations. Such scraped areas should be small in relation to undisturbed soils in the vicinity; thus, the overall impact will be negligible. Loss of soil associated with spillage will be minimized by surrounding the outdoor storage tanks with dikes (ER, p. 7-5).

### 4.6 BIOTA

#### 4.6.1 Vegetation

Construction of the mill and preparation of the tailings storage area will result in the disturbance of up to 110 ha (270 acres) of vegetation. Most of the plants to be removed are perennial grasses and sagebrush. Forbs constitute only 0.2% of the ground cover, and there is no riparian or unique vegetation. While the amount of affected land will be negligible in relation to the lands that will be undisturbed in the vicinity of the project site, the applicant will restore vegetation in accordance with the regulations of the State of Wyoming.

Native plants adjacent to the disturbed area may also be affected by fugitive dust, gaseous effluents, increased erosion, and competition from weeds. Fugitive dust from mill construction, milling operations, road construction, road traffic, tailings-area preparation, tailings storage, and topsoil and subsoil stockpiles may adversely affect nearby vegetation by covering the leaves, and interfering with photosynthesis. However, a portion of the dust is likely to be removed by the relatively strong prevailing winds of the area, and by precipitation when it occurs. Increased runoff from disturbed areas could cause water erosion and plant damage. Gaseous effluents from mill operation such as ammonia, chlorine, chlorine dioxide, kerosene vapor, and sulfur dioxide (ER, p. 5-14) may combine with atmospheric moisture to form products detrimental to plants. The staff expects all these possible effects to be negligible because of the small amounts of vapors likely to escape and because of the low ambient humidity of the area. Weeds and "undesirable" grasses--locally, Russian thistle (*Salsola kali*) and cheatgrass brome (*Bromus tectorum*)--would be expected to become established in the revegetated areas, and subsequently in adjacent areas. Timely plantings of native and other vegetation would tend to reduce the likelihood that weeds would become established (see 10.4.5).

#### 4.6.2 Wildlife

##### 4.6.2.1 Terrestrial Vertebrates

Direct impacts of mill construction and operation include killing of individual terrestrial vertebrates, destruction of habitat, and deprivation of normal habitat. Indirect impacts include the adverse effects of dust, acidic tailings, power lines, fencing, noise, increased vehicular travel, increased hunting pressure in adjacent areas, and other human disturbances.

#### Killing of Terrestrial Vertebrates

Some animals will be trampled and buried during construction by heavy earth-moving equipment; most impacted would be less mobile animals such as reptiles, amphibians, and nursing small mammals. However, this loss will have only a minimal effect on the total population, as the reproductive capacity of these species permits replacement of the lost individuals in one or two breeding seasons.

#### Destruction of Habitat

The loss of up to 110 ha (270 acres) habitat will decrease the total number of terrestrial vertebrates residing in the vicinity of the mill. Rodents will be forced to migrate to other areas, affecting the food supply of birds of prey and other predators. Sage grouse will be

forced to leave up to 110 ha and pronghorn antelope and mule deer in the vicinity will be deprived of a comparable area of forage. All will be forced to compete with animals in adjacent areas for habitat resources. The total effect, however, will be small, on a comparative-area basis, because of the vast amount of similar habitat throughout Converse County and eastern Wyoming.

#### Deprivation of Habitat

The use of depleted open mine pits for tailings disposal would eliminate 4 to 62 ha (10 to 154 acres) (ER Suppl. I, p. 3-11) of wildlife habitat for larger animals for an unspecified period because the area will remain fenced until stabilization is complete and radiation levels are reduced to acceptable levels. The land surface over these pits, to be devegetated as part of the mining operation, was originally scheduled for reclamation in about 1979-1980 (ER, App. VI, pp. A-33, A-34). However, the use of these pits for tailings disposal would delay their reclamation, the length of the delay depending on the number of pits used and their size (1 to 10 years for each pit).

#### Indirect Impacts

Dust generated during mill construction and operation and during activities related to tailings disposal, when deposited on nearby vegetation, could make them less palatable for animals, and possibly cause increased animal tooth wear. The staff believes that these impacts would be negligible.

Because open water is scarce in eastern Wyoming, waterfowl and other terrestrial vertebrates could be attracted to the man-made ponds (Options A-D, and L) or the open water associated with pit disposal (Options E-J, and L). It is unlikely they would remain on, or habitually frequent, a pond because of the acidity of the water, the lack of food and other vegetation, and the noise and human activity nearby. Nevertheless, ingestion of or immersion in the water could be detrimental to animal health.

The 34.5-kV power line supplying the mill can be a very minor flight hazard for birds, during infrequent storm conditions but will not pose an electrocution hazard for large birds such as golden eagles because the applicant has specifically designed the poles and crossarms to prevent this possibility (ER Suppl. II, response to Q. 23; also Ref. 9).

Fences around the mill and tailings disposal areas (Sec. 3.2.5) will cause alteration in wildlife movement and could cause increased mortality for antelope attempting to jump the fences in search of shelter or to eat newly established vegetation.<sup>10</sup> The staff believes that few antelope will attempt to enter the fenced area, and that the area will be denied to antelope habitation until fences are removed.

Construction activities and mill operations will be accompanied by noise. Few data are available regarding demonstrated effects of noise on wildlife; however, it is clear that noise can disrupt normal patterns of animal existence.<sup>11,12</sup> The initial response of most species is the alarm-flight reaction. Some species will adapt to the increased noise levels; others will leave the area and not return.<sup>10,11</sup> However, because the construction and operational noise levels will be relatively low, the staff expects the impact on terrestrial vertebrates to be minimal.

Transportation of construction workers and operating personnel will be almost exclusively by private automobile (ER, p. 4-8). This increased vehicular traffic will cause a proportional increase in the number of wildlife road kills. However, the deaths of these individuals will have little effect on the total population as carrying capacity levels would be attained rapidly. The increase in human population associated with mill construction and operation will increase the hunting pressure on local game populations (ER, p. 4-8).

The increased number of people residing in the Converse County area as a result of the mill will cause an increase in the number of roads, power lines, and buildings. These additional human disturbances will cause small but additional adverse effects on the terrestrial ecosystem.

#### 4.6.2.2 Aquatic Vertebrates

There are no permanent bodies of water and no aquatic vertebrates in the mill site/tailings area. Because the ponds discussed in Section 2.9.2 are in a different drainage area, and because the nearest permanent body of water, the permanent stretch of Cheyenne River, is 100 km (62 miles) downstream, there will be no impact on aquatic biota from normal operation of the project.

#### 4.6.3 Endangered Species

No rare or endangered species are known to reside in the vicinity of the project (see Sec. 2.9.1.2).

### 4.7 RADIOLOGICAL IMPACTS

#### 4.7.1 Introduction

The staff has estimated the radiation dose that could be incurred by the population within 80 km (50 miles) of the mill by using:

- Estimates of the expected radioactive effluent releases as discussed in Section 3.2.4 and summarized in Table D-1.2;
- Meteorological characteristics of the site and environs discussed in Section 2.1;
- Land-use and population data from Sections 2.5 and 2.4.1.

The dose calculations are based on the 1959 recommendations of the International Commission on Radiological Protection (ICRP II)<sup>13</sup> and the 1965 report of the task group on lung dynamics for Committee II of the ICRP.<sup>14</sup> These calculations show that the radioactive effluents released to the environment from the Morton Ranch mill will result in only small radiation doses to the public.

#### 4.7.2 Preoperational Radiation Environment

The natural radiation environment at the Morton Ranch project site has been discussed in detail in Section 2.10. The natural radiation environment results primarily from a) cosmic radiation, i.e., direct and cosmogenic radionuclides; b) terrestrial radiation, principally from radionuclides in the U-238 and Th-232 decay series and K-40; c) inhalation of Rn-222 daughters; and d) internally deposited radionuclides resulting from the inhalation or ingestion of members of the U-238 and Th-232 decay series and from K-40.

The medical whole-body dose level for Wyoming is estimated to average 75 mrem/yr-person.<sup>15</sup> The whole-body radiation dose rate from the preoperational environment at the site area is estimated to be 186 mrem/yr-person (see Table 2.6).

#### 4.7.3 Exposure Pathways

The exposure pathways that were considered in estimating the potential radiation dose to man from Morton Ranch mill effluents are shown in Figure 4.2. The dose estimates are made only for radioactive effluents emitted to the atmosphere, as no radioactive liquids are expected to be released. Estimates of the 50-year dose commitment to man from one year's exposure are based on mill and tailings site characteristics, mill equipment performance, and the actual pathways by which members of the public can be exposed to the discharges. The staff's analysis included evaluations of two effluent categories: 1) pathways associated with particulate releases to the atmosphere, and 2) pathways associated with gaseous releases to the atmosphere. The pathways associated with particulates through particulate releases and gaseous releases and subsequent decay to particulate nuclides are 1) inhalation, 2) dose due to external gamma-radiation exposure from a cloud, 3) dose due to external gamma-radiation exposure from nuclides deposited on the ground, and 4) food pathways due to deposition of radionuclides on plants and on the ground. The principal parameters on which the dose estimates are based are given in Appendix D, Table D-1.1. Emission rates are given in Appendix D, Table D-1.2. Calculations are given in Appendix D-1.

#### 4.7.4 Radiation Dose Commitments to Individuals

A summary of predicted radionuclide doses to individuals at selected reference points (the nearest residence and boundary downwind of the prevailing wind) is given in Table 4.2. Estimates are presented for the two exposure pathways discussed in Section 4.7.3.

The radiation dose at a reference point would vary depending on the distance and direction of that point from the mill. The dose would decrease with distance because of the decrease in the concentration of radioactive particulates with distance. The direction of the reference point with respect to the mill is important because the concentrations of radioactive particulates would be higher downwind of the mill. The dose commitment was calculated for the 50-year period following a one-year exposure. For this one year it was assumed that the method used for the reduction of particulate effluents would be 90% effective. The tailings pit surface was assumed to be subject to dusting for the entire time period until reclamation takes place.

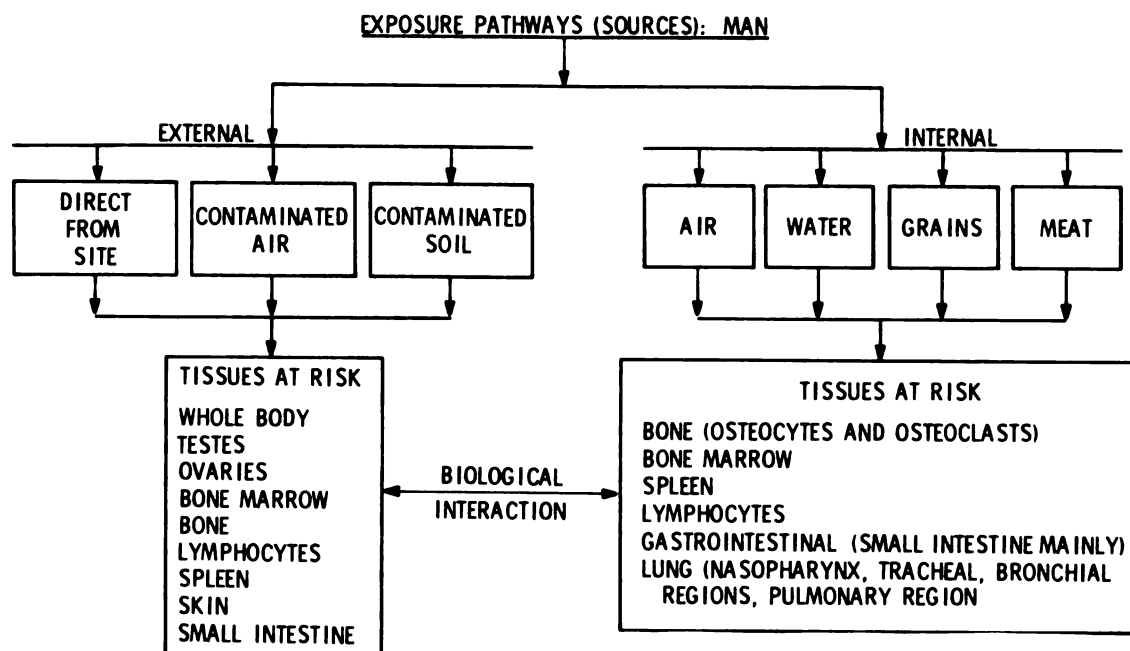


Fig. 4.2. Exposure Pathways.

Table 4.2. Radiation Dose Commitments<sup>a</sup> to Individuals (mrem/yr), Option L

| Location                                                                    | Exposure Pathway        | Whole Body | Bone | Lung   | Bronchial Epithelium |
|-----------------------------------------------------------------------------|-------------------------|------------|------|--------|----------------------|
| Boundary at point of highest dose                                           | Inhalation <sup>b</sup> | 0.42       | 9.5  | 19.2   | 76.8                 |
|                                                                             | External                | 2.9        | 3.2  | 2.7    |                      |
|                                                                             | Total                   | 3.3        | 12.7 | 21.9   | 76.8                 |
| Fowler Ranch <sup>c</sup><br>(nearest meat and vegetable ingestion pathway) | Inhalation              | < 0.01     | 0.03 | 0.21   | 2.1                  |
|                                                                             | External                | 0.05       | 0.05 | 0.05   |                      |
|                                                                             | Meat                    | < 0.01     | 0.09 | < 0.01 |                      |
|                                                                             | Vegetation              | < 0.01     | 0.09 | < 0.01 |                      |
|                                                                             | Total                   | < 0.08     | 0.26 | < 0.28 | 2.1                  |
| Vollman Ranch (meat only ingestion pathway)                                 | Inhalation              | < 0.01     | 0.02 | 0.18   | 2.0                  |
|                                                                             | External                | 0.04       | 0.05 | 0.04   |                      |
|                                                                             | Meat                    | 0.01       | 0.17 | 0.01   |                      |
|                                                                             | Total                   | < 0.06     | 0.24 | 0.23   | 2.0                  |

<sup>a</sup>Doses are integrated over a 50-year period from one year of inhalation or ingestion.

<sup>b</sup>Doses to whole body, lung, and bone are those resulting from inhalation of particulates of U-238, U-234, Th-230, Ra-226, and Pb-210. The doses to the bronchial epithelium are those resulting from inhalation of radon daughters.

The private residence closest to the proposed mill is the Fowler Ranch, 10 km (6.2 miles) to the north. Both vegetables and cattle are raised at the Fowler Ranch,<sup>17</sup> which resulted in its being the reference point with the highest total calculated dose. Cattle and feed grain are also raised at the Volman Ranch, 13 km (7.8 miles) northwest (upwind) of the mill site. Therefore, this was the residence with the highest calculated dose from the meat pathway. The nearest unrestricted approach to the mill that the general public could use is at the edge of the project site, 2.4 km (1.5 miles) east northeast of the mill structure. Accordingly, this was used as the reference point for the site boundary.

The sum of the predicted annual dose commitment from inhalation and the external radiation dose for an individual living at the Fowler Ranch will be <0.06 mrem to the whole body, 0.08 mrem to the bone, 0.26 mrem to the lungs, and 2.1 mrem to the bronchial epithelium. The ingestion dose commitment from eating cattle raised in the vicinity of the Fowler Ranch is calculated to be <0.01 mrem to the whole body, 0.09 mrem to bone, and <0.01 mrem to the lung. The ingestion dose commitment from eating vegetables grown at the Fowler Ranch is <0.01 mrem to the whole body, 0.09 mrem to the bone, and <0.01 mrem to the lungs. The sum of the predicted annual dose commitments from inhalation and the external radiation dose for an individual living at the Volman Ranch are 0.05 mrem to the whole body, 0.07 mrem to the bone, 0.22 mrem to the lungs, and 2.0 mrem to the bronchial epithelium. The ingestion dose commitments to an individual from eating cattle raised on the Volman Ranch are calculated to be 0.01 mrem to the whole body, 0.17 mrem to the bone, and 0.01 mrem to the lungs. The annual dose commitments from inhalation and external radiation to an individual living at the downwind (northeast) border with the highest calculated dose commitments are 3 mrem to the whole body, 13 mrem to the bone, 22 mrem to the lung, and 77 mrem to the bronchial epithelium. The ingestion dose commitment from eating cattle raised in this vicinity is calculated to be 2.4 mrem to the whole body, 16 mrem to the bone, and 2.4 mrem to the lung.

A brief discussion of the various pathways for radiation exposure is presented in the following sections.

#### 4.7.4.1 Internal Exposure

##### Air Pathway

Concentrations of U-238, U-234, Th-230, Ra-226, and Pb-210 in the air during active milling operations are given in Appendix D-3 as a function of distance from the source. The contribution of each of these radionuclides to the annual inhalation dose commitment is given in Appendix D, Table D-1.3. This analysis shows that the inhalation of radon daughter products and radioactive particulates of uranium and thorium released from the Morton Ranch mill will represent a negligible source of radiation exposure to individuals. After the termination of mining, milling, and reclamation operations, the concentrations of radionuclides released to the air will be reduced to near-background levels.

##### Water Pathway

No liquids will be released to the environment from the operation of the Morton Ranch mill except for treated sewage discharges. Seepage of radium and thorium is not expected to be significant, because any repository would be provided with a clay liner. Therefore, no dose contribution is expected from mill operations by way of a water pathway.

##### Food Pathway (Grains)

The area around the proposed mill can be characterized as rangeland, providing forage for cattle, sheep, horses, and antelope. Although soil conditions and low precipitation currently prevent the use of the land for large-scale agricultural purposes except rangeland, residents of the Fowler Ranch grow vegetables for private consumption, as previously noted.

Conservative assumptions are used in the model for calculating the dose commitments from the vegetable pathway. It is assumed that 50% of the aboveground vegetation in the diet of an individual living at the Fowler Ranch is from the ranch. The annual dose commitment is calculated for an individual who consumes 300 grams per day of these vegetables. The dose commitments from the vegetation-ingestion pathway are included in Table 4.2.

##### Food Pathway (Meat)

The area around the project site is used for the grazing of cattle and sheep. As beef is a more common source of meat than mutton, beef is considered the critical meat in this pathway. Wild

horses and antelope are also found in the area, but because these are not normally used for food, their contribution to the dose in the meat pathway is expected to be negligible.

Conservative assumptions are used in the model for calculating the dose from the meat pathway. It is assumed that some cattle are raised and consumed locally (ER, Secs. 2.2.1 and 2.2.2); cattle are assumed to graze at the Fowler and Volman ranch sites for six months per year. Feed grain is grown at the Volman Ranch, and is assumed to be used to feed the cattle at the ranch for another six months per year. The annual dose commitment is calculated for an individual who consumes 250 grams per day of meat from these cattle. The dose commitments from the meat-ingestion pathway to individuals living at these nearer ranches are included in Table 4.2.

#### 4.7.4.2 External Exposure

##### Direct Radiation

Direct radiation from the tailings varies with the concentration of the Ra-226 contained, which is estimated to be about 560 pCi/g. For this concentration, continuous exposure to gamma radiation at the surface of the tailings would result in a dose of about 12 rem/yr. The dose from direct gamma radiation to the population living outside the mill boundary will be negligible.

##### Airborne Particulates

During operation of the mill, ore dust, yellowcake dust, and tailings dust will be released to the environment. The dust will ultimately be deposited on the ground, but during its passage through the air individuals in the vicinity will be exposed to radioactive particulates. The model used to calculate dose rates for this exposure pathway is also conservative. It assumes that an individual is immersed in a cloud of this dust and receives radiation from radioactive particles in the cloud.

##### Ground-Deposited Particulates

Dust emitted from the mill that is deposited on the ground will add to the existing concentrations of radionuclides in the ground. The additional activity will increase with time during mill operation, as a function of deposition rate and radioactive decay. After mill shutdown, activity will decrease as a function of radioactive decay.

#### 4.7.5 Radiation Dose Commitments to Local Populations

Within an 80-km (50-mile) radius of the project site, there are three major communities with a projected 2005 total population of 103,000 people (App. B, Table B-5). Table 4.3 gives the 50-year dose commitment to these populations for one year of exposure by inhalation. The natural background doses to these populations have also been presented for comparison. The population dose commitments due to normal operations of the Morton Ranch mill represent only very small increases in the overall population dose rates over the background rate.

#### 4.7.6 Evaluation of Radiological Impacts on the Public

The predicted annual dose commitments to the whole body, skeleton, lungs, and bronchial epithelium (Table 4.3) from the use of tailings-pits impoundments (Option L) resulting from the normal operation of the Morton Ranch mill are less than the present NRC dose limits for members of the public outside of restricted areas [specified in 10 CFR Part 20, Standards for Protection Against Radiation and the proposed EPA standard for annual dose commitment (40 CFR 190)]. Table 4.4 compares NRC and EPA standards with the calculated dose commitments to residents of Fowler Ranch from the Morton Ranch mill.

The population dose commitments (Table 4.3) resulting from the Morton Ranch mill are only small fractions of the dose received from natural background radiation. They are also small when compared to the average medical and dental X-ray exposures currently given to the public for diagnostic purposes (Sec. 4.7.2).

#### 4.7.7 Occupational Dose

The Morton Ranch mill will be designed and built to minimize radiation exposure for both mill workers and the general public (see Sec. 3.2.1). The doses are expected to be similar to or less than those of currently operating mills. Special studies at selected mills elsewhere have

Table 4.3. Annual Dose Commitments<sup>a</sup> and Background Dose to Populations in Towns Surrounding the Morton Ranch Project

| Towns and Associated Subareas | Distance and Direction from Project Site | 2005 Population <sup>b</sup> | Whole Body                |                              |                                                      | Bone                      |                              |                                                      |
|-------------------------------|------------------------------------------|------------------------------|---------------------------|------------------------------|------------------------------------------------------|---------------------------|------------------------------|------------------------------------------------------|
|                               |                                          |                              | Individual Dose (mrem/yr) | Population Dose (man-rem/yr) | Background Population Dose <sup>c</sup> (man-rem/yr) | Individual Dose (mrem/yr) | Population Dose (man-rem/yr) | Background Population Dose <sup>c</sup> (man-rem/yr) |
| Glenrock                      | 40 km WSW                                | 5,400                        | 0.0418                    | 0.226                        | 999                                                  | 0.073                     | 0.39                         | 1,040                                                |
| Casper                        | 70 km WSW                                | 83,500                       | 0.0092                    | 0.770                        | 15,400                                               | 0.023                     | 1.94                         | 16,100                                               |
| Douglas                       | 30 km SSE                                | 14,100                       | 0.119                     | 1.68                         | 2,610                                                | 0.248                     | 3.50                         | 2,720                                                |
| Total                         |                                          | 103,000                      |                           | 2.68                         | 19,000                                               |                           | 5.84                         | 19,900                                               |

| Towns and Associated Subareas | Lung                      |                              |                                                      | Bronchial Epithelium      |                              |                                                      |
|-------------------------------|---------------------------|------------------------------|------------------------------------------------------|---------------------------|------------------------------|------------------------------------------------------|
|                               | Individual Dose (mrem/yr) | Population Dose (man-rem/yr) | Background Population Dose <sup>c</sup> (man-rem/yr) | Individual Dose (mrem/yr) | Population Dose (man-rem/yr) | Background Population Dose <sup>c</sup> (man-rem/yr) |
| Glenrock                      | 0.122                     | 0.66                         | 1,000                                                | 1.20                      | 6.48                         | 1,690                                                |
| Casper                        | 0.036                     | 3.01                         | 15,500                                               | 0.60                      | 50.4                         | 26,100                                               |
| Douglas                       | 0.385                     | 3.43                         | 2,620                                                | 1.79                      | 25.2                         | 4,410                                                |
| Total                         |                           | 7.10                         | 19,100                                               |                           | 82.1                         | 32,200                                               |

<sup>a</sup>Dose integrated over a 50-year period from one year of exposure (equivalent to the dose received in the 50th year of a continuous, 50-year exposure).

<sup>b</sup>From Appendix B, Table B.5.

<sup>c</sup>Annual dose from background radiation multiplied by the population.

Table 4.4. Comparison of Annual Dose Commitments to Individuals (pit option L) at Fowler Ranch with Radiation Protection Standards

| Receptor Organ                     | Estimated Annual Dose Commitments, mrem/yr | Radiation Protection Standard, mrem/yr | Fraction of Standard, % |
|------------------------------------|--------------------------------------------|----------------------------------------|-------------------------|
| PRESENT NRC REGULATION (10 CFR 20) |                                            |                                        |                         |
| Whole body                         | <0.08                                      | 500                                    | 0.02                    |
| Lung                               | <0.28                                      | 1500                                   | 0.02                    |
| Bone                               | 0.26                                       | 3000                                   | 0.009                   |
| Bronchial epithelium               | 0.0000145 (WL) <sup>a</sup>                | 0.033 (WL) <sup>a</sup>                | 0.04                    |
| FUTURE EPA STANDARD (40 CFR 190)   |                                            |                                        |                         |
| Whole body                         | <0.08                                      | 25                                     | 0.3                     |
| Lung                               | <0.28                                      | 25                                     | 1.1                     |
| Bone                               | 0.26                                       | 25                                     | 1.0                     |
| Bronchial epithelium               | 0.0000145 (WL) <sup>a</sup>                | NA <sup>b</sup>                        | NA <sup>b</sup>         |

<sup>a</sup>Radiation standards for exposures to Rn-222 and daughter products are expressed in Working Level (WL). WL means the amount of any combination of short-lived radioactive decay products of Rn-222 in one liter of air that will release  $1.3 \times 10^5$  mega electron volts of alpha particle energy during their radioactive decay to Pb-210 (radium D).

<sup>b</sup>Not applicable, since 40 CFR 190 does not include doses from Rn-222 daughters.

shown that the workers' exposures are normally below 25% of the allowable concentrations<sup>18</sup> and that the external exposures are normally less than 25% of the 10 CFR 20 limits.<sup>16,18</sup> Occupational doses will be monitored and kept in compliance with NRC dose limits.

#### 4.7.8 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.<sup>19-23</sup> Doses to terrestrial biota, such as birds and mammals, from gaseous effluents are quite similar to those calculated for man, and arise from the same dispersion pathways and considerations. Because the mill's effluent release 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

The direct impact of the Morton Ranch mill, given likely future conditions in construction and public services, will affect Converse County, and to a lesser degree the town of Casper. These effects involve to varying degrees the immigration of construction personnel, operating personnel, induced workers, and the families of each group, all of whom are referred to hereinafter as "newcomers."

#### 4.8.1 Demography and Settlement Pattern

##### 4.8.1.1 Population Changes

Some of the employment opportunities created by the Morton Ranch project will undoubtedly be filled by local residents, but many people will be drawn into the county by these jobs. The percentage of employees (both construction and operation) moving into the area will depend in part on the amount of construction and employment activity then occurring in the area.

Although there is a large pool of construction workers in Converse County (see App. B, Table B.9), current and projected developments will use most of these people. Surveys conducted at two

other communities in Wyoming revealed that 70% and 72% of the construction force were nonlocal.<sup>24</sup> An average of 70% of the Morton Ranch mill construction workers are likely to be newcomers to the area. Because of the temporary nature of their work, construction workers will try to live in the county near their work. It has been projected that only between 5% and 15% of the construction force will live in Casper.

Mill construction will require approximately two years, and will provide an average of 80 and a maximum of 140 jobs (ER, Sec. 8.1.2). Although manpower requirements will fluctuate during the construction phase, the staff will use the higher number of 140 employees to assess the maximum impact to the area.

The operational phase of the mill will involve a total work force of about 80 persons. This does not include personnel in the south shop (68 employees) or office (80 employees) (Sec. 3.2.3.4). Most of these employees will have been hired previously for the mining operation, and impacts caused by their migration to the Morton Ranch area have been assessed elsewhere (FES-TVA). The present assessment applies only to the approximately 80 employees who will be hired to operate the mill. The applicant expects that 40 positions can be filled by local residents and has committed itself to an in-house training program for them. The staff agrees that a 50% immigration rate can be anticipated.

Secondary jobs will be created in other sectors of the county's economy, such as retail trade and services industries, as a result of expenditures by the mill and its employees.<sup>25</sup> The Wyoming Department of Economic Planning and Development estimates a total job multiplier of 1.5 for construction workers and 2.5 for permanent employees.<sup>26</sup> Thus, about 280 new jobs are expected to be created directly and indirectly during the construction phase, and the operation of the mill can generate 80 jobs locally.

The induced-employment rate projected here is considered to apply only to newcomers because the economic sector is already providing these services to local workers. Because of the area's current low unemployment rate (Section 2.4.2.2), a 50% induced-worker immigration has been considered for the project.

Thus, about 175 newcomer workers are projected to move into the area during the construction phase, and 40 workers during the operation phase. Total direct and induced employment projected for the mill are shown in Table 4.5.

Table 4.5. Total Employment and Estimated Number of Newcomers

|              | Direct<br>Jobs   | Direct<br>Newcomers | Induced<br>Jobs      | Induced<br>Newcomers | Total Newcomers<br>(Direct & Indirect) |
|--------------|------------------|---------------------|----------------------|----------------------|----------------------------------------|
| Construction | 140 <sup>a</sup> | 98 <sup>b</sup>     | 147 <sup>d</sup>     | 74 <sup>f</sup>      | 172                                    |
| Operation    | 80 <sup>a</sup>  | 40 <sup>c</sup>     | (100) <sup>e,g</sup> | --                   | 40 <sup>g</sup>                        |
| Total        | 220              | 138                 | 147                  | 74                   | 212                                    |

<sup>a</sup>Estimated by applicant.

<sup>b</sup>70% mover (immigrant) rate for construction force as estimated by the staff.

<sup>c</sup>50% mover (immigrant) rate for operation workers as estimated by the staff.

<sup>d</sup>1.5 job multiplier for construction workers (Wyoming Dept. of Economic Planning and Development).

<sup>e</sup>2.5 job multiplier for operation employees (Wyoming Dept. of Economic Planning and Development).

<sup>f</sup>50% mover (immigrant) rate for induced workers as estimated by the staff.

<sup>g</sup>It is assumed that the induced jobs created during the construction phase will be similar to induced services required during the operational phase and that those persons employed during the construction phase will continue to work at these jobs during the operational phase.

#### 4.8.1.2 Settlement Pattern

The severity of the impact of newcomers will depend on where they choose to reside. Estimates of the distribution of mill workers are limited by a number of factors, particularly the development of housing subdivisions and multifamily homes, restrictions on mobile homes, and the cost of housing. Therefore, a distribution range has been determined for each community rather than a fixed percentage, to project the minimum/maximum impacts expected for each area.

Many of these newcomers will bring a partner and/or children, but the short construction stage (~ 2 years) will discourage some construction workers from moving their families. Therefore, a low population multiplier of 2.0 (normally 2.5) is used in determining the number of additional people moving to the area during construction.

Family characteristics are assumed to be different for the construction and operating phases. The permanent nature of their positions will allow the operating personnel to live in a more normal family structure. Thus, for each of the operating personnel moving to the impact area, the staff assumes a population multiplier of 2.5.<sup>26</sup>

Residence patterns and housing accommodations of operating personnel will differ from those of construction workers. Operating personnel, who generally move into an area with the intention of remaining, will be more inclined to live in single-family homes and apartments than in mobile homes. This will result in the selection of areas where these housing preferences are available. Data from the Exxon uranium mine/mill operations adjacent to the Morton Ranch site indicate that 30% of the employees reside in Casper, 18% in Glenrock, and the remaining 52% in Douglas (ER Suppl. II, response to Q. 10). The proportion of people living in Casper will probably be as high or higher for Morton Ranch as the population from other projects strains the available housing in Converse County (see Sec. 4.8.2.1).

Induced workers who move to the area may look for permanent jobs. Therefore, it is assumed that induced workers will reside in the same general geographical locations as operation workers and have the same population multiplier (2.5) (See Table 4.6).

Table 4.6. Distribution of Newcomers (Staff Estimate)

|                                                  | Douglas | Glenrock | Casper |
|--------------------------------------------------|---------|----------|--------|
| <u>Construction Phase</u>                        |         |          |        |
| % of construction workers                        | 60-70   | 20-30    | 5-15   |
| Number of construction workers                   | 60-70   | 20-30    | 5-15   |
| Total number of construction people <sup>a</sup> | 120-140 | 40-60    | 10-30  |
| % of induced workers                             | 45-55   | 15-25    | 25-35  |
| Number of induced workers                        | 33-40   | 11-19    | 19-26  |
| Total number of induced people <sup>a</sup>      | 82-100  | 28-48    | 48-65  |
| Total number of newcomers <sup>b</sup>           | 202-240 | 68-108   | 58-95  |
| <u>Operational Phase<sup>c</sup></u>             |         |          |        |
| % of operation workers                           | 45-55   | 15-25    | 25-35  |
| Number of operation workers                      | 18-22   | 6-10     | 10-15  |
| Total number of operation people <sup>a</sup>    | 45-55   | 15-25    | 25-35  |

<sup>a</sup>Includes employees, their partners, and children.

<sup>b</sup>Total of direct and indirect employees and families.

<sup>c</sup>Although 100 induced-employment jobs will be created during the operational phase, construction-induced employees and local residents are likely to fill these positions.

The total number of people moving to the area varies for each stage of the Morton Ranch project, with the maximum impact occurring at Douglas during the mill construction period (Table 4.6). The additional people projected to reside in Casper will go relatively unnoticed when added to its current population.

#### 4.8.2 Social Organization

##### 4.8.2.1 Housing

The type of housing required to meet the needs of immigrating workers will depend on the number of individuals and their choice of accommodations. Individuals living alone will be more interested in renting rooms and apartments, whereas couples or families will usually prefer single-family or mobile homes.

The greatest proportion of workers living alone, i.e., unmarried personnel or those who have not brought their partner and/or children, will be present during the construction phase. If it is assumed that half of the construction workers live alone, a maximum of 30 to 35 apartments or rooms will be needed in Douglas, 10 to 15 in Glenrock, and 3 to 8 in Casper. Some of these workers will share apartments or rent mobile homes in the two towns because, as discussed in Section 2.4.2.2, housing construction has not kept up with demand, and mobile homes are being used to provide the necessary accommodations. The impact on the Casper housing market will be negligible. Operating personnel and induced workers will have to rely on mobile-home living until sufficient homes are available.

Available housing is costly. An "average" three-bedroom house in Douglas costs \$47,000, and the "average" monthly rental for a three-bedroom unit is \$300.<sup>27</sup> This factor will also induce many people, including permanent residents, to rely on mobile homes.

The combination of few houses, high prices, and the unacceptability of mobile homes could encourage many people to live in Casper. The number of families that may move to Casper during the construction phase (assuming half the construction workers have partners) and operational phase (assuming all have partners) are projected in Table 4.7. Permanent employees at the site and secondary induced employees who will reside in Casper will move there to enjoy a wider choice in housing and urban services than provided in Glenrock or Douglas. The impact to Casper's housing market will be minimal, whereas the housing situation will be strained in the Glenrock and Douglas areas by those seeking to live close to the mill.

Table 4.7. Housing Requirements

|                                       | Douglas | Glenrock | Casper |
|---------------------------------------|---------|----------|--------|
| <b>Construction Phase<sup>a</sup></b> |         |          |        |
| Apartments and rooms                  | 30-35   | 10-15    | 3-8    |
| Houses and mobile homes               | 63-75   | 21-34    | 25-34  |
| <b>Operational Phase<sup>b</sup></b>  |         |          |        |
| Houses and mobile homes               | 18-22   | 6-10     | 10-14  |

<sup>a</sup>Assumes half of the construction force employees are without partners and will live alone in an apartment or room.

<sup>b</sup>Assumes all direct workers are with a partner and/or children.

#### 4.8.2.2 Education

The greatest impact to the school system will be Converse County School District No. 1 during the construction phase (Table 4.8). As children leave the school systems at the conclusion of the construction phase, they will be replaced by newcomer children whose parents are involved directly or indirectly with the operational phase of the mill. While the initial influx of children into School Districts Nos. 1 and 2 will be noticeable, the second wave will not be as numerous. However, since the District 1 is currently arranging to increase classroom facilities, impact on the school system will be minor during the initial increase of children and negligible during the operational phase.

Table 4.8. Distribution of Morton Ranch Employee School-Aged Children (Staff Estimate)

|                                | Converse County<br>School District<br>No. 1<br>(Douglas) | Converse County<br>School District<br>No. 2<br>(Glenrock) | Natrona County<br>School District<br>No. 1<br>(Casper) |
|--------------------------------|----------------------------------------------------------|-----------------------------------------------------------|--------------------------------------------------------|
| <u>Construction Phase</u>      |                                                          |                                                           |                                                        |
| Construction-workers' children | 30-35                                                    | 10-15                                                     | 2-10                                                   |
| Induced-workers' children      | 33-41                                                    | 11-19                                                     | 19-26                                                  |
| Total                          | 63-76                                                    | 21-34                                                     | 21-36                                                  |
| <u>Operational Phase</u>       |                                                          |                                                           |                                                        |
| Operation workers' children    | 10                                                       | 5                                                         | 5                                                      |

#### 4.8.2.3 Public Services

With the addition of approximately 225 people to Douglas and 100 people to Glenrock during the construction phase, law enforcement, fire protection, utilities, and medical services may be strained if these services, already strained by other development, remain at their present levels. If plans for expansion of these services are funded and implemented, the communities should be able to integrate these people and provide the necessary services.

The increase of new personnel for the operational phase of the mill will be mitigated by the outmigration of the construction force. About 50 newcomers will move into Douglas, while Glenrock will have about 20 new residents.

Other public service areas may not be able to expand or change as rapidly as the above-mentioned services. Recreational facilities, libraries, and shopping areas will be impacted by increased use and can rapidly deteriorate if overused.

Roads connecting the site to the local communities and the streets of the municipalities will be moderately impacted by the increase of vehicular traffic generated by the facility. Additional traffic could lead to an increase in accidents, damage to the roads, and congestion and inconvenience to those who use these roads, but the staff does not consider that these effects will be major.

#### 4.8.3 Economic Organization

##### 4.8.3.1 Personal Income

The construction of the mill will provide an annual average gross income of \$22,000 for each construction worker. With an average of 80 construction workers per year, approximately \$1.6 million will be paid in gross wages, for a total of \$3.2 million during the construction period. The permanent work force of the mill, about 80 people, will receive on the average \$17,500 per year for a total of \$1.4 million annually in gross wages during mill operations.

The applicant's estimation of its contribution to the economic sector through direct and indirect taxes is presented in Table 4.9. Income from induced services over the lifetime of the mill has been estimated by the applicant to be \$16,150,000. The staff believes that the applicant's estimates are reasonable.

The wages introduced as a result of mill construction and operation will affect the cost of living in the area. Prices in the area are high, not only due to the current inflationary trend

Table 4.9. Estimated Income over the Lifetime  
of the Applicant's Mill Project<sup>a</sup>

| Source                                                   | Present Value<br>Amount, \$ |
|----------------------------------------------------------|-----------------------------|
| <u>Direct Taxes (corporate)</u>                          |                             |
| Federal income                                           | 95,800,000                  |
| State production<br>and mineral severance                | 11,500,000                  |
| Local property                                           | 1,300,000                   |
| State sales                                              | 900,000                     |
| <u>Indirect Taxes<br/>(wages, salaries, procurement)</u> |                             |
| Mill construction and<br>initial procurement             | 8,300,000                   |
| Mill operation and<br>operating materials                | 9,300,000                   |
| Construction induced services                            | 200,000                     |
| Permanent induced services                               | 5,700,000                   |
| Royalties                                                | 16,600,000                  |

<sup>a</sup>Source: ER, Table 8.1-2, Rev. 1.

in the United States, but due to "boom town" situations in this region of rapid development of energy resources. Salaries, particularly in local services employment, have not increased to meet the rising prices. Income from mill salaries could increase local inflation to an unknown extent, to the detriment of those local people whose income has not similarly kept pace with prices.

#### 4.8.3.2 Public Finances

The local communities are in the process of obtaining revenues from current developments and government sources to pay for the costs imposed by these projects. Demands for new services and requirements for new public expenditures will be likely to increase with the construction of the mill. The ability of the municipalities to meet these projected demands is unknown at this time.

#### 4.8.4 Conclusion

##### 4.8.4.1 Social Impact

Rapid energy developments in other Wyoming communities have seriously damaged the perceived quality of life for its residents.<sup>28</sup> Poor living conditions and inadequate health services are two major problems recognized in Wyoming "boom towns."

Glenrock and Douglas have been managing their new growth with planning assistance and funding from the Wyoming Community Development Authority. In these communities the quality of life may be affected by the increased demands of mill workers, but the degree to which it is affected will depend on the existing infrastructure at that time. As long as the communities continue to expand and strengthen their infrastructure, the staff believes that the impact on the residents' living conditions should be minor.

Glenrock and Douglas will have to weigh the demand and financing for new and improved public services. As long as these communities can provide needed public services to newcomers, while maintaining service costs within the reach of existing residents, impacts on the quality of life should be manageable.

The immigration of people to Converse County due to placement of the mill will extend the social changes currently in progress in the community: a society once based on small-town, rural beliefs and attitudes becoming a rapidly changing, urban society with more "liberal" ideas and "materialistic" values. The rapid and continual infusion of people from this and other projects will affect the social and cultural character of the area in the near future. Because communities are always evolving, these changes cannot be considered negative unless they occur faster than the social system can adjust.

#### 4.8.4.2 Cumulative Impacts

The total impacts that could result from the construction and operation of the mill can be considered to be manageable by the communities under normal conditions. However, Converse County is already undergoing expansion and many new projects are currently being implemented. The cumulative impact of the proposed Morton Ranch mill and other ongoing and planned projects can be substantial if there is not a parallel growth in the various sectors of the communities, and planned coordinate activities by the local governments.

The applicant is making an effort to help the area in planning and coordinating measures to counteract the impacts caused by development of the proposed project by being an active member of the Converse Area Industrial Association. The staff encourages the applicant to undertake other activities to assist the County, including working directly with the Converse Area Planning Office.

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## 5. ENVIRONMENTAL EFFECTS OF ACCIDENTS

The occurrence of accidents related to uranium milling operations can be minimized through the proper design, manufacture, and operation of mill components, as well as a quality assurance program designed to establish and maintain safe operations. In accordance with the procedures set down in NRC Regulatory Guide 3.5, the applicant has submitted a license application containing descriptions of the facility design, the organization of the operation, and the quality assurance program. This document, together with the environmental report and supplements, has been reviewed by the NRC staff to assure that there is a basis for safe operations at the site. Moreover, the NRC 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.

Notwithstanding the above safeguards, accidents involving the release of radioactive materials or harmful chemicals have occurred in operations similar to those proposed by the applicant. Therefore, in this assessment, accidents which might occur during mill operations have been postulated and their potential environmental impacts evaluated. The probabilities of occurrence and the nominal consequences are assessed, using best available estimates of probabilities and realistic assumptions regarding release and transport of radioactive materials. In cases of doubt, or where information adequate for a realistic evaluation was unavailable, extremely conservative assumptions were used to compute environmental impacts. Thus, the actual environmental effects of the postulated accidents would be, in some cases, less than effects predicted by this assessment.

### 5.1 MILL ACCIDENTS INVOLVING RADIOACTIVITY

The specific activities of the radioactive materials handled at the mill are extremely low:  $\sim 10^{-9}$  Ci/g for the ore and tailings and  $\sim 10^{-6}$  Ci/g for the refined yellowcake product.\* The quantities of materials handled, on the other hand, could be relatively large, ranging from 600 to 1200 MT (590 to 1100 tons) of yellowcake per year\*\* representing 370 to 740 Ci of radioactivity. Therefore, substantial releases of radioactive materials from the site would require the dispersal of exceedingly large quantities of material, for which the driving forces are generally unavailable.

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 operations),
3. Large releases to the environment (relative to the annual release from normal operations).

Trivial incidents include spills, ruptures in tanks or plant piping containing solutions or slurries, failures of the centrifuge used for yellowcake dewatering, and failure in the air cleaning system serving the yellowcake dryer. Small releases include a fire or explosion in the solvent extraction (SX) circuit, and a gas explosion in the yellowcake dryer. Large releases include a major tornado strike and large releases to the watercourses from an evaporation pond or tailings distribution system (e.g., slurry pipelines).

For most of the postulated cases resulting in a release to the environment the analysis gives the estimated magnitude of the release; the estimated annual likelihood of occurrence; and, for radioactive releases, the corresponding maximum individual dose at the closest residence. The

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\*In contrast to the relatively high specific activities of a number of prominent radionuclides, e.g.,  $\sim 10^{-1}$  Ci/g for Pu-239 and  $\sim 10^3$  Ci/g for Co-60.

\*\*Based on a revised value for the average grade of uranium expected to be mined (0.077%  $U_3O_8$ ),<sup>1</sup> a nominal 418 MT/yr (410 tons/yr) would be produced at the mill. However, the 0.2% value is used for the present accident analyses.

latter estimates are based on a diversity of sources, including incidents on record, chemical industry statistics, and failure prediction methodologies. The dispersion model was taken from NRC Regulatory Guide 1.4,<sup>2</sup> and the dose conversion factors are based on the recommendations of the International Commission on Radiological Protection (Committee 11),<sup>3</sup> updated by the lung model advocated by the Environmental Protection Agency.<sup>4</sup>

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 that similar accidents might occur in the future is usually lower. Based on analysis, it is believed that even if major accidents did occur, 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 or equipment failure, would not result in the release of radioactive materials to the environment.

#### 5.1.1.1 Leaks or Rupture in Tanks or Piping

Uranium-bearing slurries and solutions will be contained in several tanks comprising the acid leach, countercurrent decantation, solvent extraction, and precipitation stages of the mill circuit. Human error during the filling or emptying of tanks, or the failure of valves or piping in the circuit, would result in spills which might be expected to occur several times annually during operations. Large spills from tank failures or uncorrected human error might involve the indoor release of several hundred pounds of uranium in the liquid phase. However, the entire content of the tanks would be contained within the mill sumps and would not, therefore, reach the environment.

#### 5.1.1.2 Centrifuge Failure

The underflow from the thickener will be fed to a centrifuge that dewateres the yellowcake product prior to its roasting in the dryer. If the centrifuge rotor were to fail, penetration of adjacent tanks could conceivably occur, releasing yellowcake slurry to the room. However, the entire contents of a breached tank would be contained by mill sumps and dikes and would not reach the environment.

#### 5.1.1.3 Failure in the Air Cleaning System Serving the Yellowcake Drying Area

The off-gases from the yellowcake dryer, which contain entrained solid particles of uranium oxide, will pass through a wet venturi scrubber before being discharged to the environment. The rated efficiency of the scrubber is 99.8%; thus, should the scrubber fail catastrophically during operations, the release rate of yellowcake to the atmosphere would be increased by a factor of 500. According to the applicant, however, the system is designed so that if there is a loss of water pressure or of power to the fan drive train, an alarm would be sounded and the entire system would be automatically shut down. Moreover, catastrophic failure of the scrubber itself is highly unlikely. Progressive failure, in which the plugging of vents would cause back pressure, would be readily detectable during operational checks and would cause inefficiencies, rather than failure. Thus, scrubber failure would not result in an abnormal release of yellowcake to the environment.

### 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 Fire or Explosion in the Solvent Extraction Circuit

The solvent extraction circuit, which will be located in a separate building, is expected to contain ~2000 kg (4400 lbs) of uranium oxide in either the aqueous or organic phase. Major fires have occurred in solvent extraction circuits of uranium mills in recent history.<sup>5</sup> If a fire were to occur to the Morton Ranch SX circuit, heat or smoke detectors would sound an alarm and automatically activate a sprinkler system.

In the event of a major fire, it is conservatively assumed from previous estimates<sup>6,7</sup> relating to both uranium and plutonium solutions that as much as 1% of the uranium would be dispersed.\* This would result in the ultimate release to the environment of approximately 17 kg (38 lb) of uranium, conservatively assumed to be entirely soluble. Figure 5.1 indicates the 50-year dose commitments to the bones\*\* of individuals at various distances from the mill corresponding to this magnitude of release.

From chemical industry data, the probability of a major fire per plant-year is estimated to be  $4 \times 10^{-4}$ .<sup>6</sup> However, at least two major solvent extraction circuit fires are documented in the literature.<sup>5</sup> There have been approximately 550 plant-years of mill operation in the U. S.--roughly equivalent to 200 plant-years handling 660,000 MT ore/yr. Thus, judging from historical incidents, the likelihood of a major solvent extraction fire is in the range of  $4 \times 10^{-3}$  to  $1 \times 10^{-2}$  per plant-year. Using these two estimates to bracket the probability, the likelihood of a major solvent extraction fire at the Morton Ranch mill is assumed to fall in the range of  $4 \times 10^{-4}$  to  $1 \times 10^{-2}$  per year.

#### 5.1.2.2 Gas Explosion in the Yellowcake Drying Operation

A multihearth furnace will be used to remove the remaining water from the yellowcake slurry after the centrifuge operation. The furnace will be fueled by natural gas, propane, or fuel oil. The off-gas from the dryer will be ventilated through a wet scrubber. If natural gas or propane are used as fuel, an explosion in the dryer or the piping could conceivably blow off the duct work associated with the ventilation system and disperse yellowcake into the room.

The consequences of explosion accidents are limited by the concentration of heavy material that can be maintained in the air, estimated to be approximately 100 mg/m<sup>3</sup>.<sup>6</sup> Then, for a room volume estimated to be approximately  $4 \times 10^4$  m<sup>3</sup>, the quantity of uranium released to the room air is estimated to be approximately 4000 g (140 oz). Conservatively assuming that all of the uranium would be swept out into the environment when the room is ventilated, and that 100% of the insoluble particles are in the respirable size range, the 50-year dose commitments to the lungs of individuals at various distances from the mill are plotted in Figure 5.2.

No quantitative data have been found relating either to propane or natural gas furnace explosions. Failure rates have been observed for piping used in natural-gas transmission and have been converted to equivalent failure rates per plant-year.<sup>8</sup> The result of this analysis yields approximately  $5 \times 10^{-3}$  failures per plant-year. This is likely to constitute an upper limit of the likelihood of a gas explosion because it is based on a generous estimate of 50,000 meters (164,000 ft) of piping per plant and does not take into account the probability of ignition, given a failure.

#### 5.1.3 Large Releases

The following incidents might release large quantities of radioactive materials to the environment compared with the annual release from normal operations. 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 Morton Ranch mill is located is approximately  $3 \times 10^{-4}$ /yr.<sup>9</sup> The area is categorized as Region 3 in relative tornado intensity,<sup>10</sup> i.e., for a "typical" tornado, the wind speed is 107 m/sec (240 miles/hr), of which 85 m/sec (190 miles/hr) is rotational and 22 m/sec (50 miles/hr) is translational. None of the mill structures will be 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 without it. Accordingly, a "no warning" tornado was postulated. Moreover, since it is not possible to accurately predict the total amount of material dispersed by the tornado, a highly conservative approach was adopted in which a total of 4.55 MT (five short tons) was assumed to be lifted by the tornado. Because the yellowcake product has the highest specific activity of any material handled at the mill and a number of drums may be

\*It is estimated that a smaller fraction of the uranium inventory would be released to the room, and subsequently to the environment, in the event of an explosion.

\*\*The illustrations in Section 5 show radionuclide doses commitments in terms of the critical receptor organ, i.e., either the bone dose from the inhalation of soluble uranium or the lung dose from the inhalation of insoluble uranium.

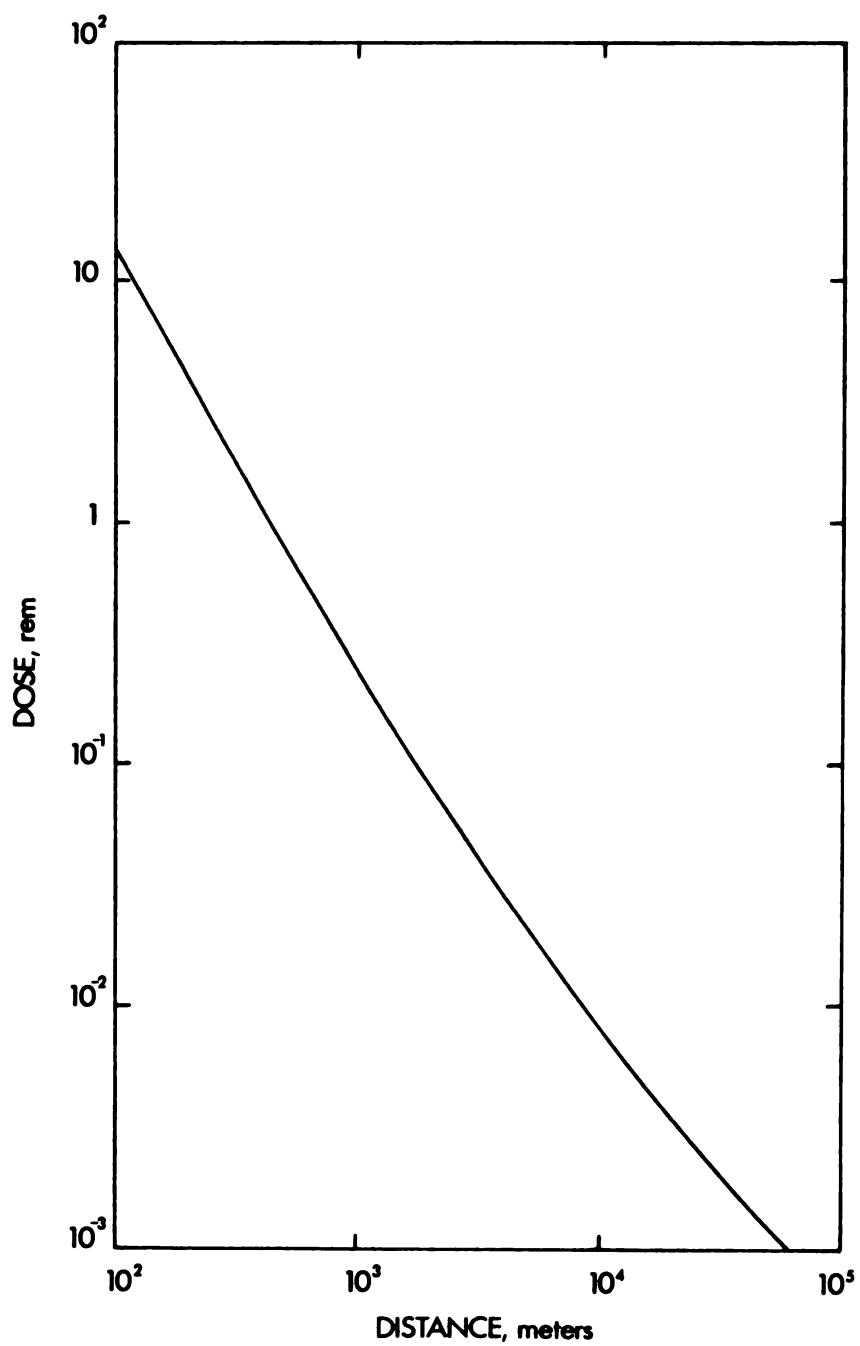


Fig. 5.1. Fire in the Solvent Extraction System--50-year Dose to Bone.

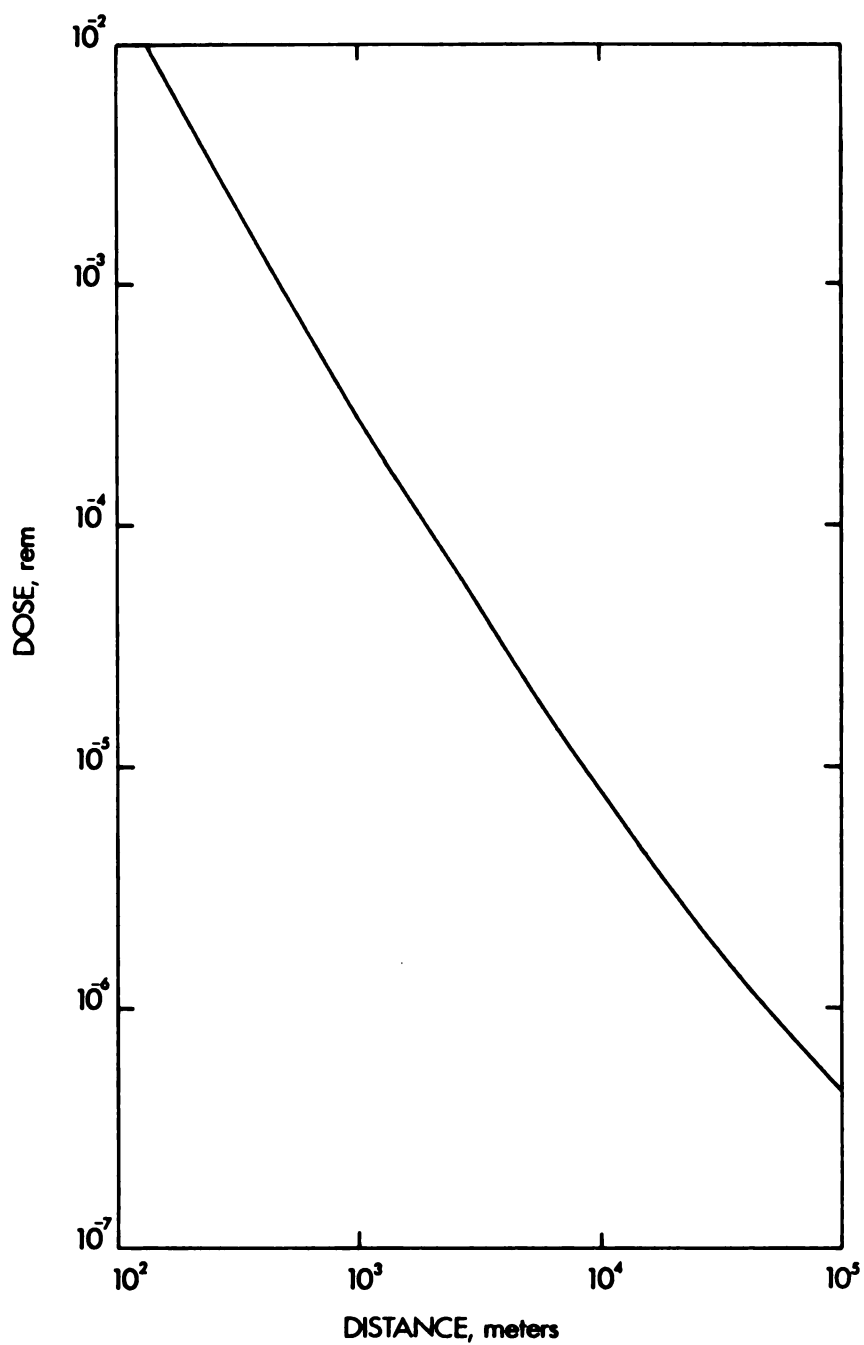


Fig. 5.2. Gas Explosion in the Yellowcake Drying Operation--50-year Dose to Lungs.

accumulated prior to shipment, it is assumed that the tornado lifts 4550 kg (10,000 lb) of yellowcake.

A conservative model,<sup>11</sup> which assumes that all of the yellowcake is in respirable form, was used for the dispersion analysis. 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 disperses through an arc of 45°. With the small particle sizes assumed, the settling velocity is judged to be negligible.

The model predicts a maximum exposure at 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  $\sim 1.1 \times 10^{-7}$  rem. The 50-year dose commitment as a function of distance from the mill is plotted in Figure 5.3.

#### 5.1.3.2 Release of Tailings Slurry

At the projected mill capacity of 1800 MT (2000 tons) of ore per day, approximately 1300 kg/min (2800 lb/min) of barren tailings will have to be disposed of. The tailings will be pumped from the mill as a slurry in approximately 43 L/sec (680 gpm) of process solution, 18 L/sec (290 gpm) of which will be recycled back to the process (see Fig. 4.1). Over the projected life of the mill, it is currently anticipated that approximately  $1.2 \times 10^7$  MT ( $1.3 \times 10^7$  tons) of solid tailings will be generated.

The solid tailings will be coated with acid solution and are predicted to have a radiological composition of approximately 17  $\mu\text{Ci/MT}$  of U-238, 17  $\mu\text{Ci/MT}$  of U-234, 535  $\mu\text{Ci/MT}$  of Th-230, and 562  $\mu\text{Ci/MT}$  of Ra-226. The composition of the tailings solution will depend on its acidity and on other details of the process. Table 5.1 gives predicted concentrations of radionuclides in the tailings solution, as estimated by the applicant. Although the actual composition is difficult to establish because of losses due to seepage, evaporation, and entrapment in the solid tailings, these concentrations are comparable to those reported by operating mills using the acid-leach process.<sup>12</sup> Additionally, the tailings solution will contain trace quantities of the components of the organic phase of the solvent extraction step in the milling circuit and of metals in the original ore.

The applicant has examined 12 optional methods of tailings disposal for tailings treatment, disposal sites, dust control, and reclamation. These are described in Section 10.4. In Option L, the preferred alternative of the applicant, ten clay-lined, mined-out open pits with a total volume of about  $8 \times 10^6 \text{ m}^3$  ( $10.5 \times 10^6 \text{ yd}^3$ ) would receive the tailings slurry by way of pipelines; however, all free liquid would be removed by decant pipelines. Some of the liquid would be routed back to the mill process stream, but the remaining excess would be disposed of in an evaporation pond south of the mill, expected to cover a maximum area at the end of the lifetime of the mill of about  $4.5 \times 10^5 \text{ m}^2$  (110 acres). The accident considerations discussed below are subdivided under the headings of "Evaporation Pond Release" and "Open-Pit Mine Release."

#### Evaporation Pond Release

The applicant would construct a dam across the south fork of Box Creek to create an evaporation pond immediately south of the mill site. Inadvertent releases of the tailings solution might result from an overflow of the pond or a failure of the dam. Failure of the dam could be attributed to floodwater breaching, a destructive earthquake, or structural failure.

A minimum freeboard of approximately 4.0 m (13 ft) at the initial dam height and 2.7 m (9 ft) at the final pond height will be required as a condition of the license. This will provide sufficient emergency storage capacity in the evaporation pond to hold a Probable Maximum Flood (PMF) series of 1.4 PMF's and a 100-year flood.<sup>14</sup> Considering these conditions, dam failure due to flooding is unlikely.

Failure of the evaporation pond dam due to an earthquake would be unlikely, as the site is in the Zone One ("minor damage") seismic-risk category (intensities V to VI on the Modified Mercalli Scale).<sup>15</sup> For this zone, the horizontal acceleration in rock is estimated to be less than 4% of gravity,<sup>16</sup> well within the design specifications of the proposed dam. Within a 240-km (150-mile) radius of the Morton Ranch site, an earthquake of intensity VII on the Modified Mercalli Scale has occurred only once within the past 100 years (centered in Casper, in 1897).

There has been little experience with the use of evaporation ponds primarily for tailings-liquids disposal, although considerable experience has been accumulated on the disposal of both

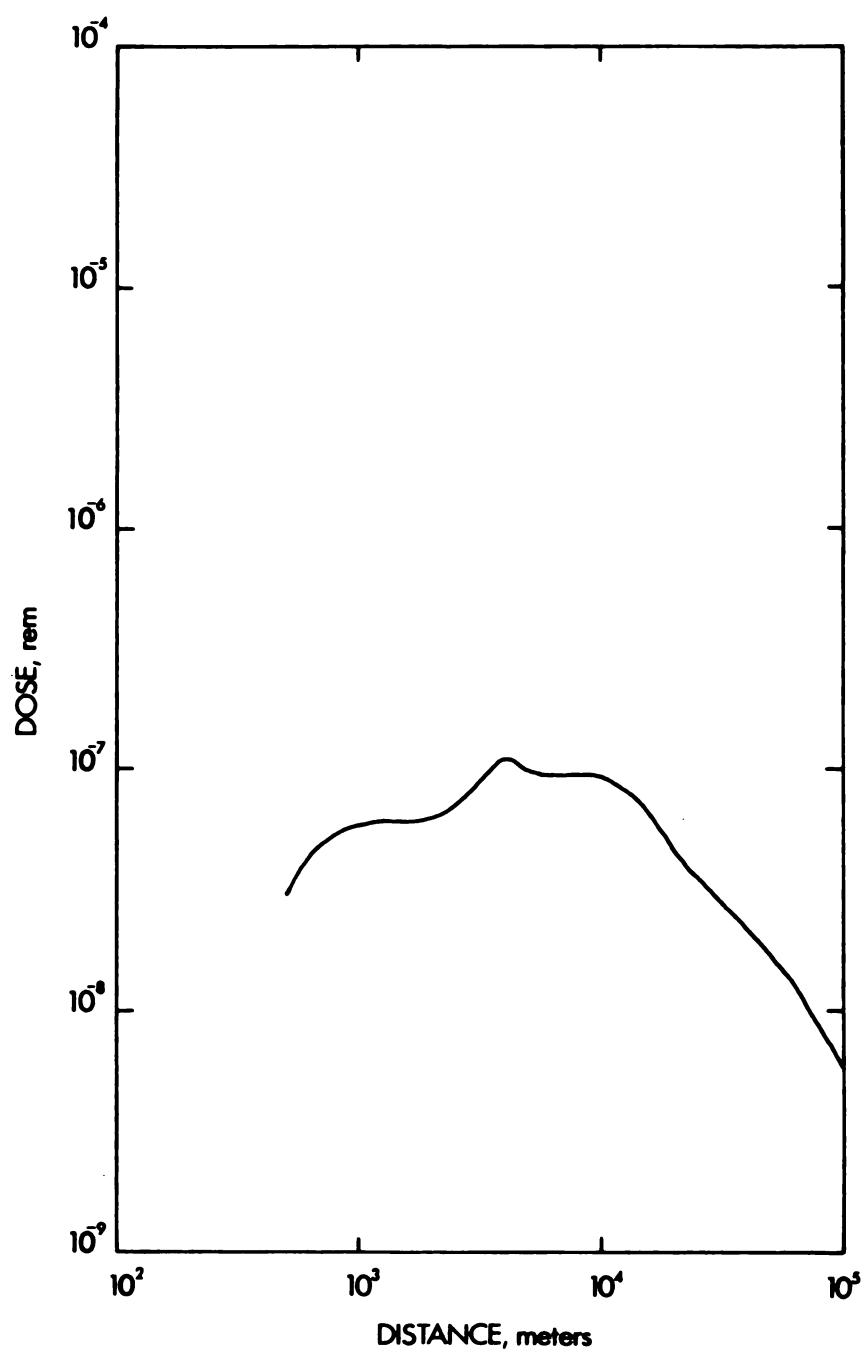


Fig. 5.3. Tornado Damage--50-year Dose to Lungs.

Table 5.1. Predicted Concentrations of Radionuclides in the Tailings Solution

| Radionuclide | Concentration,<br>$\mu\text{Ci/mL}$ | Maximum Permissible<br>Concentration in<br>Unrestricted Areas, <sup>13</sup><br>$\mu\text{Ci/mL}$ |
|--------------|-------------------------------------|---------------------------------------------------------------------------------------------------|
| U-238        | $6.7 \times 10^{-6}$                | $4 \times 10^{-5}$                                                                                |
| U-234        | $6.7 \times 10^{-6}$                | $3 \times 10^{-5}$                                                                                |
| Th-230       | $1.9 \times 10^{-4}$                | $2 \times 10^{-6}$                                                                                |
| Ra-226       | $5.0 \times 10^{-7}$                | $3 \times 10^{-8}$                                                                                |
| Pb-210       | $5 \times 10^{-7}$                  | $1.0 \times 10^{-7}$                                                                              |
| Po-210       | $5 \times 10^{-7}$                  | $7 \times 10^{-7}$                                                                                |
| Bi-210       | $5 \times 10^{-7}$                  | $4 \times 10^{-5}$                                                                                |

liquids and solids in conventional tailings impoundments. Thus, although it is not possible to predict the probability of an evaporation pond dam failure specific to the Morton Ranch site, historical data can be used to infer the likelihood and consequences of an evaporation pond release. Table 5.2 summarizes incidents recorded by the NRC (AEC) for 1959 through 1977.

From these historical data, the average release from tailings dam failure or flooding was approximately  $1.4 \times 10^7$  L ( $3.7 \times 10^6$  gal) of liquids and  $1.6 \times 10^7$  kg ( $3.5 \times 10^7$  lb) of solids. Ten of the 15 releases for which data are available reached the watercourse, and nine of the 15 involved dam failure or flooding. Thus, considering the 394 mill-years of operation in the period, handling a nominal 423,000 tons of ore, per year, the likelihood of release from the evaporation pond to the watercourse is roughly estimated to be  $1-2 \times 10^{-2}$  per plant-year. This is a conservative estimate, because new mills are required to conform to strict new construction standards<sup>17</sup> which include criteria for embankment stability, safety factors, seismic evaluations, and flood protection. In addition, an independent analysis of the dam will be performed prior to the issuance of a license to ensure that its design and construction meet these criteria. Thus, the staff believes that a failure of this dam would be highly improbable.

In a letter<sup>14</sup> to the NRC dated 13 January 1978, the applicant stated that the evaporation pond would be used as a surge pond to receive tailings solids, as well as liquids, during an emergency [e.g., freezing of slurry lines in winter]. No data are available from which to estimate the amount of solid tailings that would be present in the evaporation pond at any period during its operational use, but the staff believes that this amount would be very small compared to an amount that would be in a conventional impoundment. While the staff believes that the estimated potential for dam failure of Option L would not be significantly affected if a small quantity of solids were to be present in the evaporation pond, the impacts could be greater. As discussed elsewhere, tailings solids are more radioactive than tailings liquids, and some solids would be likely to be carried with the tailings liquids during an evaporation pond dam failure. Thus, some portion of the solids would be deposited on the land, or could eventually enter a watercourse. The degree of potential impact would depend on the amount of solids released. Mitigation of the impact could be achieved by removing the solids from the area of the spill and transporting them to the pits for disposal.

#### Open-Pit Mine Release

Because there is little experience with the method of open-pit disposal of tailings, the consideration of accidents with this method must necessarily be speculative. There are uncertainties in both the potential numbers, locations, and lengths of the slurry lines from the mill to the mined-out pits and in the decant lines from the pits to the evaporation pond. Uncertainties also exist in the schedules for filling the pits and the timing required for reclamation of the land once the pits have been filled.

No potential for retention-system failure similar to that of a dam failure is believed to exist for the storage of tailings in open-pit mines. Although the plan is to minimize the amount of liquid maintained in the pits, failure of the clay liner would undoubtedly result in a potential for groundwater intrusion. However, if sufficient thicknesses of clay are suitably compacted on the pit walls and bottoms, to ensure stability, failure of the liner is not very likely. The impact on groundwater from seepage of tailings solution from an open-pit disposal site is discussed

Table 5.2. Summary of Accidental Tailings Slurry Releases, 1959-1977<sup>a</sup>

| Cause                | Solids Released, lb (kg)                                                  | Liquids Released, gal (L)                                    | Reached Watercourse |
|----------------------|---------------------------------------------------------------------------|--------------------------------------------------------------|---------------------|
| Flash flood          | $3 \times 10^7$ ( $14 \times 10^6$ )                                      | $3 \times 10^6$ ( $1.2 \times 10^7$ ) <sup>b</sup>           | Yes                 |
| Dam failure          | $2 \times 10^6$ ( $9 \times 10^5$ ) <sup>b</sup>                          | $2 \times 10^5$ ( $9.1 \times 10^5$ )                        | Yes                 |
| Dam failure          | $1 \times 10^6$ ( $5 \times 10^5$ )                                       | $1 \times 10^5$ ( $4 \times 10^5$ ) <sup>b</sup>             | No                  |
| Dam failure          | $4 \times 10^5$ ( $2 \times 10^5$ )                                       | $5 \times 10^4$ ( $2 \times 10^5$ ) <sup>b</sup>             | Yes                 |
| Pipeline failure     | $7 \times 10^5$ ( $3 \times 10^5$ )                                       | $5 \times 10^4$ ( $2 \times 10^5$ )                          | Yes                 |
| Flooding             | $2 \times 10^8$ ( $1 \times 10^8$ ) <sup>b</sup>                          | $2 \times 10^7$ ( $8.7 \times 10^7$ )                        | Yes                 |
| Pipeline failure     | $1 \times 10^5$ ( $6.4 \times 10^4$ ) <sup>b</sup>                        | $2 \times 10^4$ ( $6.1 \times 10^4$ )                        | Small amount        |
| Pipeline failure     | $4 \times 10^6$ ( $2 \times 10^6$ ) <sup>b</sup>                          | $4 \times 10^5$ ( $1.7 \times 10^6$ )                        | Yes                 |
| Dam failure          | $2 \times 10^6$ - $3 \times 10^7$ ( $1$ - $14 \times 10^6$ ) <sup>b</sup> | $3 \times 10^5$ - $3 \times 10^6$ ( $1$ - $11 \times 10^6$ ) | Yes                 |
| Pipeline failure     | $2 \times 10^5$ ( $1 \times 10^5$ ) <sup>b</sup>                          | $3 \times 10^4$ ( $1.3 \times 10^5$ )                        | Yes                 |
| Dam failure          | $2 \times 10^4$ ( $9 \times 10^3$ ) <sup>b</sup>                          | $2 \times 10^3$ ( $8 \times 10^3$ )                          | No                  |
| Pipeline/dam failure | No quantitative information                                               |                                                              | No                  |
| Pipeline failure     | $1 \times 10^8$ ( $4.5 \times 10^7$ )                                     | $2$ - $8 \times 10^6$ ( $8$ - $30 \times 10^6$ )             | No                  |
| Dam failure          | $1.8 \times 10^7$ ( $8.2 \times 10^6$ ) <sup>c</sup>                      | $2 \times 10^6$ ( $7.6 \times 10^6$ )                        | No                  |
| Pipeline failure     | $2.5 \times 10^3$ ( $1.1 \times 10^3$ )                                   | $4 \times 10^3$ ( $1.5 \times 10^4$ )                        | Yes <sup>d</sup>    |

<sup>a</sup>From: "Environmental Survey of the Uranium Fuel Cycle," WASH-1248, U. S. Atomic Energy Commission, Fuels and Materials, Directorate of Licensing, April 1974. Updated through 1977 by the staff.

<sup>b</sup>Assuming equal weights of solids and liquids released, and density of the liquids to be approximately 1.1 kg/L (2.4 lb/gal).

<sup>c</sup>Assuming equal weights of solids and liquids released, and density of the liquids to be approximately 4 kg/L (9 lb/gal).

<sup>d</sup>Approximately 80% of solids and 20% of liquids.

in Section 4.3 and Appendix E. Even though each pit (see Fig. 3.7) could hold in excess of  $7 \times 10^5$  m<sup>3</sup> when empty and unlined and the applicant will maintain diversion ditches to assure that drainage will be directed away from the pits, flooding still remains a possibility. Based on the maintaining of 2.4 m (8 ft) of freeboard, there will be  $9.6 \times 10^4$  m<sup>3</sup> ( $1.3 \times 10^5$  yd<sup>3</sup>) of emergency storage in the smallest pit when full. In the event of the PMF of  $7 \times 10^5$  m<sup>3</sup> ( $9.2 \times 10^5$  yd<sup>3</sup>), it is therefore conceivable that flooding of the pits could occur if they were filled to near capacity at the time of such a flood. The quantity of release and the extent of ground contamination is difficult to predict since it would depend to a great extent on the area of filled and unreclaimed pits.

Failures in the tailings-distribution system from the mill to the open pits could result in the release of the slurry to the environment. From the historical data cited in Table 5.2, the average release to the watercourse from piping failures has been approximately  $3.5 \times 10^6$  L ( $9.2 \times 10^5$  gal) of liquids and  $8.2 \times 10^6$  kg ( $1.8 \times 10^7$  lb) of solids, roughly a factor of 30 lower than the average quantities released from conventional tailings-impoundment failures. The historical frequency of release from pipeline failures, roughly  $1.0 \times 10^{-2}$  per plant-year, is also lower than that of impoundment failures.

However, the likelihood of pipeline failure may be significantly higher for Option L than slurry systems at some other mills that comprise the data base simply because of the distances involved and the effects of local topography, necessitating the use of pumps. Considering the probable total length of piping from the mill to the open pits, recycle lines to the mill circuit, and decant lines to the evaporation ponds, a rough estimate of the likelihood of tailings-distribution pipeline failure is approximately 0.15 to 0.3 per plant-year.

For accidental releases of tailings slurry from pipeline failures, the slurry is likely to find its way to the local drainage provided by the south fork of Box Creek. The extent of the area covered by solid tailings would depend on the details of the failure, and is difficult to assess. Scaling from previous estimates<sup>18</sup> on the basis of the total mass of tailings, the estimated  $6 \times 10^5$  kg ( $1.3 \times 10^6$  lb) of solid tailings released may be assumed to follow the Box Creek channel for approximately 700 m (2252 ft), covering a width of approximately 40 m (128 ft), and forming a wedge of 1.4 cm (0.5 inch) in average thickness.

The main radiological concern associated with the deposition of the solid tailings is the small increase in background radiation levels in the affected and adjacent areas, and the eventual transport of these low levels of contamination by wind and rain. These long-term effects may be prevented by removing the contaminated material from the environment. Accordingly a measure of the impact associated with the release of the solid tailings from the mill area is the estimated cost of excavating, removal of the tailings and contaminated soil, and transporting the material back to the tailings disposal site. Estimates of a similar operation have been made in connection with the Vitro mill.<sup>19</sup> Assuming that 15 cm (6 inches) of contaminated soil would have to be removed along with the tailings, the estimated total cost for excavation, removal of tailings and contaminated soil, and truck transport of the material back to the tailings-disposal site is approximately \$10,500.

The fate of the tailings solution released either from the evaporation pond or from a pipeline failure would depend on the flow of the intermittent streams comprising the drainage basin. As these streams are dry most of the year, the solution would most likely seep into the moderately permeable soils comprising the creek beds. The liquid would tend to move downward through the soil profile to the bedrock; part of the acidity of the tailings solution would be neutralized by the calcareous nature of the soils, but there would still be substantial leaching of organic matter and cations from the surface horizons. Subsequent revegetation of the affected areas would be slow, and would require ameliorative procedures such as additions of lime, organic matter, and fertilizers. Even if the accident were to occur in the spring of the year when there may be flow in Box Creek, Lightning Creek, and Lance Creek, it is highly unlikely that the effluent would find its way to the Cheyenne River, almost 200 km (124 miles) downstream from the south fork of Box Creek.

## 5.2 NONRADIOLOGICAL ACCIDENTS

The potential for environmental effects from accidents involving nonradiological materials at the Morton Ranch site is small. Failure of the boiler supplying process steam to the acid-leach process could release low-pressure steam to the room, possibly causing injuries to workers, but not involving 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, but would have a negligible effect on the environment.

The only chemical that might seriously affect the environment is ammonia. It is possible that the line carrying ammonia to the storage tank from the tank truck could be ruptured, in which case the release rate would be limited to 100 g/sec (400 L/sec) of ammonia vapor. Assuming that the release could not be terminated, the resulting concentrations of ammonia as a function of distance from the mill are given in Figure 5.4. Beyond 4 km (2.4 mile) the resulting concentration is below the 600  $\mu\text{g}/\text{m}^3$  short-term air quality standard derived from State of Colorado regulations (at 1/30 threshold limit values).<sup>20</sup> Within 300 m (980 ft) from the tank, ammonia concentrations would be less than the 40,000  $\mu\text{g}/\text{m}^3$  needed to produce a detectable odor and the 69,000  $\mu\text{g}/\text{m}^3$  recommended limit for prolonged human exposure.<sup>21</sup> Thus, the released ammonia would not be noticed by offsite residents and would pose no health risk in the environment.

On the other hand, workers at the mill within a radius of 50 m (164 ft) from the ruptured line could be exposed to an ammonia concentration in excess of 10<sup>6</sup>  $\mu\text{g}/\text{m}^3$ . At these levels, there exists a risk of suffocation due to tracheal spasm or, for individuals with myocardial disease, of heart attack. Following the initial detection of a strong ammonia odor (at  $\sim 40,000$   $\mu\text{g}/\text{m}^3$ ), however, most healthy individuals should be able to escape the area, possibly suffering some permanent damage to the pulmonary or ocular tissues.

## 5.3 TRANSPORTATION ACCIDENTS

Transportation of materials to and from the mill can be divided into three categories: 1) shipments of ore to the mill, 2) shipments of refined yellowcake 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.

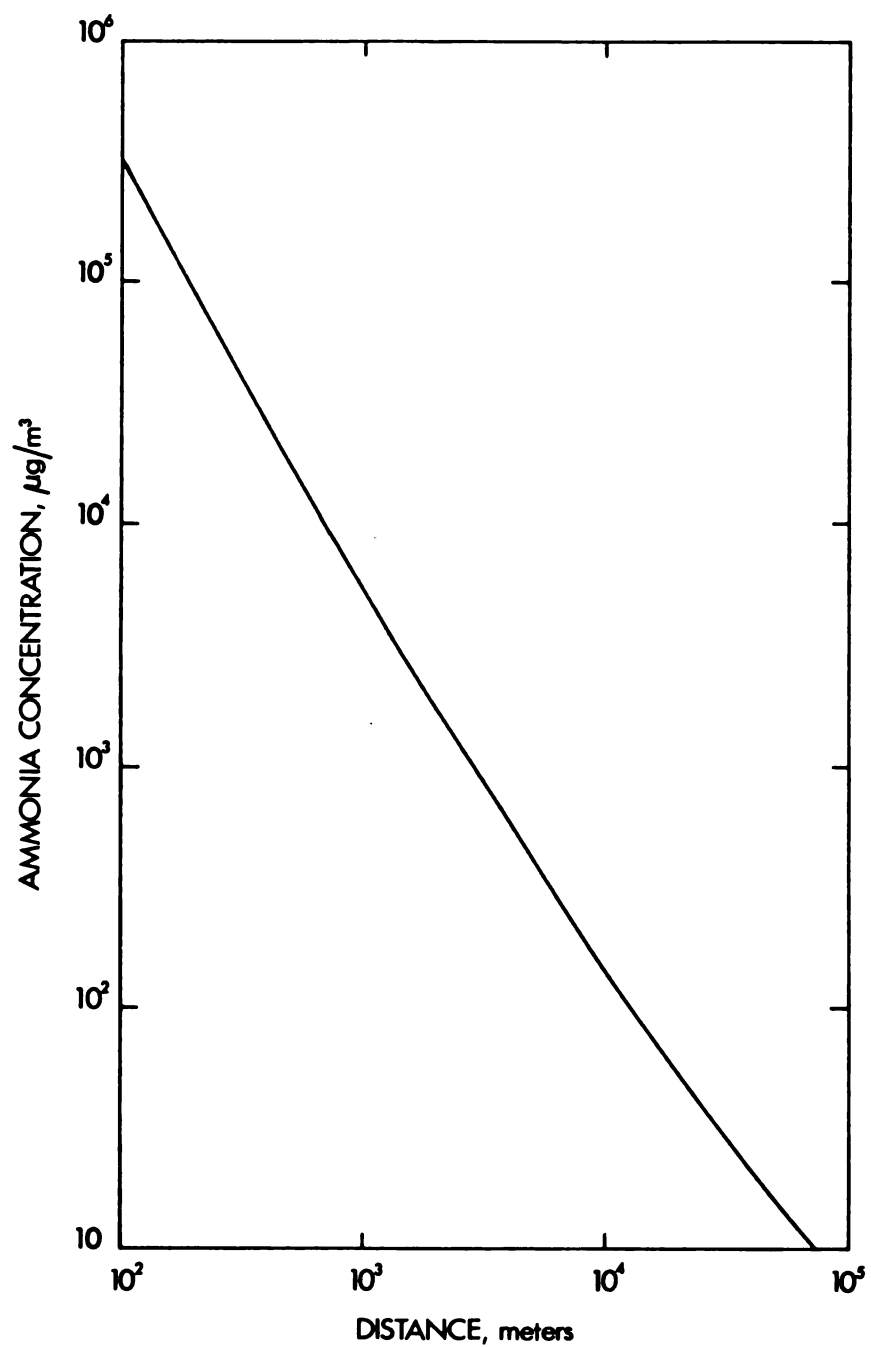


Fig. 5.4. Toxic Chemical Plant Failure--Ammonia Release.

### 5.3.1 Shipments of Yellowcake

Refined yellowcake product is generally packaged in 55-gallon (208 L), 18-gauge drums holding an average of 364 kg (800 lb) and classified by the Department of Transportation (DOT) as Type A packaging (49 CFR Parts 171-189 and 10 CFR Part 71). It is shipped by truck an average of 2100 km (1300 miles) to a conversion plant, which transforms the yellowcake to uranium hexafluoride for the enrichment step of the light water-cooled reactor fuel cycle. An average truck shipment contains approximately 45 drums, or 16 MT (17.5 tons) of yellowcake. Based on the Morton Ranch mill's predicted annual yellowcake yield of 418 MT (460 tons) approximately 26 such shipments are required annually.

From published accident statistics,<sup>22,23</sup> the probability of a truck accident is in the range of  $1.0$  to  $1.6 \times 10^{-6}/\text{km}$  ( $1.6$  to  $2.6 \times 10^{-6}/\text{mile}$ ). Truck accident statistics include three categories of traffic accidents: collisions, noncollisions, and other events. 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 and 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 yellowcake from the mill being involved in an accident of any type during a one-year period is approximately 0.07.

The ability of the materials and structures in the shipping package to resist the combined physical forces arising from impact, puncture, crush, 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 classifies accidents into eight categories, depending upon the combined stresses of impact, puncture, crush and fire. 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 5.3.<sup>24</sup> In order to assess the risk of a transportation accident, it is necessary to know the fraction of radioactive material that is released when involved in an accident of a given severity. Two models are postulated for this analysis, and the fractional releases for each model are shown in Columns 3 and 4 of Table 5.3.<sup>24</sup> 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 5.3. 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, LSA & Type A | Model II, LSA & Type A |
|----------------------------|-----------------------------------|-----------------------|------------------------|
| 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                        | $8.5 \times 10^{-5}$              | 1.0                   | 1.0                    |
| VIII                       | $1.5 \times 10^{-5}$              | 1.0                   | 1.0                    |

For Model I and Model II, the quantity of yellowcake released to the atmosphere in the event of a truck accident is estimated to be about 7400 kg (16,200 lb) and 500 kg (1100 lb), respectively. Most of the yellowcake 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. Battelle has developed expressions for the dispersal of similar material to the environment based on actual laboratory and field measurements over several years.<sup>23</sup> 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:

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

where:

f = the fractional airborne release,  
 u = the wind speed at 15.2 meters (50 ft) expressed in m/sec, and  
 t = the duration of the release, in hours.

In this expression, the first term represents the initial "puff" immediately airborne when the container is failed in an accident. Assuming that the wind speed is 5 m/sec (10 miles/hr), and that 24 hours are available for the release, the environmental release fraction is estimated to be  $9 \times 10^{-3}$ . Assuming insoluble uranium all particles of which are in the respirable size range and a population density of 160 people per square mile characteristic of the eastern United States,<sup>25</sup> the consequences of a truck accident involving a shipment of yellowcake from the mill would be a 50-year dose commitment\* to the general population of approximately 13 and 0.9 man-rem 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 3200 kg (7000 lb) of concentrate on the ground and 2300 kg (5000 lb) in the truck trailer. Thirty-nine of the 50 drums were either destroyed or substantially damaged. Approximately three hours after the accident, the material was covered with plastic to prevent further release to the atmosphere. Were such an accident to occur due to the Morton Ranch project, from the above formula and local mean values of wind speed, for the least windy and most windy months, the release for 3200 kg for a three-hour period would range from 32 kg (70 lb) to 85 kg (190 lb) of  $U_3O_8$ . The consequence of this accident would be a 50-year dose commitment to the general population of 6.3 to 16.6 man-rem 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 from 0.083 to 0.22 man-rem. This can be compared to a 50-year integrated lung dose of 19 man-rem from natural background.

### 5.3.2 Shipments of Ore to the Mill

Ore will be transported a distance of approximately 13 km (8-9 miles) from the underground mines in the northern deposits, and an average distance of approximately 1.3 km (0.8 mile) from the open-pit mines adjacent to the mill. The applicant expects to process equivalent amounts of ore from its northern and southern deposits. Assuming that the average shipment contains 60 MT (66 tons) of ore, approximately 17,000 shipments of ore will be made annually to the mill. Therefore, based upon the probability of a truck accident cited in the previous section, the likelihood of an ore spill is roughly 0.16 per year.

The ore as it comes from the mine contains a significant fraction of moisture and has a lower percentage of fines than ore after it has been crushed. Because of the low specific activity and the ease with which the contaminant can be removed, the radiological impact is not considered to be significant.

### 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 35 shipments of anhydrous ammonia will be made annually in lots of ~19 MT (~21 tons) from Cheyenne, Wyoming, a distance of 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 which is shipped in that form is approximately  $6.9 \times 10^6$  MT ( $7.6 \times 10^6$  tons). It is estimated that about 26% of the shipments are made by truck (with the remainder by rail, pipeline, and barge). Assuming that the average truck shipment is roughly 19 MT (21 tons), approximately 93,000 truck shipments of anhydrous ammonia are made annually. From accident data collected by DOT,<sup>26</sup> 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  $2.7 \times 10^{-6}$  per km ( $4.3 \times 10^{-6}$  per mile). The DOT data also reveal that a release of ammonia [770 kg (1700 lb) on the average] resulted from approximately 80% of the reported incidents, and that an injury to the general public occurred in roughly 15% of the reported incidents involving a release. (Most of the injuries were sustained by the driver.)

On the basis of these data, the probability of an injury to the general public resulting from an average shipment of anhydrous ammonia is roughly  $3 \times 10^{-7}$  per km ( $4.8 \times 10^{-7}$  per mile). This would be expected to be an overestimate for shipments in the vicinity of the Morton Ranch mill because of the relatively low population density. Nevertheless, accepting this estimate, the likelihood of an injury to the general public resulting from shipments of ammonia to the mill is predicted to be roughly  $3 \times 10^{-3}$  per year.

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\*The DOT accident statistics are extrapolated from the number of shippers reporting, estimated to constitute approximately 10% of the total number of shippers.

References for Section 5

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## 6. MONITORING PROGRAMS

### 6.1 AIR QUALITY

Temperature, wind speed, and wind direction have been intermittently monitored at the proposed mill site since 24 August 1975 and continuously monitored since April 1978; these data will continue to be collected throughout the life of the mill. Air samples have been taken twice since 1975 and analyzed for suspended particulates.

In the applicant's current operational monitoring program, ambient air samples will be taken continuously and analyzed for particulate concentration. A monitoring program for airborne radioactive mill effluents is presented in Table 6.3.

### 6.2 LAND USE

#### 6.2.1 Reclamation

Surety arrangements with the Wyoming Department of Environmental Quality are reviewed annually to ensure that sufficient funds are available for mill decommissioning and tailings stabilization and reclamation.

#### 6.2.2 Historical and Archeological Resources

An archeological survey of the site has been conducted by the state (Sec. 2.5.2.2). The applicant is committed to immediately notify the State of Wyoming if archeological artifacts are discovered during construction of the mill facility. The applicant will be required to have an archeological survey performed prior to disturbing any previously unsurveyed areas.

### 6.3 WATER

A water quality monitoring program for both surface water and groundwater at the mill site was initiated by the applicant in the summer of 1975 (FES-TVA, p. 5.2-4). The results are summarized in Appendix C. Additional water monitoring is being performed by the applicant (Sec. 6.6.1). The applicant's operational radiological monitoring program will include the water monitoring requirements presented in Section 6.6.2.

### 6.4 SOILS

The soils will be tested for stability, fertility, and the presence of toxic materials (ER App. VI, pp. A-26, A-36). The applicant will be required to take whatever steps are necessary to assure that the soils will be stable and of adequate fertility. No toxic materials were disclosed in preoperational analyses of core samples of topsoil, subsoil, or overburden. Throughout the life of the project, annual reports will be filed with the State of Wyoming, Department of Environmental Quality, describing the progress in backfilling, contouring, and soil replacement (ER App. VI, p. A-35).

The applicant will also monitor soils for radioactivity for the life of the project. Requirements for preoperational and operational radiological soil monitoring are given in Section 6.6.

## 6.5 BIOTA

### 6.5.1 Terrestrial

#### 6.5.1.1 Vegetation

The revegetation program (see Sec. 10.4.5) will be monitored for stability and self-sustaining ability, composition, productivity, uses by native fauna, and climatic effects (ER App. VI, p. A-36). Test plots (about 1.5 m × 1.5 m, or 5 ft × 5 ft) will be established in both reclaimed and undisturbed areas. Annual production in these test plots will be compared on a weight basis (ER Suppl. II, response to Q. 27). Throughout the life of the project, annual reports will be filed with the State of Wyoming, Department of Environmental Quality, describing the revegetation progress (ER App. VI, p. A-35).

The applicant will also monitor vegetation (forage) adjacent to the mill and tailings area for radioactivity for the life of the project (Tables 6.2 and 6.3) to verify the prediction that there will be no radiation hazard through ingestion.

#### 6.5.1.2 Wildlife

The uses made by native fauna of reclaimed areas will be monitored by the applicant (ER App. VI, p. A-36) to verify that the proposed reclamation techniques are effective. No other animal sampling is planned, unless vegetation samples show levels of radiation contamination in excess of federal and state limits, or some other adverse effect is noted (ER, p. 6-11; ER Suppl. II, response to Q. 26).

### 6.5.2 Aquatic

No aquatic monitoring program has been proposed or is required.

## 6.6 RADIOLOGICAL

### 6.6.1 Preapplication Environmental Radiological Monitoring Programs and Studies

A preapplication/preoperational monitoring program--outlined in the applicant's Environmental Report and in the TVA's Final Environmental Statement on Morton Ranch mining--has been established to collect data on ambient background concentrations of radionuclides in the Morton Ranch mill region. The program is outlined in Table 6.1. Sampling sites are shown in Figure 6.1.

Table 6.1. Summary of Preapplication Sampling and Monitoring Programs<sup>a</sup>

| Medium                   | No. of Samples | Parameters Monitored                             |
|--------------------------|----------------|--------------------------------------------------|
| Surface water            | 14             | Unat, Th-230, Ra-226, gross αβ                   |
| Groundwater              | 16             | Unat, Th-230, Ra-226, gross αβ                   |
| Air                      | 2              | Unat, Th-230, Ra-226, particulate concentrations |
| Soils                    | 4              | Unat, Th-230, Ra-226, gross αβ                   |
| Vegetation               | 4              | Unat, Th-230, Ra-226, gross αβγ                  |
| External gamma radiation | 20             | External γ radiation                             |

<sup>a</sup>Sampling locations are given in Figure 6.1.

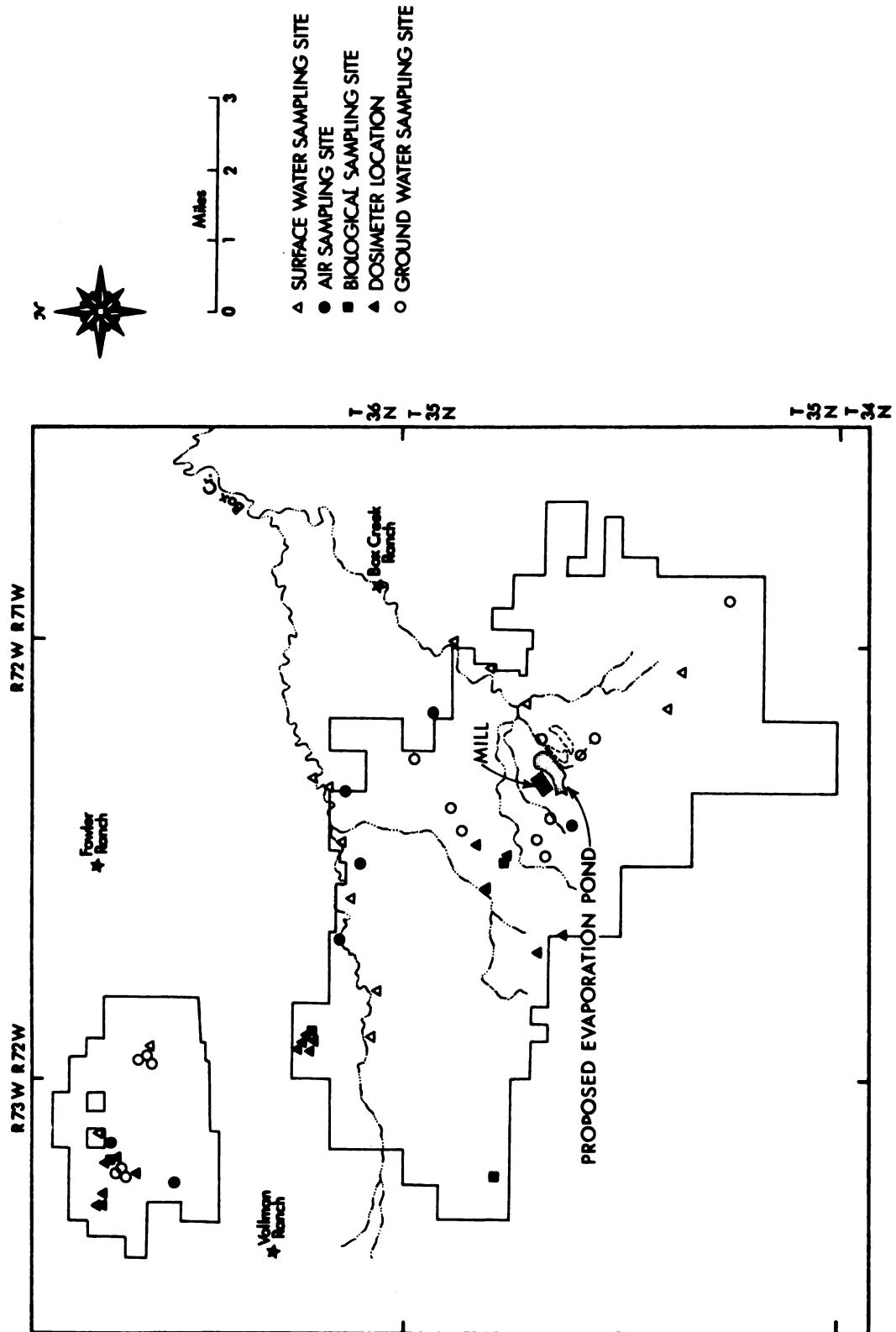


Fig. 6.1. Preoperational (pre-application) Radiological Sampling Sites.

The applicant reports<sup>1</sup> the following ranges of background radionuclide particulate concentrations in air in the vicinity of the mill site for samples taken throughout 1977 and part of 1978:  $1.4 \times 10^{-5}$  pCi/m<sup>3</sup> to  $1.8 \times 10^{-3}$  pCi/m<sup>3</sup> of U<sub>nat</sub> and  $2.4 \times 10^{-5}$  pCi/m<sup>3</sup> to  $1.7 \times 10^{-2}$  pCi/m<sup>3</sup> of Ra-226. The average concentrations of these samples was  $4.1 \times 10^{-4}$  pCi/m<sup>3</sup> of U<sub>nat</sub> and  $1.8 \times 10^{-4}$  pCi/m<sup>3</sup> of Ra-226. These average concentrations are close to reported national averages of these radionuclides in air (Sec. 2.10). Additional data presented in the applicant's environmental report (p. 2-84) shows higher concentrations; however, those samples were taken in the vicinity of an operating mill. Additional particulate monitoring is currently being performed as part of the applicant's preoperational monitoring program, Table 6.2.

For the first three months of their preoperational monitoring program (Table 6.2), the applicant reports<sup>2</sup> radon concentrations ranging from .03 pCi/L to 2.94 pCi/L with the mean value being 0.6 pCi/L. This mean value is within the range of expected background concentrations in mineralized regions such as the Powder River Basin (Sec. 2.10). Higher radon concentrations were reported in the applicant's ER (pp. 2-85, 2-87), but the staff does not believe them to be representative of background. Additional radon monitoring is currently being performed as part of the applicant's preoperational monitoring program, Table 6.2.

Surface and groundwater have been tested for U<sub>nat</sub>, Th-230, Ra-226; and data is presented in Table C.2. The applicant has added a barium chloride treatment system to their mine dewatering system because this water if untreated may exceed NPDES limitations. Groundwater samples contained levels of uranium ranging up to 50 mg/L. Two samples showed greater than one mg/L U<sub>nat</sub> (App. C, Table C.2). Five samples tested had levels greater than three pCi/L of Ra-226, the NPDES license limit for that radionuclide; all contained less than 30 pCi/L Ra-226, the 10 CFR 20 maximum concentration for discharge to uncontrolled areas. All samples had Th-230 concentrations below the 10 CFR 20 release limit of 2000 pCi/L (ER, p. 2-96). Additional surface and groundwater monitoring is currently being performed as part of the applicant's preoperational monitoring program, Table 6.2.

Soil has been sampled and tested for U<sub>nat</sub>, Th-230, and Ra-226 (ER, Table 2.9-6 and Ref. 1). U<sub>nat</sub> soil concentrations ranged from 0.03 pCi/g to 3.1 pCi/g and averaged 1.2 pCi/g. Th-230 soil concentrations ranged from 0.06 pCi/g to 3.6 pCi/g and averaged 1.2 pCi/g. Ra-226 soil concentrations ranged from 0.4 pCi/g to 2.7 pCi/g and averaged 1.2 pCi/g. The Th-230 and Ra-226 concentrations are consistent with a regional background level of one pCi/g as indicated in Section 2.10. Additional soil sampling and analysis is currently being performed as part of the applicant's preoperational monitoring program, Table 6.2.

The staff believes that additional preoperational radiological environmental monitoring is needed to provide baseline data on background radionuclide concentrations and radiation dose rates at the mill site and environs. These data are needed in assessing the radiological impacts of the future milling operations and as baseline data for reference at the time of site decommissioning. The applicant's program for accomplishing this is presented in Table 6.2. At least 12 months' data will be collected prior to plant start-up.

#### 6.6.2 Operational Radiological Monitoring Program

A radiological environmental monitoring program, as proposed by the applicant and modified as necessary by the staff, will continue throughout all phases of operations. The monitoring program that will be required is summarized in Table 6.3. The sampling frequency and the number of sampling locations may be changed in the future when necessitated by changing environmental and demographic patterns, subject to approval by the NRC.

Table 6.2. Preoperational Radiological Monitoring Program for Uranium Mills

| Type of Sample       | Sample Collection   |                                                                                                                                                                                                                                                                                                      |                                                                             | Sample Measurement                                                  |                                        |                                                                      |
|----------------------|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|---------------------------------------------------------------------|----------------------------------------|----------------------------------------------------------------------|
|                      | Number              | Location                                                                                                                                                                                                                                                                                             | Type                                                                        | Frequency                                                           | Frequency                              | Type of Measurement                                                  |
| AIR<br>Particulates  | Four<br>Hi Vol      | At or near the site boundaries in different sectors that will have the highest predicted airborne radionuclide concentrations during milling operations.                                                                                                                                             | Continuous for 24 hours                                                     | One every sixth day                                                 | Quarterly composites of weekly samples | Particulates (total suspended)<br>Unat, Ra-226,<br>Th-230, Pb-210    |
|                      | One<br>Low Vol      | At a control or background location remote from site, 10-20 km SE or SSE from the tailing deposition point.                                                                                                                                                                                          | Continuous <sup>a</sup>                                                     | Weekly filter change or more frequently as required by dust loading | Quarterly composites of weekly samples | Particulates (total suspended)<br>Unat, Ra-226,<br>Th-230, Pb-210    |
|                      | One<br>Low Vol      | At or close to the nearest <sup>c</sup> residence(s) or occupied offsite structure(s) (if within 10 km of site).                                                                                                                                                                                     | Continuous <sup>a</sup>                                                     | Weekly filter change or more frequently as required by dust loading | Quarterly composites of weekly samples | Particulates (total suspended)<br>Unat, Ra-226,<br>Th-230, Pb-210    |
|                      | Six                 | Same locations as four Hi Vol and two Low Vol air particulate sites.                                                                                                                                                                                                                                 | Continuous for one week/month representing about the same period each month | Samples collected for 48-hr intervals                               | Each 48-hr sample                      | Rn-222                                                               |
| WATER<br>Groundwater | One <sup>c</sup>    | Applicant's site drinking water                                                                                                                                                                                                                                                                      | Grab                                                                        | Quarterly                                                           | Quarterly                              | Suspended and dissolved Unat, Ra-226, Th-230, chemicals <sup>d</sup> |
|                      | Eleven <sup>c</sup> | Wells located around future solution pond and tailings. Three wells hydrologically up-graded of all disturbed areas, four wells downgradient of tailings disposal site and up-gradient of tailings effluent pond, three wells downgradient of tailings effluent pond, one well in Box Creek alluvium | Grab                                                                        | Quarterly                                                           | Quarterly                              | Suspended and dissolved Unat, Ra-226, Th-230, chemicals <sup>d</sup> |
|                      |                     |                                                                                                                                                                                                                                                                                                      |                                                                             | Semiannually                                                        | Semiannually                           | Suspended and dissolved Pb-210, Po-210                               |
|                      |                     |                                                                                                                                                                                                                                                                                                      |                                                                             | Quarterly                                                           | Quarterly                              | Dissolved Unat, Ra-226, Th-230, chemicals <sup>d</sup>               |
|                      |                     |                                                                                                                                                                                                                                                                                                      |                                                                             | Semiannually                                                        | Semiannually                           | Dissolved Pb-210, Po-210                                             |
|                      | Three <sup>c</sup>  | Wells within 2 km of tailings disposal area which are or could be used for potable supplies, watering of livestock, or crop irrigation                                                                                                                                                               | Grab                                                                        | Quarterly                                                           | Quarterly                              | Suspended and dissolved Unat, Ra-226, Th-230, chemicals <sup>d</sup> |
|                      |                     |                                                                                                                                                                                                                                                                                                      |                                                                             | Semiannually                                                        | Semiannually                           | Suspended and dissolved Pb-210, Po-210                               |

Table 6.2. Continued

| Type of Sample                              | Number            | Sample Collection                                                                                                                                                       |                 | Sample Measurement                                                 |                                                                                |
|---------------------------------------------|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------------------------------------------------------|--------------------------------------------------------------------------------|
|                                             |                   | Location                                                                                                                                                                | Type            | Frequency                                                          | Type of Measurement                                                            |
| WATER (cont.)<br>Surface water <sup>d</sup> | Three             | Drainage system downstream of mill and tailings area                                                                                                                    | Grab            | Quarterly following precipitation event                            | Suspended and dissolved Unat, Ra-226, Th-230, Pb-210, Po-210, suspended solids |
|                                             | Two               | Drainage system upstream of mill and tailings area                                                                                                                      | Grab            | Quarterly following precipitation event                            | Same as above                                                                  |
|                                             | One               | Mill water impoundment                                                                                                                                                  | Grab            | Quarterly                                                          | Suspended and dissolved Unat, Ra-226, Th-230                                   |
| VEGETATION<br>(Forage)                      | Four              | Grazing areas near the site same as Hi Vol air samplers                                                                                                                 | Grab            | Semiannually                                                       | Suspended and dissolved Pb-210 and Po-210                                      |
|                                             | 2 cows<br>1 sheep | Livestock raised within 5 km of mill site                                                                                                                               | Grab            | Three times during grazing season                                  | Unat, Ra-226, Th-230, Pb-210, Po-210                                           |
| SITE SURVEY<br>Gamma Dose-rate              | 81                | 150-m intervals to a distance of 1500 m in each of eight directions from center of milling area or at a point equidistant from milling area and tailings disposal area. | Gamma dose-rate | Time of harvest or slaughter                                       | Unat, Ra-226 and Th-230, Pb-210, Po-210                                        |
|                                             | Ten               | 150-m intervals in both horizontal and vertical traverses across milling area.                                                                                          | Gamma dose-rate | Once prior to site construction                                    | Pressurized ionization chamber (PIC)                                           |
|                                             | Six               | At same locations as used for collection of particulate samples.                                                                                                        | Gamma dose-rate | Once following excavation, leveling, or contouring of milling area | PIC                                                                            |

Table 6.2. Continued

| Type of Sample                        | Sample Collection               |                                                                                                                                                                                                                                   |      | Sample Measurement                                                                 |                                                                            |
|---------------------------------------|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
|                                       | Number                          | Location                                                                                                                                                                                                                          | Type | Frequency                                                                          | Type of Measurement                                                        |
| Surface Soil <sup>f</sup>             | 41                              | 300-m intervals to a distance of 1500 m in each of eight directions from center of milling area or at a point equidistant from milling area and tailings disposal area.                                                           | Grab | Once prior to site construction                                                    | Once<br>All samples for Ra-226, 10% of samples Unat, Th-230, and Pb-210    |
|                                       | Seven                           | 300-m intervals in both a horizontal and vertical traverse across the milling area.                                                                                                                                               | Grab | Once following excavation, leveling or contouring of milling area                  | Once<br>Ra-226 (all samples), Unat, Th-230, and Pb-210 (one sample)        |
|                                       | Six                             | At same locations as used for collection of air particulate samples.                                                                                                                                                              | Grab | Once prior to site construction                                                    | Once<br>Unat, Ra-226, Th-230, and Pb-210                                   |
|                                       | Five                            | At center reference location and at distances of 750 m in each of four directions.                                                                                                                                                | Grab | Once prior to site construction                                                    | Once<br>Ra-226 (all samples), Unat, Th-230 and Pb-210 (one set of samples) |
| Sub-surface Soil Profile <sup>g</sup> | One                             | At center of mill building area.                                                                                                                                                                                                  | Grab | Once following excavation, leveling or contouring                                  | Once<br>Unat, Ra-226, Th-230, and Pb-210                                   |
|                                       | Two from each stream            | Up and downstream of surface waters passing through site; or from offsite surface waters which may be subject to direct runoff from potentially contaminated areas, or which could be affected by a tailings impoundment failure. | Grab | Once following spring runoff and late summer following period of extended low flow | Twice<br>Unat, Ra-226, Th-230, and Pb-210                                  |
| Sediment <sup>h</sup>                 | One from each water impoundment | Onsite water impoundments (lakes, ponds, etc.), or off-site impoundments which may be subject to direct surface runoff from potentially contaminated areas, or which could be affected by tailings impoundment failure.           | Grab | Once prior to site construction                                                    | Once<br>Unat, Ra-226, Th-230, and Pb-210                                   |

Table 6.2. Continued

| Type of Sample              | Number | Sample Collection                                                                           |                |                                        | Sample Measurement |                     |
|-----------------------------|--------|---------------------------------------------------------------------------------------------|----------------|----------------------------------------|--------------------|---------------------|
|                             |        | Location                                                                                    | Type           | Frequency                              | Frequency          | Type of Measurement |
| Radon-222 Flux <sup>i</sup> | Nine   | At center reference location and at distances of 750 and 1500 m in each of four directions. | 2-3 day period | One sample during each of three months | Each sample        | Radon-222 flux      |

<sup>a</sup>Continuous collection means continuous sampler operation with filter change weekly or as required by dust loading, whichever is more frequent.

<sup>b</sup>Sampling type and frequency refers to continuous collection of a gaseous air sample with samples being changed about every 48 hours for a one-week period. If a continuous monitor is used, then this sampling frequency would not apply.

<sup>c</sup>A total of fifteen wells will be sampled, including ten monitoring wells upgradient and downgradient of tailings disposal site, and four water wells including the potable water supply and possible livestock water sources.

<sup>d</sup>Natural drainage systems (dry washes) which carry surface runoff from the site following a precipitation event will be sampled following the event but at a greater frequency not greater than monthly.

<sup>e</sup>The milling area refers to the area which includes ore storage pads, mill buildings, and other processing areas.

<sup>f</sup>Surface soil samples will be collected to a depth of 5 cm. (See Section V of the Branch Position for references on sampling methodology.)

<sup>g</sup>Subsurface soil profile samples will be collected to a depth of three feet. Samples will be divided into one-foot sections for analysis. (See Section V of the Branch Position for references on sampling methodology.)

<sup>h</sup>Several samples should be collected at each location and composited for a representative sample. (See Section V of the Branch Position for references on sampling methodology.) A total of six sites will be sampled.

<sup>i</sup>Radon exhalation measurements should not be taken during periods when the ground is frozen or covered with ice or snow or following periods of rain. It is recommended that these measurements be taken during normal type weather conditions in a period spring through fall.

<sup>j</sup>Chemical analysis will be determined on sulfates, chlorides, nitrates, arsenic, selenium, iron, total dissolved solids, pH, conductivity.

Table 6.3. Operational Radiological Monitoring Program

| Type of Sample       | Number              | Sample Collection                                                                                                                                       |                                                                             | Sample Measurement                                                  |                                                                                                                        |
|----------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|---------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
|                      |                     | Location                                                                                                                                                | Type                                                                        | Frequency                                                           | Type of Measurement                                                                                                    |
| AIR<br>Particulates  | One                 | One grinder and leach tank stacks                                                                                                                       | Isokinetic or equivalent                                                    | Monthly for first year, quarterly thereafter                        | Same<br>Unat. flow rate, Ra-226, Th-230, Pb-210                                                                        |
|                      | One                 | Yellowcake dryer and packaging stack                                                                                                                    | Isokinetic or equivalent                                                    | Continuous                                                          | Monthly<br>Unat. flow rate                                                                                             |
|                      | One                 | Final product drums                                                                                                                                     | Composite product sample for isotope ratio                                  | Quarterly                                                           | Quarterly<br>Th-230, Ra-226, Pb-210                                                                                    |
|                      | 4 Hi Vol            | At or near the site boundaries in different sectors that will have the highest predicted airborne radionuclide concentrations during milling operations | Continuous for 24 hours                                                     | One every sixth day                                                 | Quarterly composites of weekly samples<br>Particulates (total suspended)<br>Unat. Ra-226, Th-230, Pb-210               |
|                      | 1 Low Vol           | At a control or background location remote from site, 10-20 km SE or SSE from the tailing deposition point                                              | Continuous                                                                  | Weekly filter change or more frequently as required by dust loading | Quarterly composites of weekly samples<br>Particulates (total suspended)<br>Unat. Ra-226, Th-230, Pb-210               |
| Radon Gas            | 1 Low Vol           | At or close to the nearest residence(s) or occupied off-site structure(s) (if within 10 km of site)                                                     | Continuous                                                                  | Weekly filter change or more frequently as required by dust loading | Quarterly composites (total suspended)<br>Unat. Ra-226, Th-230, Pb-210                                                 |
|                      | Six                 | Same locations as for air particulates (above)<br>Four Hi Vol; two Low Vol                                                                              | Continuous for one week/month representing about the same period each month | Samples collected for 48-hr intervals                               | Rn-222                                                                                                                 |
| WATER<br>Groundwater | One                 | Applicant's site drinking water                                                                                                                         | Grab                                                                        | Monthly for first year, quarterly thereafter                        | Quarterly<br>Total<br>Unat. Th-230, Ra-226, Pb-210, chemicals <sup>a</sup>                                             |
|                      | Eleven <sup>b</sup> | Wells located around future solution pond and tailings disposal pits                                                                                    | Grab                                                                        | Monthly for first year, quarterly thereafter                        | Monthly for first year, quarterly thereafter<br>Dissolved Unat. Ra-226- Th-230, Pb-210, Po-210, chemicals <sup>a</sup> |

Table 6.3. Continued

| Type of Sample               | Number                         | Sample Collection                                                                                                                                                                                                        |                 | Sample Measurement                            |                                                                                |
|------------------------------|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------------|--------------------------------------------------------------------------------|
|                              |                                | Location                                                                                                                                                                                                                 | Type            | Frequency                                     | Type of Measurement                                                            |
| WATER (cont.)<br>Groundwater | Eleven <sup>b</sup><br>(cont.) | Three wells hydrologically up-gradient of all disturbed areas, four wells downgradient of tailings impoundment and up-gradient of effluent pond, three downgradient of effluent pond, one well in the Box Creek alluvium |                 |                                               |                                                                                |
|                              | Three <sup>b</sup>             | Wells within 2 km of tailings disposal area which are or could be used for potable water supplies, watering of livestock or crop irrigation                                                                              | Grab            | Quarterly                                     | Total Unat, Ra-226, Th-230, Pb-210, Po-210, chemicals <sup>a</sup>             |
|                              | Three                          | Drainage system downstream of mill and tailings area                                                                                                                                                                     | Grab            | Quarterly following precipitation event       | Dissolved and suspended Unat, Ra-226, Th-230, Pb-210, Po-210, suspended solids |
| SOILS                        | Two                            | Drainage system upstream of mill and tailings area                                                                                                                                                                       | Grab            | Quarterly following precipitation event       | Same as above                                                                  |
|                              | One                            | Mill water impoundment                                                                                                                                                                                                   | Grab            | Quarterly                                     | Same as above                                                                  |
|                              | One                            | Mill effluent impoundment                                                                                                                                                                                                | Grab            | Quarterly                                     | Same as above                                                                  |
| VEGETATION<br>(Forage)       | Six                            | Same as for air particulates                                                                                                                                                                                             | Grab (0-5 cm)   | Annually                                      | Unat, Ra-226, Pb-210                                                           |
|                              | Four                           | Grazing areas near the site Same as Hi Vol air particulate samples                                                                                                                                                       | Grab            | Three times each season during grazing season | Ra-226, Pb-210                                                                 |
|                              | Six                            | At same locations as used for collection of particulate samples                                                                                                                                                          | Gamma dose-rate | Quarterly                                     | Pressured ionization chamber (PIC)                                             |

<sup>a</sup>Chemical parameters to be analyzed will be determined from an analysis of samples taken from the tailings pond once mill operations have begun but will include sulfates, chlorides, nitrates, arsenic, selenium, iron, total dissolved solids, pH, and conductivity.

<sup>b</sup>A total of 15 wells will be sampled, including the applicant's potable water and water possibly used for livestock.

References for Section 6

1. Letter of Plant Superintendent, Wyoming Operations, United Nuclear Corporation, to U. S. Nuclear Regulatory Commission, dated 27 July 1978.
2. Letter of Plant Superintendent, Wyoming Operations, United Nuclear Corporation, to U. S. Nuclear Regulatory Commission, dated 12 December 1978.



## 7. UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

### 7.1 AIR QUALITY

The unavoidable impacts of mill operation on the air quality of the area will be slight. Some increases in suspended particulates will occur, particularly during construction, but the resulting impact on the air quality of the surrounding region will be minor, and will drop to and remain at a low level during the operating lifetime of the plant. The anticipated small chemical emissions will have a negligible impact on air quality.

### 7.2 LAND USE

#### 7.2.1 Topography

Destruction and alteration of some of the natural features and drainage channels in the project area cannot be avoided. Duplication of the exact shape and contours of the present topography of the area during reclamation is not possible. Unavoidable alterations in topography will result from 1) increased erosion from overburden stockpiles, and 2) subsidence of fill material after restoration of the site by replacing overburden and filling depressions.

#### 7.2.2 Land Use

The change from livestock grazing to mineral extraction will be a temporary alteration in land use. Grazing patterns and practices will have to be modified during construction and operation.

### 7.3 WATER

Operation of the Morton Ranch mill will result in the use of about  $7.2 \times 10^5$  m<sup>3</sup> ( $1.9 \times 10^8$  gal) of water annually. However, because water for milling operations will be drawn from mine wastewater effluents no changes in the water-use patterns of the area will occur as a result of mill operation except for potable water consumed at the mill. Most of this water will enter the atmosphere from the evaporation pond (Option L).

### 7.4 MINERAL RESOURCES

The extraction of uranium ore will be an unavoidable adverse effect on the area's mineral resources. The mining and milling of the major uranium deposits will deplete those naturally occurring ore bodies bearing higher-grade ores. Belowgrade disposal of tailings will make both the tailings and any lower-grade ores in the perimeter of the pits less accessible to mining if it becomes economically feasible to rework the mill tailings or the lower-grade ores.

### 7.5 SOILS

In the course of mill construction and operation, some topsoil will be lost by being mixed with lower-grade substances, some by erosion, and some by contamination with spilled chemicals, petroleum products, and other byproducts of milling. Compaction, where it occurs, will cause a loss in soil quality, but can be mitigated by proper ripping during reclamation. Other losses in quality caused by leaching and the anaerobic effects of stockpiling are not as easily mitigated. However, if care is exercised during stripping, construction, operations, and reclamation, to preserve soil quantity and quality, these unavoidable impacts can be kept minimal.

### 7.6 BIOTA

#### 7.6.1 Vegetation

Vegetation will be removed from up to 110 ha (270 acres), which will be occupied by the mill, mill facilities, tailings areas, and roads. Plants adjacent to the disturbed area may also be affected

through fugitive dust, increased erosion, noxious weeds, and gaseous effluents; but with care during construction and mill operation, these unavoidable impacts can be kept minimal.

#### 7.6.2 Wildlife

During mill construction some less-mobile terrestrial vertebrates will be killed and others will be displaced or their habitats destroyed if located in the acreage to be devegetated. If depleted open mine pits are used for tailings disposal, terrestrial vertebrates will also be denied the use of mine-area habitat scheduled for reclamation (4 to 62 ha, or 10 to 154 acres) for an unspecified period of time (1 to 10 years for each pit).

#### 7.7 RADIOLOGICAL

Radioactive emissions from excavation and milling of the ore will increase the level of radioactivity in the surface environment.

#### 7.8 SOCIOECONOMIC

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

The present high consumer prices for goods and services in the area of the Morton Ranch site caused by "boom town" conditions will be further stimulated by the project. Rising cost of living primarily affects the original residents who have not increased their income at the same rate as energy-development workers but are faced with higher prices.

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 Morton Ranch 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 increases in suspended particulates during plant construction and the short-term 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; thus, no long-term effects are expected.

#### 8.1.3 Water

Because water for milling operations will be drawn from mine wastewater effluents and will ultimately be evaporated to the atmosphere, no changes in the water-use patterns of the area will occur as a result of mill operation except for potable water consumed at the mill. Effects of mining are discussed elsewhere (FES-TVA).

#### 8.1.4 Mineral Resources

The extraction of currently proved deposits of uranium ore will restrain future mining activities at the site, as uranium is currently the only major mineral resource known to exist on the site area in quantities that are economic to mine. The proposed actions do not preclude extraction of other minerals in the future if deposits are found to occur near to or in association with the uranium deposits and extraction is economically feasible. Reworking of tailings or reopening portions of the mines for extraction of lower grades of uranium or other minerals could occur if economics warrant. Below-ground disposal will make recovery more difficult.

#### 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--i.e., the production of forage and habitat for livestock and wildlife. The program will begin immediately after utility lines are installed and will continue throughout the life of the project (ER, p. 9-2). As a result, about half the disturbed soils should be back in production by the time mill operation ceases (ER, p. 4-1).

#### 8.1.6 Biota

##### 8.1.6.1 Vegetation

Revegetation of disturbed areas will begin immediately after utility-line installation and will continue throughout the life of the project. A satisfactory vegetative cover can be established in two or three years and made available for livestock and wildlife grazing in about four years. About half the disturbed area will be revegetated by the time mill operations cease (ER, p. 4-1), and the remainder will be revegetated shortly thereafter. Because of the many variables (climatic conditions, precipitation, geochemistry and fertility of soil, grazing pressure, insects, genetic variations of plant species, human disturbances, etc.), it is uncertain when (if ever) the vegetation will return to the present species composition through the natural selection process.<sup>1</sup> It is also uncertain if the present species composition is the most desirable for livestock grazing, wildlife habitat, and soil conservation.

#### 8.1.6.2 Wildlife

Terrestrial vertebrates now inhabiting the acreage to be devegetated will be killed or will flee the area but, after reclamation, will repopulate the area with the return of the vegetation; however, there will be some differences in the relative numbers of the animal species inhabiting the area until the fences surrounding the tailings storage areas are removed.

#### 8.1.7 Radiological

The tailings will be impounded in lined mine pits. Such enclosures would be overlain with cover material to meet radon release standards, and then reclaimed. The buried tailings deposit will constitute a source of radon emission of about twice the natural background but the impact is minor.

#### Reference for Section 8

1. R. R. Curry, "Biogeochemical Limitations on Western Reclamation: The High Northern Great Plains Example," in: "Practices and Problems of Land Reclamation in Western North America," M. K. Wali, ed., pp. 18-47, University of North Dakota Press, Grand Forks, 1975.

## 9. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

### 9.1 LAND AND MINERAL

#### 9.1.1 Land

A restriction on digging or other forms of intrusion may indefinitely prevent the development of the lands adjoining buried tailings. This is considered an irreversible commitment of resources.

#### 9.1.2 Mineral

No major irreversible or irretrievable commitments of mineral resources are anticipated other than 1) the uranium that will be recovered, 2) the fuel oil consumed in the yellowcake dryer, and 3) those fuels consumed in milling operations.

The commitment of the natural resources associated with the construction and operation of the proposed project are small in comparison to the benefits derived from the uranium that will be mined.

### 9.2 WATER

#### 9.2.1 Water

Virtually all water needed for mill construction and for mill processes during operation will be wastewater drawn from mine sumps, and will eventually re-enter the hydrologic cycle; thus, its use is not considered a commitment of a resource. The impacts of water extraction, as a consequence of mining have been assessed elsewhere (FES-TVA).

### 9.3 BIOTA

#### 9.3.1 Vegetation

There will be some loss in soil quantity and quality on the project site, but the amount that will be irreversibly or irretrievably lost is slight in comparison to the amount that will remain. Up to 110 ha (270 acres) of vegetation could be disturbed. The applicant will restore this vegetation in accordance with State of Wyoming regulations.

#### 9.3.2 Wildlife

Although there will be no irreversible or irretrievable loss of terrestrial vertebrate species, there will be a long-term loss of habitat for some species. However, vast amounts of similar habitat exist adjacent to the project area; this habitat will host the same animal species lost on the affected areas.

### 9.4 MATERIAL RESOURCES

Major irretrievable and irreversible commitments of material resources to be incurred per year by the Morton Ranch milling project consist of the following: 17,600 tons ( $16 \times 10^6$  kg) of sulfuric acid; 992,250 lb ( $45 \times 10^4$  kg) of sodium chlorate; 14,266 gallons ( $54 \times 10^3$  L) of SX diluent;  $1.4 \times 10^6$  gallons ( $5.5 \times 10^6$  L) of ammonia; 364 lb (165 kg) of isodecanol; 512 lb (232 kg) of amine; 235,935 lb (107,000 kg) of flocculents; and those fuels consumed to produce the electricity used.



## 10. ALTERNATIVES

### 10.1 ALTERNATIVE SITES

The north and south areas of the Morton Ranch lease property are separated by about three miles; the main ore bodies on the two properties are about eight miles apart. In comparing these two areas for placement of the Morton Ranch mill and tailings-disposal site, the applicant and the staff have considered a number of factors, principally 1) the geological stabilities of the areas, 2) minimum destruction of the biological communities, 3) the presence and grade of underlying mineable ore, 4) ore haulage and topography, and 5) site-exclusion factors.

The north and south areas have similar geological stabilities. The biological communities are also comparable, and neither area contains a unique habitat that would be more likely to support protected, threatened, or endangered species. Therefore, the placement of the mill and tailings facilities cannot be decided from geological or biological considerations alone, as the impacts would be essentially the same for both areas.

Site selection, therefore, was based on economic (items 3 and 4 above) and site-exclusion (item 5) considerations. Because most of the ore tonnage is located in the south property and is of lower quality, it is more economically feasible to place the proposed mill in the south area. Furthermore, possible north-area sites would be within 366 to 458 meters (400 to 500 yards) from the main highway and/or other properties. Mining in the north area is primarily underground, whereas in the south area it is by the open-pit method, providing a nearby belowgrade disposal site. Therefore, the choice of a specific site within the south area was based principally on proximity to ore-mining activities.

Consequently, the staff and applicant agree that the south area offers the most potentially suitable sites for the proposed mill and tailings-disposal facilities.

### 10.2 ALTERNATIVE PROCESSES

There are eight principal steps in the milling of uranium ore to produce yellowcake: 1) ore crushing (primary), 2) ore grinding (secondary), 3) production of an ore-water slurry (sometimes combined with secondary grinding), 4) ore leaching, 5) separation of leach liquor from the tailings (waste), 6) concentration and purification of the leach liquor, 7) precipitation of uranium values from the leach liquor, and 8) drying and calcining of this precipitate to form yellowcake.

The specific manner in which each of these steps is accomplished, singly or in combination, is ore- and site-specific. Usually, decisions are based on economic considerations covering the overall process, including the costs of controlling chemical and radiological effluents to water, air, and land.

Crushing and grinding are needed to prepare run-of-mine ores for slurry formation and to reduce the particle size for efficient contact of the ore with the uranium-dissolving reagents. The use of a rod mill for crushing and wet grinding is an efficient and reliable method of providing the ore/water slurry for the leaching operation. Wet grinding also eliminates dust and the need for bin storage of ground ores, thus reducing environmental impacts and costs. For these reasons the staff concurs with the particle-size reduction steps proposed by the applicant.

Methods used for leaching the ore-water slurry depend on the characteristics of the ores. Of the two processes considered, the applicant selected the acid leach process because it requires less grinding than the alkaline (carbonate) leach process and because the Morton Ranch ores are more amenable to acid than to alkaline leaching. The two processes are generally believed to have approximately equal environmental impacts, but the staff believes that the acid process would be most acceptable for extracting uranium from the Morton Ranch ores.

Separation of the leach liquor (which, at Morton Ranch, will contain approximately 97% of the uranium in the ore) from the barren, undissolved waste (tailings) can be accomplished by filtration (see Additional Options, Sec. 10.4.3), settling, or countercurrent decantation. The

applicant has chosen countercurrent decantation. The staff believes that this method is acceptable in that it is widely used throughout the uranium milling industry and has proved to be reliable.

There are two commonly used methods for concentrating and purifying leach liquor, each involving an interchange of ions between an aqueous solution (the leach liquor) and either a solid resin (the resin ion-exchange method) or a liquid organic solvent (solvent extraction). The applicant has chosen the latter method, using a petroleum distillate solution, for the following reasons:

- Its simplicity allows continuous, automated handling and control.
- Most resin-based processes are less efficient because they require a finishing solvent extraction to assure maximum yields.
- The solvent-extraction system has a lower capital cost (the special resin required for resin ion-exchange is expensive).
- The solvent-extraction method requires less water.

The staff believes that the applicant's reasons for proposing solvent extraction are appropriate.

The milling process, even if alkaline leaching is used, generally concludes with precipitation of the uranium values from an acid solution by addition of ammonia (or, in some operations, hydrogen peroxide). The complex precipitate is then filtered, washed, dried, and calcined to produce oxides of uranium. Thus, no significantly different alternatives exist for this process step.

The NRC staff has reviewed the various alternative process steps and considers none to be clearly superior to those chosen by the applicant. Further developments, such as changes in the characteristics of the ore or unexpected changes in the relative costs of reagents, may result in applicant-initiated changes in the process. If such changes are suggested, the staff will again assess the environmental impacts and weigh the relative merits of the viable alternatives.

### 10.3 ALTERNATIVE OF USING AN EXISTING MILL

Where deposits of uranium are close together, the construction of a centrally located milling operation to process ore from several mines might be feasible. Such an arrangement would centralize environmental impacts, and could conceivably produce economies of scale from the greater throughput per mill.

The option of utilizing existing mills for ore processing entails a consideration of numerous factors. The quality of ore and the distance and method of mine-to-mill transport are the principal factors. Other variables include, but are not limited to, consideration of variations in grade and quality of haul roads, total tonnage to be transported, hauling schedules, traffic and weather conditions, possible interim transfer and storage costs, and hauling and milling costs. Environmental costs must also be considered.

For larger operations, hauling costs of \$0.05 to \$0.06/ton-mile are commonly quoted. Hauling distances may range up to 200 miles; however, longer hauls are primarily the result of mining small deposits in areas where the construction of milling facilities is not feasible.

The applicant has considered both onsite processing and the use of existing mills. The proposed Morton Ranch site is five miles from Exxon's Highland uranium mill. Rocky Mountain Energy Company's Bear Creek uranium mill is 18 miles from the main ore bodies. The proximity of these mills to Morton Ranch's main ore bodies makes the alternative of using an existing mill feasible, but at higher transportation costs (approximately \$0.05/lb  $U_3O_8$  for a 2000 ton/day maximum throughput with a maximum average  $U_3O_8$  content of about 0.2%, to transport the ore to the Exxon mill). However, because the Exxon mill is operating at capacity and Bear Creek mill is operating at capacity, these mills could not accept the applicant's ore. To expand the capacity of these mills to accommodate an additional 2000 tons/day would not likely be any more economically feasible than constructing a new mill at the applicant's mine site. Therefore the applicant has discarded the alternative of using an existing or proposed mill.

Use of existing mill facilities would preclude the environmental costs of construction and operation of a Morton Ranch mill; on the other hand, increased production at an existing mill would tend to intensify operational impacts on that local environment, although probably to a lesser degree than constructing a new mill facility elsewhere. Ore hauling from Morton Ranch deposits to an existing mill would tend to increase the radioactive and non-radioactive dust contamination of the area in the vicinity of the haulage road(s). Additionally, the existing

mill and tailings pond would have to be expanded to accommodate the increase in processing capacity, thereby contributing to increased environmental costs.

In consideration of the foregoing, the applicant has proposed to erect a new mill facility near the Morton Ranch ore bodies. Although the staff has not performed a thorough analysis of the effects of upgrading existing mills to accept Morton Ranch ores, it believes that, on the basis of current information, that the applicant is justified in proposing that a new mill facility be built.

#### 10.4 ALTERNATIVE METHODS FOR TAILINGS MANAGEMENT

##### 10.4.1 Introduction

For the purposes of this section, *tailings management* is defined as the disposition of the tailings and waste leach solutions following extraction (separation) of the uranium-bearing solutions, *tailings stabilization* is the containment of the tailings in such a way that long-term leaching of milling wastes to groundwater or subsurface waters is minimized and applicable radiation safety limits are not exceeded; and *reclamation* is the restoration of affected land to a condition equal to or greater than the highest previous use. Decommissioning of the mill must therefore include disposal of the tailings in a manner that will fulfill the requirements of both stabilization and reclamation.

Each alternative tailings management plan has been evaluated against the following set of performance objectives developed by the staff and designed to ensure that potential public health hazards that otherwise could occur in the operation of the project are avoided or minimized:

##### Siting and Design

1. Locate the tailings isolation area remote from people such that population exposures would be reduced to the maximum extent reasonably achievable.
2. Locate the tailings isolation area such that disruption and dispersion by natural forces is eliminated or reduced to the maximum extent reasonably achievable.
3. Design the isolation area such that seepage of toxic materials into the groundwater system would 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 assure that sufficient funds are available to complete the full reclamation plan.

Engineering techniques required to control pollutants from tailings-storage areas during operational and post-operational stages of milling projects have been demonstrated. The unique characteristics of each facility must be identified, and appropriate environmental controls applied. Alternatives (options) presently available or feasible (i.e., potentially available with existing technology and within legal constraints) are discussed in Section 10.4.2 and evaluated in Section 10.4.3.

##### 10.4.2 Alternatives (Options)

Twelve alternatives for tailings management have been proposed by the applicant (ER Suppl. I and Ref. 3). Option L was the applicant's preferred alternative.<sup>3</sup> The twelve alternatives proposed are summarized as follows.

#### Option A - Clay-Lined Tailings Pond - Constructed in Five-Year Increments in North Basin

A tailings dam would be constructed in increments in the drainage basin to the north of the proposed plant site. The initial embankment would provide storage capacity for approximately five years of mill tailings and would have an available tailings surface area of approximately 44 ha (110 acres). Accommodation of tailings over the full projected life of the mill would require later increases in the embankment height to a maximum of 27 m (90 ft), and would provide a surface area of about 83 ha (250 acres). The pond areas are shown in Figure 10.1.

Topsoil would be removed from the entire pond surface and stockpiled so that it would be available for reclamation after mill shutdown. The clay present onsite from stripping the open pit areas would be compacted to provide a 0.9-m (3-ft)\* liner to reduce seepage (ER Suppl. I, p. 3-20). The clay would be prepared and compacted for the initial pond before mill operation, and additional area would be prepared as needed during the life of the project.

#### Option B - Clay-Lined Tailings Pond - Constructed in Five-Year Increments in South Basin

Option B basically would be a tailings pond similar to the one discussed for Option A, but constructed in the southern drainage basin (ER Suppl. I, Fig. 3.2-4). The final area of the tailings pond would be approximately 69 ha (171 acres).

One ore body lies within this pond area, about 50 m (160 feet) deep. This ore would be mined and the pit backfilled and capped with compact clay before the start of mill operations.

Site location of the South Basin in relation to the plant bench and the North Basin is shown in Figure 10.1.

#### Option C - Clay-Lined Tailings Pond - Constructed for the total project life in North Basin

Option C is identical to Option A except that the final centerline dam and pond liner would be constructed entirely before mill operation begins.

#### Option D - Clay-Lined Tailings Pond - Constructed for the total project life in South Basin

Option D is identical to Option B except that the final centerline dam and pond liner would be constructed entirely before mill operation began.

#### Option E - Depleted Open Pits Backfilled Above the Water Table - Compacted Clay Liner

Option E is based on the assumption that the mill would be built in the central portion of the south Morton Ranch ore bodies. Seven pits adjacent to the mill would be used for disposal of slurried tailings (pits 2105, 1801, 1805, 1802 and 1803, 1804 and 2114).<sup>2</sup> A portion of the pooled water in the pits would be returned to the mill circuit, while the remainder would be decanted and discharged to pits 2103, 2104, 2112, and 2113 (which constitute one large pit). Figure 3.5 shows the present or proposed location of these pits and Figure 3.6 shows a conceptualized cross section; Appendix E, Table E-1, summarizes their design.

The use of pits for tailings retention would require the sealing of the floor and of the permeable rock strata exposed in the pit walls. The ore sand is underlain by an impermeable clay, but would have to be backfilled above the water table and lined with compacted clay.

Sealing the sides would be accomplished by applying a clay blanket along the wall by use of scrapers. Side slopes would be 1:1 (45° angle) (ER Suppl. I, p. 3-14).

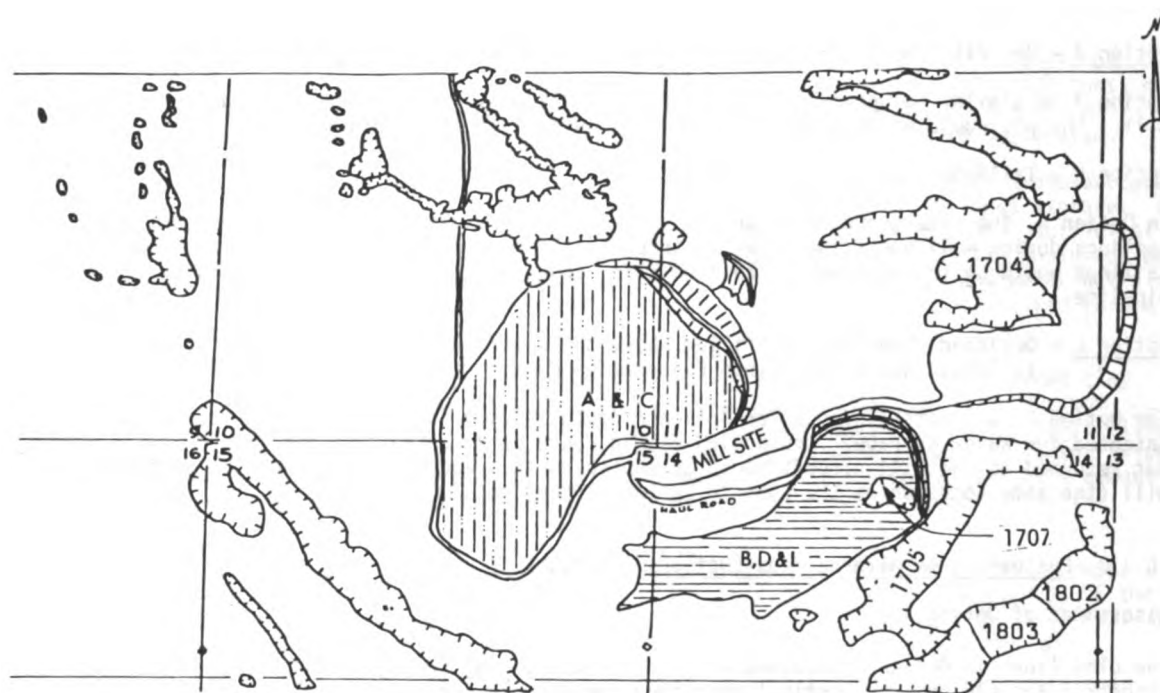
#### Option F - Depleted Open Pits, Backfilled Above the Water Table, Compacted Clay Liner on Horizontal Surfaces, Membrane on Vertical and Near-Vertical Surfaces

In Option F, the pit bottom, above the water table, would be lined with compacted clay. A membrane such as polyethylene, hypalon, or other commercially available lining material would be laid over the wall faces to seal permeable strata.

#### Option G - Depleted Open Pits, Backfilled Above the Water Table, Compacted Clay Liner on Horizontal Surfaces, Guniting or Equivalent on Vertical Surfaces.

Under Option G, Guniting (a concrete sealant) or other sprayed sealant material would be sprayed on the pit walls.

\*For Options A through J, the applicant has proposed the use of 0.6 m (2 ft) of clay as a sealant. The staff, for stability, will require the compaction of 0.9 m (3 ft) of clay,<sup>1</sup> in options involving clay liners to minimize seepage of tailings solution.



#### LEGEND

|                     |                                 |
|---------------------|---------------------------------|
| Open Pits           | 1704, 1705, 1707, 1802 and 1803 |
| North Tailings Pond | A & C                           |
| South Tailings Pond | B & D                           |

Fig. 10.1. Mill Site, Adjacent Ore Pits, and Proposed Tailings Disposal Sites. [Letters A, B, C, D, and L refer to the applicant's tailings-disposal options that involve an impoundment. The preferred alternative, Option L, involves both the pits (Fig. 3.5) and the south pond area.] (Modified from ER Suppl. I, Fig. 3.2-5).

**Option H - Depleted Open Pits, Backfilled Above the Water Table, Compacted Clay Liner on Horizontal Surfaces, Sprayed Asphalt on Vertical Surfaces**

Option H is identical to Option G except for the material used.

**Option I - Expansion of Depleted Pit for Tailings Retention (Utilizing Optimum Seepage Barriers)**

In Option I, a mined-out pit would be enlarged by removing material from the pit walls to provide a shallower slope for stabilization, effective sealing, and additional volume; tailings would be confined to one location. This option would involve a 30.5 m (100 ft) deep, round pit, 700 m (2300 ft) in diameter at the top, with side walls at a 30° slope (ER Suppl. I, p. 3-28). A compacted-clay liner would be placed along the base and the sidewalls.

**Option J - New Pit Constructed for Tailings Disposal (Utilizing Optimum Seepage Barriers)**

Option J is similar to Option I except that this pit would probably be located closer to the mill. The pit would be excavated for the sole purpose of tailings disposal.

**Option K - Tailings Storage in Underground Mine**

In Option K, the underground mine on the north property would be mined out and then filled with tailings during mill operation or after interim storage or drying at another location. The tailings would be transported to the mine site, about 13.6 km (8.5 miles) north, by truck or pipeline.

**Option L - Depleted Open Pits Backfilled Above the Water Table and Clay Lined for the Tailings, and a Clay-Lined Evaporation Pond for the Excess Liquid\***

For Option L, all pits listed under Option E would be used for tailings disposal including those intended for water storage. The pooled liquid would be decanted from the pits. That portion not returned to the mill circuit would be routed to an evaporation pond located south of the mill (the same location as the pond in Option B; see Fig. 10.1).

### 10.4.3 Evaluation of Alternatives (Options A through L)

#### Assessment of Option A

The clay liner in Option A provides a means for minimizing seepage. The seepage rate would be about 2.3 lps (36 gpm), slightly larger than the 1.6 lps (25 gpm) calculated for Option D (App. E, Sec. E-2). The clay liner would reduce both total seepage and cationic pollutants. However, common anions such as sulfate and chloride would slowly seep through and the potential exists for these contaminants to reach the water table. Because of the low seepage rate, the amount of contamination would be very small in relation to the concentration of such ions in the water table.

The tailings pond described would be larger than the impoundment in Option B. The applicant has stated that the Option A pond would have sufficient volume to contain all tailings, although the staff has not verified this. It is probable, however, that an impoundment with sufficient capacity could be designed for the Option A drainage basin area.

Option A represents the conventional method of tailings disposal. The site location, the specific design which minimizes seepage, and a stabilization and reclamation program similar to that discussed in Sections 10.4.4 and 10.4.5 would be a minimum acceptable program meeting the staff's performance objectives (Section 10.4.1).

#### Assessment of Option B

This tailings pond would not be of sufficient size to contain all of the tailings for the lifetime of the mill facility. This is evident from the following discussion.

Table 5.0-1 of ER Suppl. I shows that the total volume of the tailings pond would be  $7.03 \times 10^6 \text{ m}^3$  (5700 acre-ft). The average bulk density of the dry tailings is about  $1400 \text{ kg/m}^3$  ( $1.17 \text{ tons/yd}^3$ ).<sup>2</sup> Thus, the total quantity of tailings that could be contained in the tailings pond would be  $9.76 \times 10^9 \text{ kg}$  ( $10.8 \times 10^6 \text{ tons}$ ). Because an estimated  $11.9 \times 10^9 \text{ kg}$  ( $13 \times 10^6 \text{ tons}$ )<sup>3</sup> of uranium ore will be mined, more tailings would be produced than could be contained in the south tailings pond. Therefore, Option B is not viable as proposed.

\*Since issuance of the Draft Statement, the applicant-estimated number and sizes of the pits have changed. For this reason, a re-analysis of Option L is provided in Sec. 10.4.3 and Appendix E of this Final Environmental Statement.

Seepage from this pond is estimated to be about 1.6 Lps (25 gpm) (see App. E). As in Option A, radioactive contaminants are expected to be retained in the clay liner. Other contaminants, such as sulfates and chlorides, would pass through the liner and the potential exists for these contaminants to reach the water table (see App. F). Because the seepage rate is so small, the amount of contamination is expected to be very small.

#### Assessment of Options C and D

These assessments are identical to those of Options A and B, respectively; the only variation is the schedule for construction.

#### Assessment of Option E

The total storage volume available in the pits reserved for tailings (see App. F) would be about  $6.98 \times 10^6 \text{ m}^3$  ( $9.13 \times 10^6 \text{ yd}^3$ ). The required storage for  $12 \times 10^9 \text{ kg}$  ( $13 \times 10^6 \text{ tons}$ ) of tailings to be produced during the life of the mill would be  $8.63 \times 10^6 \text{ m}^3$  ( $11.3 \times 10^6 \text{ yd}^3$ ). Therefore, more tailings would be produced than could be contained in the pits designated.

The staff considered a slight variation on this option, namely, using those pits proposed for storing the excess water (pits 2103, 2104, 2112, and 2113) for additional tailings storage. In this variant the total volume of all pits would be  $11.0 \times 10^6 \text{ m}^3$  ( $14.4 \times 10^6 \text{ yd}^3$ ), sufficient to contain all tailings produced. However, the staff has concluded that this option would not be viable because all of the excess liquid (after accounting for recycled water and water entrained in the tailings) could not be evaporated quickly enough to make available the required volume in all the pits (see App. F).

The staff believes that storage of slurried tailings above the water table in depleted clay lined open-pit mines would have a negligible effect on groundwater (see App. F). Maximum seepage from all pits in this case would be less than 1.9 Lps (30 gpm) for a 0.9-m (3-ft) liner. The clay liner would reduce both total seepage and cationic pollutants. However, common anions such as sulfate and chloride could seep through. Because of the low seepage rate, the amount of contamination would be very small in relation to the concentration of such ions in the water table.

Exposure of plant personnel to tailings effluent would be less than in aboveground storage, because the wind blows from the proposed location of the pits to the mill site only 9% of the time and because the pits would be a greater distance from the mill (ER Suppl. I, p. 3-23). In addition, the tailings would be below grade, where wind effects are expected to be less.

The transport of tailings to the pit and recycling of water to the mill represent major drawbacks in the use of depleted pits for tailings retention. Not only are the pits farther from the proposed plant site, but the tailings and recycle lines would have to be rerouted each time different pits were to be used. Also, overburden removed during stripping would have to remain on the surface, possibly complicating reclamation.

Because the tailings are below-grade, there is a greater assurance of meeting the staff's performance objective to eliminate the need for ongoing monitoring and maintenance following reclamation.

#### Assessment of Options F, G, and H

In Option F, a membrane liner on the vertical surfaces of a pit would serve to protect groundwater from seepage during the life of the mill. It is not known whether a liner material can be constructed to keep its integrity on the vertical surfaces in order to mitigate the possible effects of seepage on the groundwater aquifer.

In all other respects, except possibly economics, a membrane liner would not differ significantly from clay (Option E) in isolating noxious and radioactive materials from the groundwater.

In Option G, Guniting would be used as the membrane liner. Mill effluent would have to be neutralized in order to avoid decomposing the Guniting (a cement-base, sprayed coating). In all other respects, the use of Guniting should be equivalent in effect to the liner proposed in Option F.

Option H, like Option G, could probably be accomplished without significant modification of the pit walls. Asphalt could be spray-applied to permeable strata and is known to be a good sealant. However, asphalt tends to flow when heated, making reapplication necessary in warm weather. Catalytically blown asphalt provides a better barrier, and is therefore the product being considered by the applicant.

### Assessment of Options I and J

Option I, which would require the expansion of an existing pit to accept additional tailings, would confine radiation to one location, and provide less wall area to line and less surface area to cover than options involving multiple pits. This excavation could assure that adequate volume would be available to contain all tailings and unevaporated liquids. In other respects, this option is similar to other options involving pits. Seepage in this case would be about 1.8 Lps (28 gpm) for a 0.9-m (3-ft) liner.

The radioactive contaminants are expected to be retained in the liner, but other contaminants could enter the groundwater. Because the seepage rate is so small, the amount of contamination is expected to be very small.

Option J does not differ significantly from Option I, except that the pit could be placed closer to the mill, reducing the tailings transport distance.

### Assessment of Option K

Option K, the storage of tailings in the mined-out, underground workings of the mine on the north property, would involve numerous inherent problems. The most significant of these would be protection of the groundwater aquifer and exposure of miners to radiation. The transportation of up to  $1.8 \times 10^6$  kg/day (2000 tons/day) of tailings to the mine, 13.6 km (8.5 miles) away, would be a major undertaking with many problems of its own (such as spillage). Although insufficient information is available to accurately assess this option, the staff does not believe that it is a better option than the preferred option (Option L), for the reasons stated above.

### Assessment of Option L

As discussed in Appendix E, the total storage volume currently estimated for Option L would be adequate for all but about 8% of the tailings solids expected to be produced during the lifetime of the mill. However, the applicant will be required to provide adequate storage volume for all tailings prior to the end of this period. The staff has calculated that a pond with a surface area of approximately 44 ha (110 acres) would eventually be required, in addition to the pits, to contain all unevaporated water that will have accumulated after 20 years of operation, the projected lifetime of the mill facility. This pond would thus be somewhat smaller than the tailings-impoundment area discussed for Option B, and seepage from the pond (1 Lps or 25 gpm) would also be somewhat less than from Option B. Seepage from the most recently defined pits would be somewhat less than that from Option E. Contamination from radioactive species and other chemicals would be similar to that from Option E.

Because the tailings are below-grade, there is greater assurance of meeting the staff's performance objective to eliminate the need for ongoing monitoring and maintenance following reclamation.

Costs estimated by applicant, as calculated by the staff, for this system are as follows:<sup>4</sup>

|                              |             |
|------------------------------|-------------|
| Compaction of in place clay  | \$ 100,000  |
| Additional clay <sup>a</sup> | 300,000     |
| Wall liner                   | 3,300,000   |
| Dike construction            | 800,000     |
| Impoundment construction     | 2,000,000   |
| Total                        | \$6,500,000 |

<sup>a</sup>Applicant submitted cost figures for two feet of clay, but these figures have been modified to reflect a three-foot liner.

### Conclusion

The staff finds that the liners that would be used in Options A through J and Option L would prove sufficient to prevent any observable groundwater contamination by radium and thorium and only negligible contamination by other chemical species. Alternatives A through D are all similar with regard to environmental effects. Alternatives E through H are also similar with regard to environmental effects, as are Options I, J, and L. The principal differences are economic. There is not enough information concerning Option K to consider it a viable option. The staff finds that Option B and Options D through H would not assure that adequate storage volume would be available for storage of tailings solids and liquids through the lifetime of the project.

The facilities of Options B and D, located downwind of the mill, would reduce exposure of mill personnel to tailings pond effluents to a greater extent than for Options A or C. The contribution to doses to the public is expected to be similar for all tailings alternatives options. If additional pits were made available for tailings disposal as a result of future ore finds and excavations, additional pit options could then become viable.

Based on the preceding discussion in this section, the staff concludes that only Options A, C, I, J, and L would succeed as viable tailings disposal systems. The impacts of each of these options is similar. The choice of Option L over Options I and J is based on economic considerations. The major reason for preferring Option L over Options A or C is that below ground disposal clearly provides greater assurance that the buried tailings will not be disturbed by man or natural phenomena over the long term. The staff believes that the tailings management plan referred to as Option L is the best tailings management plan for the Morton Ranch site when considered in terms of both the staff's performance objectives and economic factors. This alternative represents the most environmentally sound, reliable, and reasonable method of tailings management for the Morton Ranch site using existing commercially available technology.

#### Additional Options

In addition to the tailings alternatives discussed in this section and elsewhere in this Environmental Statement, the applicant is currently developing<sup>3</sup> two other tailings-management alternatives: 1) a modification of Option L by the use of a different mine-pit liner design (see Fig. 10.2), and 2) dewatering the tailings with a continuous conveyor belt filter and then placing them above the water table in pits with bottom liners but without sidewall liners.<sup>3</sup> Data sufficient for an assessment of these alternatives are presently unavailable; however, either concept could prove equal to or superior to the alternatives already assessed.

The modified pit liner design appears to offer greater stability than the previously proposed design. The dewatering alternative is attractive for several reasons. Water usage may be reduced considerably depending upon the dewatering process chosen. It is unlikely that the tailings, at about 20 to 25% moisture, would contain enough tailings solution to migrate very far from the tailings area or to have any significant impact on the water table, thus obviating the need for a liner. The pit bottom liner is provided to mitigate vertical seepage. (The evaporation pond would, of course, be lined.) Without a pit sidewall liner, more space would be made available for tailings disposal (approximately  $3 \times 10^6$  yd<sup>3</sup> for Option L), and the tailings could be placed further below grade. Extensive solar drying would not be required; and the tailings pits could be stabilized and reclaimed soon after placement of the tailings, thus greatly reducing the radon and particulate releases from the pits.

The applicant is required to submit to the NRC staff for consideration and approval, adequate additional information on these or any other tailings-management alternatives that the applicant may wish to employ.

#### 10.4.4 Stabilization

Tailings stabilization will involve the following general method. The tailings, and residue scraped from the evaporation pond, will be permitted to dry within the mine pits and then be covered with mining overburden, clay, and soil in order to isolate the noxious and radioactive wastes from the environment and to prepare the area for reclamation. Estimates of the radioactivity in the tailings slimes and sands<sup>5</sup> give the ratio between slimes and sands to be about 15:1 with the slime/sand mass ratio being about 1:3. With a concentration of radium in the tailings of about 560 pCi/g, the slime and sand concentrations of radium would be about 1880 pCi/g and 125 pCi/g, respectively. The radon-emanation rate from slimes would be about 3000 pCi/m<sup>2</sup>-sec. A cover consisting of 1.2 m (4 ft) of overburden, 0.75 m (2.5 ft) of clay, another 1.2 m (4 ft) of overburden, and 15 to 22 cm (6 to 9 in.) of topsoil would suffice to bring radon emanation down to less than twice background level and gamma radiation down to essentially background. These thicknesses have been calculated by the staff, on the basis of existing literature,<sup>6-8</sup> to assure that radon emissions will be reduced to approximately twice the background rate. The calculations are conservative in that they assume 100% of the tailings area will be 100% slimes, which is clearly not the case. As discussed in Section 10.4.5, the topsoil will be stabilized by planting with native and/or other vegetation.

The preceding calculations were based on an initial assumption that the applicant would be processing ore with an average grade of 0.2% U<sub>3</sub>O<sub>8</sub>. More recent estimates<sup>9</sup> predict that the average ore grade would be closer to 0.077%. Tailings slimes from 0.077% ore will have a background rate would then be 1.2 m (4 ft) of overburden, 0.5 m (1.9 ft) of clay, 1.2 m (4 ft) of overburden, and 15 cm (6 in.) of topsoil. If operating experience shows that the average ore grade does not exceed 0.077% U<sub>3</sub>O<sub>8</sub>, the 0.6 m (2 ft) thick clay layer proposed by the applicant would suffice. In no case does the staff expect that a clay layer thicker than 0.75 m (2.5 ft) would be necessary, when used in conjunction with a total of 2.4 m (8 ft) of overburden and 15 cm (6 in.) of topsoil.

The applicant has estimated, and the staff agrees, that clay and overburden will cost \$1.25/yd<sup>3</sup> (\$2017 acre-ft) to apply (ER, Suppl. I, p. 3-37). Approximately 53 ha (130 acres) of pit surface will require stabilization.

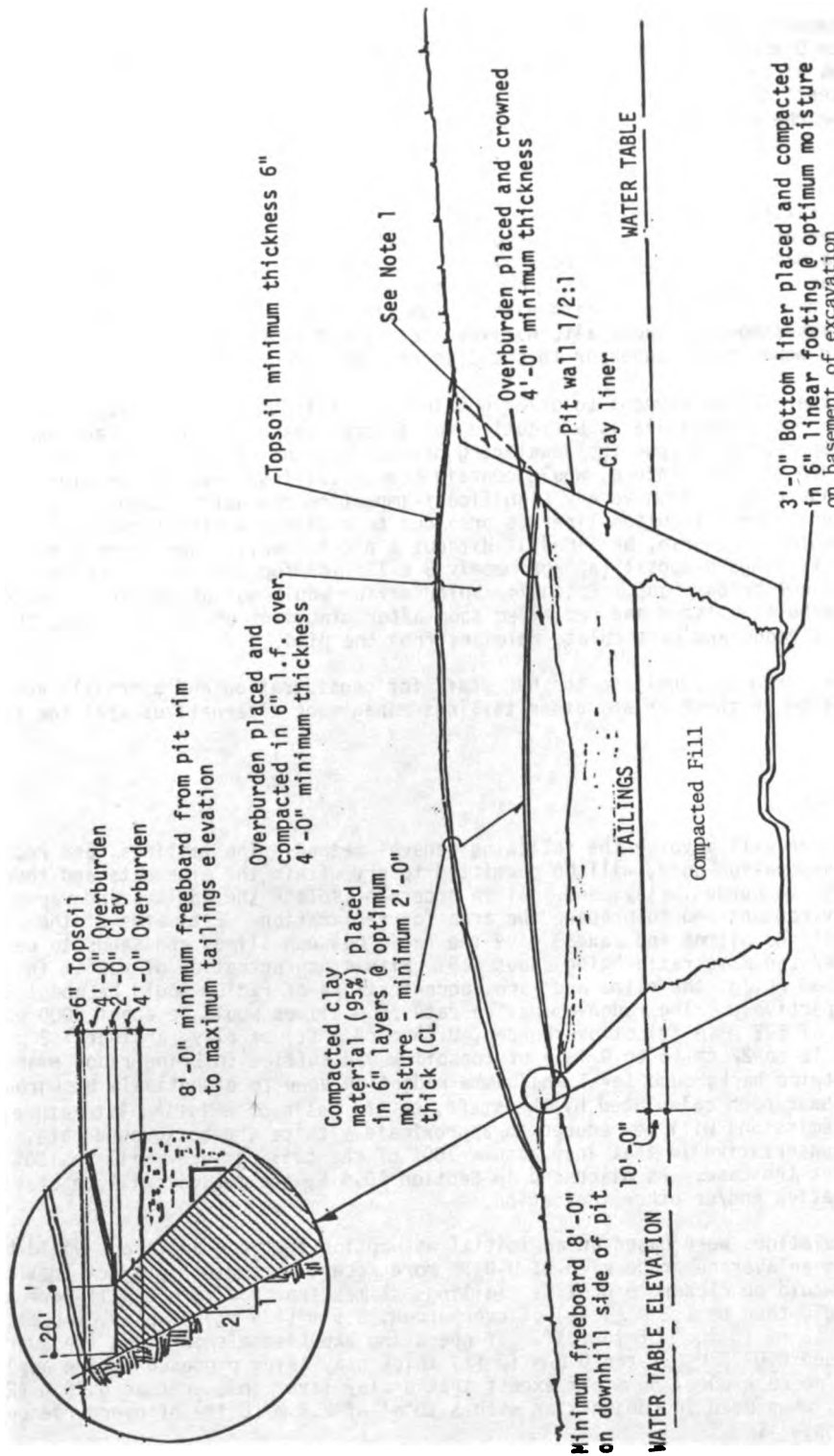


Figure 10.2. Possible Future Modification of Option L: In-Pit Tailings Disposal (typical cross section) (from Ref. 3).

Because of the sulfuric acid content, the evaporation pond may never dry; and the applicant may find it necessary to consider additional methods of stabilization such as neutralization with limestone or caustic to form a salt cake or use of absorbent materials (overburden), in order to facilitate transport of pond bottom residues to the pits for ultimate disposal. Assuming the acidity of the decanted mill tailings liquids would be pH 1.2, the staff has calculated that approximately  $3.5 \times 10^7$  kg equivalent to  $\text{CaCO}_3$  in powdered limestone, or  $2.8 \times 10^7$  kg of  $\text{NaOH}$ , would be required per year to neutralize the sulfuric acid content. The applicant's reclamation program for the pond area is to remove the clay liner, underlying soils, and any slimes and solids to a tailings disposal pit. An estimated  $8.5 \times 10^5 \text{ m}^3$  ( $1.1 \times 10^6 \text{ yd}^3$ ) of material would be removed from a 46.5-ha (115-acre) pond. The pond basin would then be either backfilled, contoured, covered with topsoil and revegetated, or a new clay liner would be installed so that a pond would form for livestock use. The applicant estimates the cost of the stabilization program for the pond will be \$2,500,000.

The applicant has stated that the materials under the 15 to 22 cm (6 to 9 inches) of "topsoil" should have water-holding capacity and a potential for root development to a depth of about 1 m (3 ft) (ER App. VI, p. A-71). However, for reasons of stability and attenuation of radon, the applicant has committed to place 1.2 m (4 ft) of "overburden" below the topsoil. Because of the high clay content of much of the overburden to be removed from the mine pits, and the potential for such material to resist penetration by plant roots, the staff urges the applicant to stockpile as much "sub-topsoil" as possible, so that it can be applied as a layer directly between the overburden and the topsoil, as a portion of the 1.2-m (4-ft) layer of "overburden"; this would enhance the development of vegetation at the root zone.

#### 10.4.5 Reclamation

Revegetation of disturbed areas will begin immediately after utility lines are installed and will continue throughout the life of the project (ER, p. 9-2). All disturbed areas will be reclaimed except for land under buildings and roads retained by the surface landowner(s) (ER, pp. 4-1, 9-2). The applicant's stated objective is to return the land to its present use, livestock grazing (ER, p. 9-1). Up to 110 ha (270 acres) may require revegetation.

Soils will be seeded with a mixture of plant species designed primarily to provide forage for domestic livestock and secondarily to provide cover and food for wildlife, and for esthetics, soil stability, and surface and subsurface water conservation (ER App. VI, pp. A-1, A-7). The species chosen must be approved by the State of Wyoming Department of Environmental Quality. The seed mixture currently required under the state mining permit for Morton Ranch consists of western wheatgrass, thickspike wheatgrass, streambank wheatgrass, and green needlegrass. Modifications in relative amounts of each species will be made depending on the soil to be seeded and the results of test plantings (ER App. VI, pp. A-8, A-9). Seeding rates will be calculated from the size of seed, percent purity, and percent germination. Seed will be planted with a drill suited to handle a variety of seed types. The basic mixture will be sown in the early spring (before 15 April) or late fall (from 15 October until the ground freezes). During the nonseeding period (15 April-15 October), an annual cover (such as wheat or oats) may be sown to minimize wind and water erosion and to contribute organic matter for the permanent species (ER, p. 9-2). To ensure optimum plant establishment, newly vegetated areas will be protected from grazing for at least two growing seasons.

Noxious weeds and grasses will be controlled by natural succession (by prompt planting of disturbed land with perennial species). However should "undesirable" species become established, they will be eradicated through careful use of selected herbicides in accordance with applicable state and federal regulations (ER App. A-I, p. A-13).

The applicant has estimated that revegetation alone will cost \$125/acre (ER, Suppl. I, p. 3-37). When other reclamation costs for fertilization, mulching, fencing, etc., are included, the applicant's estimates for reclamation costs rise to about \$430/acre, based on 1974 costs (ER, Vol. II, App. A-IV, p. A-18):

It is the opinion of the staff that the applicant's reclamation program is well designed and adequate. It meets the primary objective of a "use [of reclaimed land] equal to or greater than the highest previous use,"<sup>10</sup> and it strikes a balance between reclamation for agricultural use (grazing) and for wildlife habitat.<sup>11</sup> Most of the seeded grasses are native species. Although the planting of shrubs is limited to one or two species, other native shrubs will eventually move into the seeded areas by natural succession.

## 10.5 ALTERNATIVE ENERGY SOURCES

### 10.5.1 Fossil and Nuclear Fuels

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 unit basis than all other fuels used to generate electric power. The following discussion concerns the relative availability of fuels for power generation over the next 10 to 15 years, since availability will be the key factor in the choice of fuel to be used.

Table 10.1 shows the disparity between availability and usage of energy resources in the U. S. Although these data are for 1974 (more up-to-date figures are not yet available), estimates from 1974 through 1977 indicate little difference. Gas usage in 1976 decreased slightly ( $\sim 1\%$ ), and this decrease is continuing; oil, coal, and nuclear usage increased slightly.<sup>12,13</sup>

Table 10.1. Reserves and Current Consumption of Energy Sources<sup>13</sup>

|         | Percent of Proven U. S. Energy Reserves Economically Recoverable with Existing Technology (1974) | Percent of Total U. S. Energy Consumption Contributed by Each Energy Resource (1974) |
|---------|--------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Coal    | 90                                                                                               | 18                                                                                   |
| Oil     | 3                                                                                                | 46                                                                                   |
| Gas     | 4                                                                                                | 30                                                                                   |
| Nuclear | 3                                                                                                | 2                                                                                    |
| Other   | 0                                                                                                | 4                                                                                    |

In 1975, the U. S. consumed about 71 q of energy (1 q =  $10^{15}$  Btu); of this total, 20 q consisted of electric energy. By the end of 1977 an estimated 12% of this 20 q electric energy was being generated using nuclear fuels; within about twelve years, the percentage is expected to increase to 26%.<sup>12,13</sup>

Coal was used to produce 50% of the electric energy generated by the combustion of fossil fuels in 1975. Relative changes in resources used for electricity generation, as estimated in "Project Independence,"<sup>14</sup> are shown in Table 10.2. The National Energy Plan<sup>13</sup> confirms these views of resource dependence. All information available to date indicates that coal and uranium must be used to generate an increasing share of future U. S. energy needs, because of decreasing supplies of oil and gas available for electric power generation. The U. S. does not have sufficient oil and gas reserves to ensure a long-term supply, but coal and uranium resources are adequate for foreseeable needs. Currently, rising prices for oil and gas are a reflection of increasing competition for these two resources, which both may be severely depleted in the next few decades.

Coal production must be increased to meet projected requirements for the next decade (the total requirement is seen as 1040 million tons in 1985 vs. 640 million tons in 1977).<sup>12-14</sup> The major expansion of coal production will likely be in the western U. S. (from 92 million tons in 1974 to 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 U. S. will be increased. Since the major markets for the coal produced are located hundreds of miles from the mines, transportation costs will be high, as will the environmental impacts associated with transportation systems. Transportation costs for bringing western coal to the eastern U. S. currently account for the major portion of the delivered market price.

\*The national plan (released in April 1977) for reducing U. S. dependence on foreign energy sources and improving U. S. capability to balance energy demand and supply from U. S. sources.

Table 10.2. Estimated Relative Changes in Resources to be Used for Electricity Generation through 1985<sup>15</sup>

| Fuel Resource Used                        | Percent of Thermal Energy Required in Year |                   |                   |                   |
|-------------------------------------------|--------------------------------------------|-------------------|-------------------|-------------------|
|                                           | 1970 <sup>a</sup>                          | 1974 <sup>b</sup> | 1980 <sup>b</sup> | 1985 <sup>c</sup> |
| Coal                                      | 45                                         | 45                | 45                | 46 <sup>c</sup>   |
| Oil and gas                               | 38                                         | 34                | 25                | 16                |
| Nuclear                                   | 2                                          | 4 <sup>d</sup>    | 17                | 26                |
| Hydro, waste, etc.                        | 15                                         | 17                | 13                | 12                |
| Total q's of energy <sup>e</sup> required | 15.6                                       | 20                | 25.5              | 34                |

<sup>a</sup>Actual.<sup>b</sup>Estimated.<sup>12</sup><sup>c</sup>Coal usage must increase (from  $640 \times 10^6$  tons/yr to  $1.04 \times 10^9$  tons/yr) by 1985 to attain this level.<sup>d</sup>Uranium-fueled reactors furnished 9.9% of the total U. S. production in January 1976 and 12% in January 1977.<sup>e</sup>1 q =  $10^{15}$  Btu.

For a given thermal content, transport facility requirements (trains, trucks, etc.) for  $U_3O_8$  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-MWe nuclear plant operating at a plant factor of 80%. Annual coal requirements for an equivalent 1000-MWe coal plant would be more than three million tons, or the full capacity of at least one unit-train (100 cars of 100 tons each) per day of plant operation.

The evidence available at this time indicates that, of the resources currently used in electric power generating stations (coal, uranium, oil, gas, and hydro), only coal and uranium have the potential for long-range reliability in increasing domestic energy production. Because of the time lag between initial extraction and the consumption of the resource for energy production (3-5 years from mine to generation plant for uranium and coal, 5-7 years for construction of a coal-fired generating plant, and 7-10 years for construction of a nuclear generating plant), the exploitation of both coal and uranium resources must be integrated with contemporary energy needs. Neither the coal- nor uranium-producing industries are considered capable of singly supporting the electrical energy requirements projected for the next few decades; major expansion of both industries will be required to fill projected needs.<sup>13</sup>

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.<sup>15</sup> Results of those studies are given in Appendix G, 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.

### 10.5.2 Solar, Geothermal, and Synthetic Fuels

Estimates reported in the "National Energy Outlook"<sup>12</sup> indicate that solar and geothermal sources will each supply about one percent of U. S. energy requirements by 1985 and about two percent by 1990. Supplies of synthetic gas and oil derived from coal will probably not exceed one percent 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 government incentives. A maximum of six percent of projected 1990 energy requirements is expected to be derived from solar, geothermal, and synthetic fuel resources combined. The National Energy Plan<sup>13</sup> 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.

### 10.5.3 Byproduct Uranium

Uranium recoverable as a byproduct of phosphate fertilizer and copper production have increased from 90,000 tons ( $U_3O_8$ ) in 1974 to 140,000 tons in 1977. These resources are in addition to the 808,000 tons (\$50 forward cost) available from conventional mining and milling sources. (See also App. G.)

A report by the National Academy of Sciences states:<sup>16</sup>

"Like all byproducts commodities, byproduct 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. Byproduct 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 short tons of  $U_3O_8$  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 thought that other porphyry copper deposits might also be possible sources of byproduct uranium.

The staff has studied available data on the potential of uranium production from phosphate fertilizer production<sup>17</sup> 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.<sup>17,18</sup> 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  $U_3O_8$ .<sup>18</sup>

### 10.5.4 Energy Conservation

The cornerstone of the National Energy Plan is conservation, which is 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."<sup>13</sup>

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.
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 U. S. 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 OF MILL

Among the alternative actions available to the NRC is the denial of a source material license to the applicant. In such a case, the applicant could continue to extract from its mines and commercially transfer ores in the natural state containing source material, but could not refine or process these (10 CFR 40.136). The applicant would then have three possible courses of action: (a) mine the ore and have it processed at an existing NRC-licensed mill; (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 Section 10.3. 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 that will be discussed.

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 requirement has been discussed in Section 10.5. Appendix G discusses the need and timeliness for the current licensing action and the basis for the NRC evaluation thereof.

The  $U_3O_8$  produced by the Morton Ranch mill will be used as fuel in present and future nuclear reactors. These reactors will produce electric power for sale to U. S. consumers. 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 type and effects of the regional economic benefits that would be lost if the proposed Morton Ranch mill were not licensed, and has also pointed out the environmental costs that would not be incurred should no license be issued. The NRC staff has examined the applicant's tabulations of benefits and costs, has made an independent assessment of benefits and costs of the proposed project (see Sec. 11), and has concluded that the overall benefit-cost balance is favorable for licensing of the Morton Ranch mill.

### References for Section 10

1. Letter of R. A. Scarano, U. S. Nuclear Regulatory Commission, to Vice President, Mining and Milling Division, Wyoming Operations, United Nuclear Corporation, dated 31 January 1978.
2. Enclosure to letter of Plant Superintendent, Wyoming Operations, United Nuclear Corporation, to L. W. Rossbach, U. S. Nuclear Regulatory Commission, dated 11 November 1977.
3. Letter of Vice President, Mining and Milling Division, Wyoming Operations, United Nuclear Corporation, to U. S. Nuclear Regulatory Commission, dated 13 January 1978.
4. "Economic Evaluation of Tailings Retention Systems and Disposal Sites," United Nuclear Corporation, 7 December 1977.
5. M. 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," ORNL-TM-4903, Vol. 1, Oak Ridge, Tennessee, 1975.
6. A. B. Tanner, "Radon Migration in the Ground: A Review," in "The Natural Radiation Environment," J. A. S. Adams et al., eds., 1964.
7. H. W. Kraner, G. L. Schroeder, and R. D. Evans, "Measurements of the Effects of Atmospheric Variables on Radon-222 Flux and Soil Gas Concentrations," in "The Natural Radiation Environment," J. A. S. Adams et al., eds., 1964.
8. V. V. Alekseev et al., "Radiometric Methods in the Prospecting and Exploration of Uranium Ores," U. S. Atomic Energy Commission, AEC-tr-3738 (translated from the Russian), 1957.
9. "Application for Uranium Milling License on the Morton Ranch, Wyoming Uranium Mill," revision 2, p. 2. November 23, 1977.
10. "Wyoming Land Quality Rules and Regulations," Wyoming Department of Environmental Quality, Cheyenne, 1975.
11. "Considerations for Wildlife in Industrial Development and Reclamation," Wyoming Game and Fish Department, Cheyenne, 1976.

12. "National Energy Outlook," Federal Energy Administration, February 1976.
13. National Energy Plan, Executive Office of the President, April 1977.
14. "Project Independence," Federal Energy Administration, November 1974.
15. Report by DOE, April 1978 News Release, "Latest Estimate of U. S. Uranium Resources."
16. "Mineral Resources and the Environment," Supplementary Report: "Reserves and Resources of Uranium in the U. S.," National Academy of Sciences, p. 106, 1975.
17. J. Klemenic and D. Blanchfield, "Production Capability and Supply (of Uranium)," Paper presented at Grand Junction, Colo., ERDA Uranium Conference, October 1977.
18. J. F. Pacer, Jr., "Production Statistics," Paper presented at Grand Junction, Colo., ERDA Uranium Conference, October 1977.

## 11. NRC BENEFIT-COST SUMMARY FOR THE MORTON RANCH MILL

### 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 at an economically attractive price (see App. G). 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 Morton Ranch 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 impact 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 Morton Ranch mill.

### 11.2 QUANTIFIABLE ECONOMIC IMPACTS

Section 4 of this Environmental Statement treats the quantifiable economic impacts for the Morton Ranch mill. On the one hand, many monetary benefits accrue to the community from the presence of the mill such as local expenditures of construction and operating funds, and the state and local taxes paid by the mill. Against these monetary benefits are the monetary costs to the different communities involved, such as 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 11.1, the benefit-cost summary for a fuel-cycle facility such as the Morton Ranch mill 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 Morton Ranch mill these uncompensated environmental costs are basically two: radiological impact and disturbance of the land. As shown in Section 4.7, the radiological impact of the Morton Ranch mill is acceptable by current standards. The disturbance of the land, as shown in Section 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 Morton Ranch mill, 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 Sec. 11.2.). This aspect of the project is currently receiving attention by the institutions directly concerned, and mitigation appears possible.

In considering the energy value of the  $U_3O_8$  produced, the 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 Morton Ranch project is favorable, and the indicated action is that of licensing of the Morton Ranch mill.



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 Morton Ranch uranium mill 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.

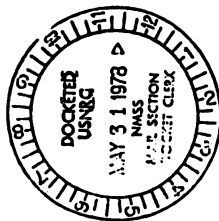
Letters of comment were received from the following:

- U.S. Department of Health, Education, and Welfare
- U.S. Department of the Army, Corps of Engineers
- U.S. Department of Energy
- U.S. Department of the Interior, Office of the Secretary
- U.S. Environmental Protection Agency, Region VIII
- State of Wyoming, Game and Fish Department
- State of Wyoming, Office of Industrial Siting Administration
- State of Wyoming, Department of Environmental Quality, Water Quality Division
- State of Wyoming, Department of Environmental Quality, Land Quality Division
- State of Wyoming, State Conservation Commission
- State of Wyoming, Department of Agriculture
- Environmental Coalition on Nuclear Power--Chauncey Kepford
- Environmental Coalition on Nuclear Power--William Lochstet
- Federal Energy Regulatory Commission
- U.S. Department of Agriculture, Soil Conservation Service
- State of Wyoming Executive Department, Governor
- State of Wyoming Executive Department
- State of Wyoming, Wyoming Recreation Commission



DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE  
PUBLIC HEALTH SERVICE  
FOOD AND DRUG ADMINISTRATION  
ROCKVILLE, MARYLAND 20857

MM 22 1378



Mr. Leland C. Rouse  
Chief, Fuel Processing  
and Fabrication Branch  
Division of Fuel Cycle  
and Material Safety  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

Dear Mr. Rouse:

The Department of Health, Education, and Welfare has reviewed the health aspects of the Draft Environmental Statement related to operation of the Morton Ranch Uranium Mill, United Nuclear Corporation, Docket No. 40-8062 and has the following comments to offer.

Chapter 4, Section 4.7.6. The annual radiation dose commitment to individuals at Fowler Ranch are within current radiation protection standards and are also within EPA's Environmental Radiation Protection Standards for Nuclear Power Operations (40 CFR 190). It would be helpful if the statement included a commitment that future operations will not result in whole body exposures greater than the EPA standard of 25 mrem/year that becomes effective on December 1, 1980.

Chapter 4, Section 4.7.7. Sufficient information is not included on the occupational dose for mill workers to permit assessing the adequacy of the control measures that will be used to minimize the dose. Also, it would be helpful to know if additional measures to assess worker exposures such as whole body counting and bioassay are to be included in the mill operating procedures.

Chapter 5, Section 5.1.3.2. The environmental consequence of accidental release of tailings slurry appears to have been minimized by use of the open-pit for solid disposal and the evaporation pond for the decanted liquid. It is important that the independent safety analysis be conducted to assure that adequate freeboard is available to contain the Probable Maximum Flood.

Since no data exist on open-pit disposal of tailings slurry, a condition should be added to the license to provide data needed for future environmental analysis of this disposal method on a schedule to be designated by NRC.

Mr. Leland Rouse

Chapter 6. The monitoring program for the proposed mill site is considered to be adequate for assessment of the environmental impact from planned mill releases.

Chapter 10, Section 10.44. The method for stabilization of the tailings after drying in the mine pits is to use a clay layer of 0.75 m (2.5 ft) in conjunction with 2.4 m (8 ft) of overburden. Sufficient information is not contained in the statement nor is there a reference to operating experience or studies that can be used to verify the staff calculation that this amount of material will reduce to radon exhalation rate to two times background. Paragraph 5 on page 3-13 indicates that research has begun to assess the impact of uranium mill tailings ponds and piles, and to obtain the data needed for determining the appropriate stabilization technique.

Appendix D. The detailed radiological assessment contains detailed dispersion and assessment based on the UGAP code. The use of this model to compute concentrations of the critical radionuclides (U-238, Th-230, Ra-226, and Pb-210) together with the proposed monitoring program should provide an adequate means for determining population exposure. However, for the first year of mill operations, considerations should be given to installing a tower at the site to obtain local meteorological data for use in the diffusion model for atmospheric dispersion of airborne effluents.

In summary, it is believed that the Morton Ranch Uranium Mill can be operated to meet current radiation protection standards and to provide adequate protection of the public health and safety.

Sincerely yours,

*Bernard L. Weaver*

Charles L. Weaver  
Consultant  
Bureau of Radiological Health

NRC RESPONSE TO THE DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Chapter 4, Section 4.7.6

The applicant will be required to maintain whole body doses below the EPA standard of 25 mrem/yr.

Chapter 4, Section 4.7.7

The review of the applicant's occupational radiation exposure monitoring program is not within the scope of this review but is documented in a safety evaluation report. Implementation of an NRC approved bioassay program for operating personnel will be a condition of the operating license.

Chapter 5, Section 5.1.3.2

NRC's independent safety analysis has concluded that the freeboard as indicated on p. 5-6 of this environmental statement is adequate to contain the Probable Maximum Flood.

The monitoring programs contained in Tables 6.2 and 6.3 of this statement meet the staff's requirements for data collection for this item.

Chapter 10, Section 10.4.4

Values given for the thicknesses of the clay, overburden, and topsoil covering layers needed for stabilization of Morton Ranch tailings disposal sites were calculated from general information on similar materials. Numerous articles exist in the open literature on the subject of radon diffusion through soil. Three articles have been added to the Section 10.4.4 literature citations as representative of existing literature from which the clay and overburden thicknesses were calculated by the staff.

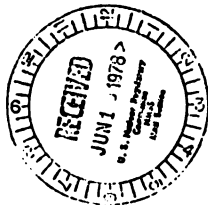
Appendix D

A meteorological tower has been installed on the site to collect local meteorological data for use in diffusion models.



DEPARTMENT OF THE ARMY  
OMAHA DISTRICT CORPS OF ENGINEERS  
6014 U.S. POST OFFICE AND COURTHOUSE  
OMAHA, NEBRASKA 68102

NRDPD-M



Director, Div. of Fuel Cycle and  
Material Safety  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

Gentlemen:

We have reviewed the Morton Ranch Uranium Mill Draft Environmental Statement for the requirements of a Department of the Army permit pursuant to Section 404 of the Federal Water Pollution Control Act as amended.

Based on the information submitted, the proposed activity will not involve the filling of a wetland area and is located on waterways which have an average annual flow of less than 5 cubic feet per second.

Therefore, in accordance with the final regulations, the proposed project is hereby permitted under the Nationwide permit provided the following are complied with:

- a. That the discharge will not destroy a threatened or endangered species as identified under the Endangered Species Act or endanger the critical habitat of such species.
  - b. That the discharge will consist of suitable material free from toxic pollutants in other than trace quantities.
  - c. That the fill created by the discharge will be properly maintained to prevent erosion and other nonpoint sources of pollution.
- In addition to the conditions specified above, the following management practices should be followed to the maximum extent practicable in the performance of the work:
- a. That fill in spawning areas during spawning seasons should be avoided.

NRDPD-M  
U.S. Nuclear Regulatory Commission

5 June 1978

- b. That fill should not restrict or disrupt the movement of aquatic species indigenous to the waters or the passage of normal or expected high flows or cause the relocation of the waters (unless the primary purpose of the fill is to impound waters).
- c. If the fill creates an impoundment of water, adverse impacts on the aquatic system caused by the accelerated passage of water and/or the restriction of its flow should be minimized.
- d. That fill in wetland areas should be avoided, especially several ponds in low-lying areas along the North Fork of Box Creek.
- e. Heavy equipment working in wetlands should be placed on mats.
- f. Sage grouse booming grounds should not be disturbed or infringed upon in the North Fork Box Creek Area.

It does not appear that any of the proposed measures would impact adversely on any existing or planned Corps of Engineers activities in the areas of concern.

We appreciate the opportunity to review this draft document. Please forward a copy of the final environmental statement when it becomes available.

Sincerely yours,

*John E. Velenhardt*  
JOHN E. VELENHARDT, P.E.  
Chief, Planning Division

NRC RESPONSE TO THE DEPARTMENT OF THE ARMY

United Nuclear Corporation states<sup>1</sup> that they will comply with conditions A through C. The staff would like to point out that material will not be discharged from the tailings impoundments. United Nuclear Corporation also states<sup>1</sup> that the management practices A through F will be implemented to the maximum extent practicable.

<sup>1</sup>Letter of Plant Superintendent, Wyoming Operations, United Nuclear Corporation, to U.S. Nuclear Regulatory Commission, dated August 3, 1978.



Department of Energy  
Washington, D.C. 20545

AUG 7 1978

Mr. Leland C. Rouse, Chief  
Fuel Processing and Fabrication  
Branch  
Division of Fuel Cycle and  
Material Safety  
Nuclear Regulatory Commission  
Washington, D.C. 20555

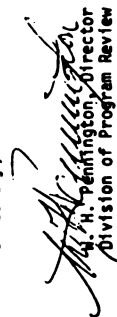
Dear Mr. Rouse:

Enclosed for your consideration are additional staff comments on the Commission's Draft Environmental Impact Statement, NUREG-0439, related to the operation of the Morton Ranch Uranium Mill, which were received after our transmittal of June 20, 1978.

We hope these comments may be useful in the preparation of the final statement.

Thank you.

Sincerely,

  
W. H. Pennington, Director  
Division of Program Review  
and Coordination  
Office of NEPA Affairs

Enclosure:  
Staff Comments

DEPARTMENT OF ENERGY STAFF COMMENTS  
ON THE  
NUCLEAR REGULATORY COMMISSION'S  
DRAFT ENVIRONMENTAL STATEMENT  
MORTON RANCH URANIUM MILL  
NUREG-0439

GENERAL COMMENTS

The potential impacts on the environment are generally quite reasonably described. However, some questions are raised concerning the management of liquid and solid tailings. This report contains several statements which seemed to be based on limited data or acknowledge insufficient information. Contingency plans do not appear to have been formulated to insure prompt action in the event of every type of potential accidental spill of tailings material. Of greater significance is that the environmental impacts refer only to the Morton Ranch Uranium Mine and Mill, and ignore the cumulative regional impacts. Bear Creek and Highlands Mills uranium facilities are located in the same area as the Morton Ranch and they contribute their share of groundwater as well as radiation impacts. The added and total impacts should be discussed in the final EIS.

SPECIFIC COMMENTS

Page 11, Table (Top of Page)

It is presumed that "a." is dose multiplied by population projected by each town though not specifically stated as in "b." IF NOT, the numbers do not relate.

Page 2-17, Surface Water (2.6.2.1)

"Concentrations exceeded U.S. PHS drinking water standards"-- appendix shows it being very high. Is there any explanation?

Page 2-23, Seismicity (2.7.3)

What are the 11 seismic events that are not natural events related to faulting?

Page 3-9, Transportation of Ore to Mill (3.2.4.1)

The short-term and long-term health and safety hazards of spilled ore should be addressed. Will the mine-to-mill roads remain in use after the site is abandoned? What is the planned procedure for removing spilled ore? Section 3.2.4.1 implies no cleanup is planned.

- 3 -

Page 3-11, Process Liquid Waste (3.2.4.5)

This is the first of many places where clay liners are assumed to prevent seepage. No studies were evidenced which would assure containment. It would be desirable that monitoring be conducted during operations and periodically thereafter to determine pathway potentials. In regard to seepage prevention, what is the capacity of the seepage sump? Is there a back-up pumping system for the sump pumps? Will the solids removed from the bottom of the evaporation pond also include the clay layer?

Page 3-12, Tailings (3.2.4.6)

The type and source of clay to be used in lining the pond and tailings pits should be specified, bentonite would be preferred. The applicant should determine the distribution coefficient of each significant radioactive ion for the clay to be used, under the chemical conditions which will prevail, for each such ion found in the effluent. The assumption of a  $K_d$  of 8 mL/g is not shown to be conservative in Appendix F. The contingency plans for frozen tailings lines should be described. Will ruptures occur before the frozen lines are detected?

Page 3-12, Stabilization and Reclamation of the Mill Tailings Area (3.2.5)

The layering seems within standard procedures, but reestablishment of vegetation on this seems limited.

Page 3-13, Stabilization and Reclamation of the Mill Tailings Area (3.2.5)

In Appendix F, the calculations show that the radium front in an undisturbed clay layer moves less than 0.16 m in 20 years. Although clays do not fracture well when wet, some slump and thinning of layers is possible, particularly if flooding causes turbulence in the pond. Complete containment cannot be guaranteed. This suggests that clay liner(s) at the bottom(s) of the evaporation pond(s) and all underlying soil that is contaminated should be treated as tailings and scraped out at the end of the operating period, before any use of the pond area for water impoundment is contemplated.

Does the State of Wyoming have statutes and procedures to enforce and policy in perpetuity the NRC requirements for management of the tailings disposal area? Were the costs to be incurred for administration of these perpetual controls included in the cost/benefit analysis? Who bears these costs? Wyoming? The Federal Government? (New Mexico has requirements for perpetual care funds for administrative control of tailings.) All these points should be discussed.

- 2 -

Page 3-13, Mill Decommissioning (3.2.6)

There are two statements that a surety arrangement will be instituted to cover costs of reclaiming the tailings disposal area. More details of the arrangement and statements about present institution and legal limitations on methods of surety arrangements should be discussed.

Page 3-19, Mill Decommissioning (3.2.6)

Do surety arrangements cover periods after decommissioning, i.e., in perpetuity from trust? Problems are perceived from a long time down the line, not the next 25 years.

Page 4-1, Air Quality (4.1)

The combined impact of the mill, associated mining activities, and other unrelated industrial activities on the airshed should be addressed.

Page 4-3, Water (4.3)

Is the conclusion that "the amount of (groundwater) contamination is expected to be very small even when combined with the impacts from the pit seepage" based on simulation of the groundwater flow expected under static conditions after operations have ceased as well as under operating conditions? Will the water table remain below the clay layer after dewatering has ceased and equilibrium is reestablished in the aquifer?

Page 4-3, Mineral Resources (4.4)

Any prognostications on which minerals "may" become valuable in future?

Page 4-5, Soil Quality (4.5.1.2)

Will soil ever recover full productivity? (Even 100 years)

Page 4-7, Terrestrial Vertebrates - Indirect Impacts (4.6.2.1)

Will birds be able to get into ponding areas and what will be potential consequences?

Page 4-8, Exposure Pathways (4.7.3)

There should be consideration and discussion of exposure pathways via earth modes.

- 5 -

Page 6-4, Preapplication Environmental Radiological Monitoring Program and Studies

"More information is needed concerning radon...pre-operational levels." Why is not the information required as a condition for licensing (along with other monitoring as shown in Table 6.2)?

Page 10-3, Alternative Methods for Tailings Management, Post Reclamation (10.4.1)

Point #7. Why? Reduce, perhaps.

Page 10-4, Option E (10.4.2)

It is not clear whether the compacted clay liner will be beneath the backfill or above it. The pit should be lined above the backfill to avoid migration of ions below the water table.

Page 10-9, Evaluation of Alternatives - Additional Options (10.4.3)

Even if the tailings are dewatered to 25% moisture, the pits should be clay lined to guard against long term moisture gains. Moisture could seep into the tailings either from collection in a tailings pit subsidence depression or from a rise in the water table.

The mine-pit liner design shown in Figure 10.2 does not include a clay liner over the completed fill. The fill is below the water table and could become saturated if the lower clay layer is fractured. The tailings should be in contact with impermeable material, i.e., a clay liner.

Why are two additional options under consideration for tailings management? Is option L considered unsatisfactory?

Page 10-9, Stabilization (10.4.4)

The stabilization of tailings by means of revegetated topsoil has been questioned in the past by the New Mexico Environmental Improvement Division. The MEID requires the Best Available Technology at the time of tailings stabilization. In order to take advantage of any advances in technology which may occur during the life of the mill.

- 4 -

Page 4-9, Radiation Dose Commitments to Individuals (4.7.4)

What is the cumulative dose commitment at the Fowler and Volman Ranches from all uranium mines and mills in the area? This may be a more significant dose because the Exxon Highland site is much closer to the two ranches.

Page 5-6, Release of Tailings Slurry (5.1.3.2)

Evaporation Pond Release

What is the justification for use of Box Creek to create an evaporation pond? In the event of the PMF, how much time will be required for evaporation of the floodwaters so that the pond can be used for the tailings solution? Appendix E states that "more than 100 years would be required for most of this pond water to evaporate," referring to the tailings water remaining at the end of 20 years of operation. How many PMF's will the pond be expected to hold in addition to tailings liquids? What procedures will be followed in the event of floodwaters filling the pond and pits to capacity? What procedures will be followed in the event of dam failure? If dam failure occurs while the pond is full, how far will the contaminated water flow down Box Creek? Can the spill be cleaned up? What will be the impacts of such a spill? Who is responsible for maintenance of the pond during the 10 years required for evaporation?

Page 5-9, Release of Tailings Slurry (5.1.3.2)

Open-Pit Mine Release

Paragraph 1: When quantity of release and extent of contamination are "difficult to predict," it raises many questions concerning contamination, spread, migration from site, etc.

Page 6-1, Water (6.3)

Are there any plans for post operational radiological monitoring?

Page 6.1, Soils (6.4)

Same comment as above.

Probable Maximum Flood

## NRC RESPONSE TO THE DEPARTMENT OF ENERGY

General Comments

There are presently no contingency plans to cover every type of accidental spill of tailings material. However, the applicant will clean up any accidental spills. NRC requires that all tailings embankments be inspected daily for erosion, cracks, and other signs of deterioration; the tailings slurry lines must similarly be inspected. In the event of a release of tailings to an unrestricted area, the applicant will be required to contact the Region 4 Inspection and Enforcement Division of NRC immediately.

Because of the distance between projects there should be no groundwater impacts that are cumulative with Bear Creek. Groundwater impacts are not expected to be cumulative with the Highland mill; however, an effluent and groundwater monitoring program has been proposed by the applicant (Table 6.3) which will serve to identify impacts (cumulative or not) before they become significant impacts.

Cumulative doses from airborne radionuclides will be highest at the Fowler Ranch. The combined particulate inhalation doses from Morton Ranch and Bear Creek at Fowler Ranch will be less than twice that shown in Table 4.2 and will thus represent about two percent of the EPA standard. Doses at the nearest boundary of Morton Ranch, attributable to Bear Creek, will be less than one percent of those from Morton Ranch; thus the doses from these two projects at the nearest boundary of Morton Ranch is essentially as shown in Table 4.2. The staff has not completed its assessment of the Highland mill; however, since the combined doses from Bear Creek and Morton Ranch are such a small fraction of the EPA standard at the Fowler Ranch, they will not be critical in determining compliance with the EPA standard, 40 CFR 190.

Page ii, Table (top of page)

The top lines (a) are the organ-dose commitments multiplied by the projected populations of the towns, as in Table 4.3. The table on p. ii has been amended.

Page 2-17, Surface Water (2.6.2.1)

The staff agrees that these measured values are high, but has no explanation for them.

Page 2-23, Seismicity (2.7.3)

The statement in the draft was misunderstood; only 12 seismic events are thought to be natural and fault-related. The other 11 are thought to be related to exploratory and/or coal-mine blasting.

Page 3-9, Transportation of Ore to Mill (3.2.4.1)

During operation, the applicant will control the release of dust from the roads as stated in Section 3.2.4.1. Ore haulage roads will be cleaned up and reclaimed at the end of mill operations as a part of the overall mill site decommissioning and reclamation program.<sup>1</sup>

Page 3-11, Process Liquid Waste (3.2.4.5)

Monitoring will be conducted during mill operations as outlined in Table 6.3.

The storage of the seepage sump on the downstream side of the effluent dam is approximately 6.3 acre-feet. Seepage through the dam is estimated to be less than 0.1 gallons per minute. At this seepage rate, and in consideration of the limited collection area of surface runoff that affects the seepage sump, it is not anticipated that pumping will be required. However, a back-up pumping system will be provided to insure that any effluent seepage is returned to the main effluent disposal system.<sup>1</sup>

Portions of the clay liner from the evaporation pond that are found to be contaminated at the end of mill operations will be removed and buried in a pit prepared to receive tailings solids.

Page 3-12, Tailings (3.2.4.6)

Clays will be obtained from excavations on or near the site, and illite is the most abundant. The staff believes that a distribution coefficient for radium of 8 ml/g is a conservative value (see App. F) and that the calculated seepage velocity, using this value, is an overestimate.

In the event of frozen tailings lines, mill tailings will be deposited in the evaporation pond until the problem is corrected. It cannot be predicted with certainty whether ruptures will occur before frozen lines are detected, but mill operators should be able to detect frozen line without difficulty. The applicant will clean up any spilled tailings.

Page 3-12, Stabilization and Reclamation of the Mill Tailings Area (3.2.5)

Reestablishment of vegetation will require careful consideration of such factors as kind of seed, seeding rate, and depth and time of seeding; but the major limiting factor is the amount of rainfall (12" annually), not the layers of clay and overburden beneath the topsoil.

Page 3-13, Stabilization and Reclamation of the Mill Tailings Area (3.2.5)

Contaminated clays and other soils will be removed with the tailings.

As provided by the Uranium Mill Tailings Radiation Control Act of 1978, ownership of the tailings and tailings disposal site will transfer to the federal or state government upon termination of NRC's license for this facility. Rules have yet to be developed implementing state ownership. Administrative costs of monitoring and control of tailings sites should not be costly and is being addressed in the Generic Environmental Impact Statement on Uranium Milling which will be issued shortly.

Page 3-13, Mill Decommissioning (3.2.6)

Deposition of tailings will not be permitted until final surety arrangements are made. Limitations on methods of making surety arrangements will be addressed in the Generic Environmental Impact Statement on Uranium Milling which will be issued shortly. A surety bond is the surety arrangement method expected to be used by this applicant. Surety arrangements for the tailings area will be made within the requirements of the Wyoming Environmental Quality Act of 1973 (as amended) and will cover mining reclamation as well.

Page 3-19, Mill Decommissioning (3.2.6)

Surety arrangements do not cover periods after decommissioning. See response to DOE comment on page 3-13 (3.2.5).

Page 4-1, Air Quality (4.1)

Mining activities have been addressed in the FES-TVA.<sup>2</sup> Unrelated industrial activities are not within the scope of this statement.

Page 4-3, Water (4.3)

Conditions after operations cease were considered in the staff's conclusion (Appendix F). By backfilling the pits with unclassified fill to a level above the original water table as shown in Figure 3.6, the water table will be below the clay liner.

Page 4-3, Mineral Resources (4.4)

Minerals typically occurring with uranium include molybdenum, nickel, cobalt, copper, and vanadium. Such mineral content could become valuable in the future if economics warrant.

Page 4-5, Impacts (4.5.1.2)Soil Quality

With the restoration of vegetation, organic material, and microorganisms, and the addition of nutrients and other substances or treatments as required by the state of Wyoming, the land can be made as productive (in terms of ground cover) as it was before it was disturbed. Reclamation is not considered to be completed until the vegetation cover of the affected land is shown to be capable of self renewal under natural conditions and until the cover is at least as dense as undisturbed areas in the immediate vicinity. The terms "natural processes" and "full productivity" may have been misleading. The statement has been modified to reflect this.

Page 4-7, Terrestrial Vertebrates (4.6.2.1)  
Indirect Impacts

See response to the comment of the State of Wyoming Game and Fish Department (p. A-27).

Page 4-8, Exposure Pathways (4.7.3)

The pathways by which man may receive dose are (1) ingestion, (2) inhalation, and (3) external  $\gamma$  from air or ground. Section 4.7.3 has been amended to specify the dose pathways.

Page 4-9, Radiation Dose Commitments to Individuals (4.7.4)

See response to DOE general comment (p. A-9).

Page 5-6, Release of Tailings Slurry (5.1.3.2)  
Evaporation Pond Release

A portion of Box Creek has been selected as the site of the evaporation pond because of its favorable topography.

Appendix E states, "More than 10 years would be required for most of this pond water to evaporate, ..." (p. E-4). One PMF series is the design capacity of the pond. A PMF series is 1.4 PMF's plus a 100-year flood. The staff estimates that it would take about four years for the PMF series floodwater to evaporate. The applicant would maintain the ponds during this time period. Tailings liquids would not be decanted from the pits to the evaporation pond until evaporation of PMF floodwater left adequate freeboard.

The accidental release of tailings solution is discussed on page 5-10. Licensees are required to notify NRC if an impoundment failure causes the release of tailings to unrestricted areas.

Page 5-9, Release of Tailings Slurry (5.1.3.2)  
Open-Pit Mine Release

There is little experience with the proposed method for open-pit disposal of tailings; however, the staff believes that there would be little spread of contamination from the site if a PMF event occurred when a pit was filled nearly to capacity. Tailings-disposal pits will be constructed in depleted areas of the ore trends. In the case of a PMF event, much of the pit overflow would enter the active sections of the open-pit mines. The capacity of these sections would exceed the flows expected during a PMF event.

Page 6-1, Water (6.3)

A water monitoring program as outlined in Table 6.3 will most likely be required until the licensee's license is terminated.

Page 6-1, Soils (6.4)

Decommissioning soil surveys will be necessary.

Page 6-4, Preapplication Environmental Radiological Monitoring Program and Studies (6.6.1)

Preoperational monitoring is not a license condition because it will be completed prior to operation under the license.

Page 10-3, Alternative Methods for Tailings Management, Introduction (10.4.1)  
Post Reclamation

The staff does not believe that tailings management plans should be designed requiring ongoing monitoring and maintenance. Therefore, our objective is to eliminate the need for it.

Page 10-4, Alternatives (10.4.2)  
Option E

The bottom liner in Option E will be above the water table as shown in Figure 3.6.

Page 10-9, Evaluation of Alternatives (10.4.3)  
Additional Options

The staff will consider these items in our assessment of these additional options. The revised clay liner design is under consideration because it may improve the stability characteristics of the clay liner. The dewatering option was mentioned as an additional option because it may be proposed by the applicant and it has environmental advantages.

Page 10-9, Stabilization (10.4.4)

Although revegetation is recommended as part of the stabilization and reclamation program at this site, it may not be appropriate at all sites, such as a site with insufficient precipitation to support vegetation.

Some changes may be made to reclamation plans during stabilization; however, the only stabilization and reclamation program that the licensee is required to perform is that which has previously been reviewed and accepted. It's therefore necessary that best available technology be incorporated in a tailings management plan during the review process rather than at the time of stabilization. Also, in order to assure that adequate funds are available to accomplish stabilization and reclamation, specification of the program cannot wait until it is time for stabilization. However, as technology advances the NRC as the regulating agency can require revisions to tailings area reclamation plans.

Reference

1. Letter of Plant Superintendent, Wyoming Operations, United Nuclear Corporation, to U.S. Nuclear Regulatory Commission, dated September 13, 1978.
2. Tennessee Valley Authority, "Final Environmental Statement, Morton Ranch Uranium Mining," Chattanooga, Tennessee, January 20, 1976.



## United States Department of the Interior

OFFICE OF THE SECRETARY  
WASHINGTON, D.C. 20240

In Reply Refer To:  
ER-78/344

JUN 22 1978

Director, Division of Fuel Cycle  
and Material Safety  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

Dear Sir:

We have reviewed the draft environmental statement for the Morton Ranch Uranium Mill in Converse County, Wyoming.

### GENERAL COMMENTS

The absence of a discrete section on mitigation leads to a somewhat confused picture as to what measures are to be applied. A separate section concisely outlining mitigating measures would provide the reader with a clearer understanding of what is to be required. This section should be in addition to item 7 of the summary sheet.

We would like to stress the importance of full implementation of the mitigation measures suggested by our Fish and Wildlife Service (copy attached). The increased number of people residing in Converse County and traveling through the area to work and to leisure activities will result in significant increased mortality to wildlife population (road kills, hunting harvest, and poaching). We suggest that United Nuclear Corporation make it company policy to encourage wildlife conservation in the area, especially among employees.

### SPECIFIC COMMENTS

Page 2-12, Land Ownership: The description does not mention Federal surface on the project area. The following parcels are Federal:

2

T35N, R71W  
Sec. 18, NW¼ NW¼  
T35N, R72W  
Sec. 4, SE¼ SW¼  
Sec. 12, S¼ SE¼: portion of NW¼ SE¼ SW¼ SE¼  
  
T36N, R73W  
Sec. 12, SE¼ SE¼  
Sec. 13, NW¼ SW¼-13 acres of minerals patented  
Sec. 23, NE¼ NE¼

Page 3-10: The statement indicates that figure 3.4 depicts the pathways by which radioactivity from mining and milling operations would enter air, surface water, and ground water (p. 3-9, sec. 3.2.4, par. 1), but figure 3.4 shows only pathways by which radioactivity enters air and ground water. The potential surface-water pathways also should be indicated.

Page 3-12: Stabilization and Reclamation: Mention is made here and on page 4-5 of a more thorough discussion of tailings management in Chapter 10 (alternatives). There is a question as to whether these measures will be applied as a part of the proposed action or will only be considered as an alternative.

Page 3-13, paragraph 3: The majority of these lands, including those occupied by mine and tailing ponds, include active oil and gas leases. The statement should discuss how oil and gas leases will be compensated if the mine/mill/tailing pond area is to be fenced and access prohibited.

Page 4-2, Transportation: Mention is made that additional access will be required; the means of acquiring this access should be described.

Page 4-5 and 10-11: We suggest that topsoil cover be increased to an 8-inch minimum. This area has a high prevailing wind and the soils generally are sandy. If intensive protection measures, such as burlapping or mulching, are not utilized, some topsoil will be lost. If only 6 inches is applied, a 1- to 2-inch loss would be disastrous for establishing vegetation. A slurry fertilizer-mulch-seed mix that binds the soil until vegetation is reestablished might be considered as a part of the reclamation plan.

Page 5-6, section 5.1.3.2: The results of the independent analysis conducted to determine the freeboard on the evaporation pond necessary to contain the probable maximum flood should be included in the final environmental statement.

Wildlife Mitigation Measures

1. All fencing should specifically consider antelope and deer populations occurring in the area and provide for their necessary movements, general well-being, and safety.
2. Land reclamation directed towards creating a smooth, level topography best suited to raising monoculture crops or providing forage for domestic livestock will result in a permanent loss of wildlife habitat. Restoring the topography to approximately its original form might best mitigate damages to existing wildlife habitat.
3. Reclamation efforts should be designed to re-establish native flora that will survive in this semi-arid climate and provide browse species of forbes and shrubs palatable to antelope, deer, and sage grouse.
4. Power lines and their supports should be designed to prevent the electrocution of raptors.
5. Selected high walls remaining after the mining operation might be left to provide valuable nesting sites for raptors where this procedure does not seriously conflict with overall reclamation plans.
6. Your company should stress wildlife preservation needs to all employees working in the area and take any necessary action to prevent local poaching and harassment of wildlife.
7. Procedures designed to discourage the use of any caustic waters in tailing ponds by waterfowl and other species of wildlife should be initiated.
8. All construction activity, including that necessary to provide roads and trails in the project area, should avoid the destruction of the scarce riparian wildlife habitat found in the area.
9. Fish and wildlife habitats suitable for management and multiple use by the general public could be made available to the Wyoming Game and Fish Department after the project is terminated.

Biologists of the Wyoming Game and Fish Commission are well equipped to advise you on the details of implementation of the above broad recommendations. We urge that you consult that agency in a consistent and positive manner as your project progresses.

3

Page 6-5, 6-10, 6-11: Monitoring of ground water should include the area(s) downgradient from the evaporation pond and the dam. The preferred alternative for tailings disposal, option L, requires thick clay liners on the bottom and sides of the tailings disposal pits (depleted open mine pits). Pooled liquid will be decanted from the pits (p. 3-17, 10-6). However, the statement should explain how the integrity of the clay linings will be maintained on the sides of the pits, as liquids are introduced with the tailings slurries and as pore pressures slowly build up within the clay liners. We note that other options have considered solving this problem by guniting or using membranes on the side walls, for example (p. 10-4). On page 10-9 the text reports that the applicant is experimenting with additional alternatives for disposal of tailings. One method would involve dewatering and storing the tailings above the water table in unlined pits. If this alternative is seriously considered, a supplement to the draft statement should be prepared.

Page 10-11, Reclamation: Nothing is mentioned about reclamation of Federal surface. The applicant should consult with the Bureau of Land Management on reclamation of any disturbance to Federal surface.

Thank you for the opportunity to comment.

*[Signature]*  
 Larry E. Meierotto  
 SECRETARY

Deputy Assistant

Enclosure

## NRC RESPONSE TO THE DEPARTMENT OF THE INTERIOR

Paragraph 1

The staff believes that mitigating measures are best described in the sections of the environmental statement describing the design or impacts assessment for which the mitigating measures apply.

Paragraph 2

See response to Wildlife Mitigation Measures on page A-16.

Page 2-12

Figure 2.5 has been revised and shows these federal lands. These federal lands are not within the mill site boundary.

Page 3-10

Page 3-9 was in error; there will be no surface water pathway through normal operation of the Morton Ranch mill. The text has been corrected.

Page 3-12

The measures discussed in Section 3.2.5 on page 3-12 are part of the proposed action, also referred to as Alternative L in Section 10.4. The measures discussed on page 4-5 under soil quality are also part of the proposed action.

Page 3-13

It is not likely that an oil or gas leasee would want to drill in an area occupied by a mine or tailings disposal area. However, in the event drilling for oil or gas were to take place, slant hole drilling would be employed as oil and gas bearing formations occur at depths thousands of feet below the surface in the Wyoming locale. Fenced and prohibited access would not necessarily create a problem due to the advanced technology in slant hole drilling. Prior oil and gas drilling in this area has not been productive, therefore, it is felt that the likelihood of drilling for oil and gas over the long term would be minimal.<sup>2</sup>

Page 4-2

Roads will have to be constructed on-site to the proposed evaporation pond area. Access from adjoining property will not be involved.

Pages 4-5 and 10-11

The staff agrees that an eight-inch minimum depth of topsoil would be more desirable than the proposed minimum of six inches. Unfortunately, available "topsoil" is sufficient to provide only four to five inches of cover (Section 4.5.1.2, p. 4-5). More such soil could be obtained from a borrow area, but this would only compound the revegetation difficulties by causing an impact elsewhere. For this reason, the staff has urged the applicant to stockpile as much "sub-topsoil" as is available (found at an average depth of 27 cm (11 in.)) and to use this soil between the overburden and topsoil (Section 10.4.4). In addition, the applicant will minimize wind and water erosion by various means and will employ straw or other mulch in especially critical areas (Section 4.5.1.2, p. 4-5).

Page 5-6, Section 5.1.3.2

NRC's independent safety analysis has concluded that the freeboard indicated on page 5-6 of this statement is adequate to contain the Probable Maximum Flood.

Pages 6-5, 6-10, 6-11

Groundwater monitoring of areas downgradient from the evaporation pond and dam is included in Table 6.3.

The buildup of pore pressures is taken into consideration by the use of consolidated undrained triaxial compression tests in the design of the liner. Also, the solution will be decanted from the impoundment so that there will only be a shallow pond in the impoundment, and the tailings will provide some strength to the embankment.

Dewatering of tailings is being seriously considered by the applicant as an alternative to Option L. However, for the dewatering alternative, the floor of the pits will be lined. If a revision of this nature is proposed, the staff will perform an environmental assessment of this alternative and will determine at that time whether a supplement to this environmental statement need be prepared.

#### Page 10-11

There will be no disturbance of the federal surface due to the construction or operation of the Morton Ranch uranium mill. Surface disturbance due to mining operations are discussed in the TVA-FES.<sup>1</sup> We agree that the applicant should consult with the Bureau of Land Management regarding reclamation of any disturbance to federal surfaces.

#### Wildlife Mitigation Measures

The applicant states<sup>2</sup> that it will implement in its construction operation and reclamation activities the wildlife mitigation measures forwarded by the Department of Interior Fish and Wildlife Service.

It is currently the applicant's policy to encourage wildlife conservation in any areas in which they operate, and to encourage wildlife conservation practices among their employees.<sup>2</sup>

The applicant also states that officials of the Wyoming Game and Fish Commission have been consulted in connection with their planning efforts and will be further consulted in a consistent and positive manner throughout the project life.<sup>2</sup>

#### Reference

1. Tennessee Valley Authority, "Final Impact Statement, Morton Ranch Uranium Mining," Chattanooga, Tennessee, January 20, 1976.
2. Letter of Plant Superintendent, Wyoming Operations, United Nuclear Corporation, to U.S. Nuclear Regulatory Commission, dated August 3, 1978.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VIII  
1850 LINCOLN STREET  
DENVER, COLORADO 80203

July 3, 1978

Ref: BAH-WH

Leland C. Rouse, Chief  
Fuel Processing & Fabrication Branch  
Division of Fuel Cycle and Material Safety  
U. S. Nuclear Regulatory Commission  
Washington, D.C. 20555

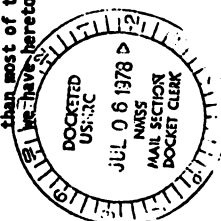
Dear Mr. Rouse:

We have completed reviewing your Agency's recently-issued Draft Environmental Statement (DES) on the Morton Ranch Uranium Mill (NUREG-0439).

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 on the Morton Ranch property, as proposed, without requiring significant changes or modifications.

When the Morton Ranch is licensed and begins operation, there will be three, fairly large, operating uranium mills located in Converse County, Wyoming. In our view, any additional mills in the County should be avoided to prevent the deleterious effects on a given land area faced with supporting clustered industrial entities producing the same environmental impacts.

The most positive feature of the proposed project is its plan for the disposal and long-term stabilization of the radioactive residuals leaving the milling process as waste. By disposing of this material in the mined-out pits, the overall acreage disturbed by the project is minimized. Also, this system's unique design has a far greater potential for safely containing the radioactive legacy our society must live with over many millennia than most of the tailings disposal and stabilization schemes we have heretofore dealt with.



2

According to the procedures EPA has adopted to rate environmental statements, NUREG-0439 will be listed in the Federal Register as LO-2. This means that based on the information presented, we have no environmental objection to the project, but request some additional information be presented.

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 yours,

*Charles C. Gonyea*  
for Alan Merson  
Regional Administrator

Enclosure

(FACSIMILE)

EPA REGION VIII  
SPECIFIC COMMENTS ON  
DRAFT ENVIRONMENTAL STATEMENT (DES)

(NUREG-0439)  
MORTON RANCH URANIUM MILL

1. Page iii, Section 2g: The applicant's emergency response capability should be included in the Final Environmental Statement for review and comment.
2. Page iii, Section 8: In the "Position of the NRC," it is stated that the issuance of a source material license will be subject to condition 7a through condition 7h (on pages ii and iii). What about condition 7i on page iii (i.e., provision of surety arrangements)?
3. Page v, Contents: The page number reference for Section 3.2.6, "MTR Decommissioning," is misnumbered. It should read page "3-13."
4. Page 1-6, Table 1.1: Table 1.1 notes that three wastewater discharge permits (RPDES) have been granted and renewals have been extended to April 1, 1978. Are discharges expected at the Morton Ranch Uranium Mill in the future (and permit renewals applied for)?
5. Page 1-7, Section 1.5, Item 3: Considering the close proximity of other uranium mines and mills to the proposed uranium recovery complex (Notably the Exxon uranium mine and mill), the NRC staff conclusion presented here is questionable and requires verification; specifically--  

"The relative isolation of the proposed site virtually ensures that all appropriate environmental impacts can be adequately addressed in this site-specific environmental statement."

There would appear to be a strong potential for cumulative environmental impacts attributable to waste-disposal practices at the Exxon and UMC-TVA sites.
6. Page 2-15, Section 2.6.1.1: All streams within the site area are stated as being intermittent. Is any flow data available for North and South Forks of Box Creek, Lightning Creek, and Cowell Draw?

7. Page 2-15, Section 2.6.1.2: The DES does not adequately discuss the groundwater situations immediately under the mill site. There needs to be some discussions as to the depth to water in the alluvium and in the Mesatch Formation. There should be some discussion as to whether ground water in the alluvium may contribute to flow in Box Creek.
8. Page 2-17, Section 2.6.2.1: It would be helpful if in the Final Environmental Statement it is delineated which samples are from natural springs and ponds and which samples are from ponds created as part of the mine-development activities.
9. Page 2-23, Section 2.7.2.3, third paragraph: Is the sub-bituminous coal still uneconomical to mine if it has to be removed as overburden? It would seem less wasteful to set this material aside for sale if economically feasible.
10. Page 2-24, Section 2.9.1.1: The vegetative cover is stated as being generally sparse. An evaluation of total vegetative cover and subsequent erosion control would be helpful in determining revegetation potential.
11. Page 3-1, Section 3.1: The specifics and potential impacts of the mining operations are not detailed in the DES. Since the environmental impacts of mining are cumulative with those from milling, this constitutes a significant omission. Information of importance is:
  - a. The average daily volume of dewatering effluent--from each mining area.
  - b. The proposed handling and disposal procedures for dewatering effluent. Since the daily flow exceeds that which can be used in the mill process, the drainages receiving such effluent should be identified.
  - c. Treatment procedures, if any.
  - d. Effluent monitoring procedures--sampling and analysis.

The reclamation plans for the northern mining area--underground mine--are not presented.
12. Page 3-1, Section 3.2: It is not clear that the yellowcake is 95% U<sub>3</sub>O<sub>8</sub> at an oxidizing temperature of 1000°F (540°C) since complete conversion to U<sub>3</sub>O<sub>8</sub> occurs between 650 and 800°C. The amount of uranium oxide versus ammonium diuranate can be of significant concern from an accident standpoint (insolubility vs. solubility).

13. Page 3-6, Section 3.2.3.3: The cited 95% dryer scrubbing efficiency seems inconsistent with Table 3.2 and Section 3.2.3.5.
14. Page 3-6, Section 3.2.3.3: Have any estimates been developed for suspended particulate emissions from the raw ore stockpiles and tailings disposal areas?
15. Page 3-9, Section 3.2.3.5: A more detailed description of the water spraying measures for controlling ore stockpile dust would be helpful.
16. Page 3-9, Section 3.2.4.1: Any significant amount of ore spillage should be picked up.
17. Page 3-13, Section 3.2.5, last paragraph: Drilling, digging and excavation should also be prohibited.
18. Page 3-14: This page is blank. Is this space reserved for further mill decommissioning information?
19. Page 4-3, Section 4.3: Seepage estimates have been provided for the evaporation pond and tailings disposal pits. What is the expected quality of this seepage?
20. Page 4-9, Table 4.2: Why isn't the dose commitment from Po-210 calculated?
21. Page 4-10, Section 4.7.4.2, Direct Radiation: The value of 12 mrem/year at the tailings surface seems much too low. We have measured exposure rates of a few mrem per hour on a number of tailings piles.
22. Page 5-3, Section 5.1.2.1, third paragraph: There has now been a third major solvent extraction fire at the Rossing Uranium Mill in South Africa.
23. Page 5-8, Table 5.1: provides predicted concentrations of radionuclides in the tailings solution. Predicted concentrations of other parameters (e.g., pH, sulfate, chloride, nitrate, etc.) would be helpful. In addition, estimates of concentrations should be provided for evaporation pond water.
24. Page 5-13, Section 5.3.1, fifth paragraph: Since the yellowcake can contain up to 5% Th-230, dose commitments from this nuclide should be discussed. The calculations should also take into consideration the fact that some fraction of the yellowcake is soluble (ammonium diuranate).

25. Page 5-13, Section 5.3.1, 6th paragraph: While it is true that in the September 1977 truck accident an estimated 15,000 lbs of yellowcake was spilled, it is important to know that 39 of the 50 drums were either destroyed or substantially damaged. The yellowcake in these drums amounted to 33,000 lbs.  
  
The truck had passed through Denver earlier, where the population density and potential for an accident were far greater. These facts should have been used in the calculation of the accident consequence. Additionally, the major potential hazard is not a radiological lung dose, but rather chemical toxicity to the kidneys.  
  
The accident emergency response plan was grossly inadequate and it was only because of a number of fortunate circumstances that larger quantities of yellowcake were not dispersed. The accident and its subsequent handling should not be used as an accident hazard model. A comprehensive emergency response plan for yellowcake truck accidents is still required.  
  
The U. S. Department of Transportation yellowcake packaging requirements referenced in the NRC regulations are inadequate. One consideration would be to seek the design of smaller and more-substantial containers for the entire industry, particularly since the contained product is a valuable commodity.
26. Page 5-13, Section 5.3.1., last paragraph: Since the applicant has submitted a transportation emergency action plan to the NRC, it should be included in the Final Environmental Statement.
27. Page 6-1, Section 6.3: The pre-operational groundwater monitoring should include analyses for the standard chemical constituents and selected heavy metals to provide baseline data for operational monitoring. These samples should be taken at least twice a year.  
  
The section on monitoring is not clear as to what geologic unit the groundwater monitoring wells will tap. The main emphasis should be placed on monitoring the unit which immediately underlies the ponds (which is apparently the alluvium). At least one of these wells should be immediately adjacent of the down-gradient side of the ponds. If the alluvium is dry, consideration should be given to installing a vacuum lysimeter under the pond site to enable samples in the unsaturated zone to be taken.

28. Page 6-2, Section 6.6.1: Although the lack of baseline radioactivity data for environmental media (on-site and off-site) was cited as a major deficiency of the TVA Environmental Statement for Norton Ranch Uranium Mining, little effort, if any, has been expended to correct this deficiency. The data in this DES are not substantially greater than those in the TVA Environmental Statement. The critical question is when will a comprehensive pre-operational monitoring program be implemented. In order to obtain meaningful, baseline values, data must be obtained before open-pit mining is started at an operational level.
29. Page 6-4, Section 6.6.1: We agree strongly with the MRC staff that additional pre-operational radiological environmental monitoring is needed. We have serious reservations about some of the reported data. We are especially curious about the value and rationale of gross alpha (or gross beta) soil analyses.
30. Page 6-4, Section 6.6.2: There are deficiencies in the proposed post-operational monitoring program:
- The proposed program provides for only one surface water station--on the drainage system downstream of the mill and tailings area. There also should be an upstream station. The surface drainage for the northern mining area--Cowell Draw--should be sampled at upstream and downstream locations following precipitation events. Drainages receiving mine dewatering effluent should be sampled at the site boundary at a frequency greater than quarterly--recommend monthly.
  - Sediment samples should be collected at each surface water station--annually; preferably semi-annually.
- There are substantial differences between the proposed preoperational and operational monitoring programs. For comparison purposes, during at least the first year of mill operation, the monitoring program should be identical to that conducted during the pre-operational period.
31. Page 6-5, Table 6.2: In addition to groundwater monitoring wells associated with the tailings disposal pits, an appropriate groundwater monitoring program should be established with respect to the evaporation pond (e.g., in the Box Creek alluvium). (Note: Figure 6.1 shows some wells in the vicinity of the evaporation pond, but they are not described in either Table 6.2 or Table 6.3.)

32. Page 7-1, Section 7.3: This Section just mentions unavoidable effects on water quantity. What about potential effects on ground and surface water quality?
33. Page 10-9, Section 10.4.3, Additional Options: While we would encourage the assessment of newly developed methods of mechanically dewatering tailings before placement into mined out pits, the utilization of unlined pits for dewatered tailings seems risky given the number of groundwater wells in the area (something like 111 in a six-mile radius).
34. Page 10-11, Section 10.4.5: As we have commented on other environmental statements, there is some question about the desirability of revegetating uranium tailings pile cover because of the possible transport by vegetation of radio-nuclides from the tailings to the surface.
35. Page C-3, "Radium-226  $\pm$  precision": We question whether this is precision or counting error. It would be more useful to show the individual results of the duplicate analyses instead of apparently presenting average results.
36. Page C-5, Table C.4: There appears to be little or no correlation between gross alpha, radium and uranium content.
37. Page D-19: We suggest that this information be rechecked. See EPA-520/1-76-001, Table 3.3-2. It would appear that the value of 0.625 mrem/yr per pci/m<sup>3</sup> should more correctly be 4 mrem.

## NRC RESPONSE TO THE ENVIRONMENTAL PROTECTION AGENCY

1. The need for revised requirements for yellowcake packaging and transport is being evaluated by an interagency (DOT and NRC) study group and a report will be issued on its results. The study group has concluded that the carrier is responsible for any emergency action following a yellowcake transportation accident. The staff is therefore not requiring an emergency response capability by applicants although we encourage them to be prepared to render assistance in the event of such an accident. If the interagency study results in any rule making requiring shippers to have such an emergency response plan, then our position will be revised accordingly.
2. This typographical error has been corrected.
3. The page number has been corrected to read 3-13.
4. There will be no discharges from the milling operation into any surface waters. Mine discharges have been covered in the Final Environmental Statement, Morton Ranch Uranium Mining, by TVA.<sup>1</sup>
5. The staff still supports this statement. It should be emphasized, however, that an effluent and groundwater monitoring program has been proposed by the applicant (Table 6.3) which will serve to identify cumulative impacts before they become significant impacts.
6. The staff is not aware of any existing flow data for the North and South Forks of Box Creek, Lightning Creek, or Cowell Draw.
7. The text has been revised (see Sec. 2.6.1.2) to include a discussion of the groundwater in the site tailings area and its contributions to the flow in Box Creek.
8. The water contained in the playa and the stagnant impoundment (samples TVA-2 and TVA-3 in Table C.1) results in part from mine-development activities. (ER, pp. 2-48 and 2-46)
9. Because the subbituminous coal in the Morton Ranch area occurs in thin and discontinuous seams, it is doubtful that its stockpiling, storage, processing, and transportation could be economically justified at the Morton Ranch site. However, if more coal is encountered than currently anticipated, the staff encourages the applicant to consider the sale of this coal as an alternative to its disposal.
10. The broad statement on page 2-24 that the vegetation is sparse refers to vegetation in the general area (western North American prairie or eastern Wyoming). The vegetation in the immediate area (applicant's ER, Fig. 2.8-2, sample site 3) is described specifically in Table 2.5, which includes percent of ground cover. Procedures to minimize wind and water erosion are described on page 4-5 of this environmental statement.
- 11(a) and (b). Impacts from mining on the Morton Ranch, an activity not licensed by NRC, are assessed in the TVA-FES. The Morton Ranch Uranium Mill Environmental Statement assesses the potential impacts of mill construction and operation, including the impacts involving that portion of mine water that will be used in the mill. The volumes and handling and disposal procedures for other mine waters are discussed in detail in the TVA-FES.<sup>1</sup>
- 11(c). Mine waters will be treated with barium chloride, as explained in a letter from the Plant Superintendent, United Nuclear Corporation, Wyoming Operations, to the U.S. Nuclear Regulatory Commission dated May 4, 1978 (see p. A-61, A-62).

- 11(d). Monitoring requirements for the dewatering effluent streams are as required by NPDES permits WY-0022098, WY-0024571, and WY-0024562.

Reclamation plans for the mines--underground and open pit--are presented in the TVA-FES.

12. The remaining 95 percent of the yellowcake product from the Morton Ranch mill is believed to be a mixture of ammonium diuranate ( $(\text{NH}_4)_2 \text{U}_2\text{O}_7$ ) and uranium oxide ( $\text{U}_3\text{O}_8$ ). The percentage of each of these compounds is not well known and will vary to some extent depending upon the conditions under which the product is dried or calcined. For the purpose of assessing radiation exposures from the routine releases of yellowcake from the Morton Ranch mill, the staff assumed that the yellowcake product was all  $\text{U}_3\text{O}_8$ . This is a conservative assumption in estimating radiation exposures because  $\text{U}_3\text{O}_8$  is a more insoluble compound than ammonium diuranate. Calculations based on the inhalation of uranium oxide result in higher estimated organ doses than do calculations based on inhalation of ammonium diuranate.
13. The staff agrees. The anticipated efficiency of the wet scrubber and bag dust collector in stack No. 4, which services the yellowcake dryer and packaging operations, is given in ER Suppl. II, 1977, p. 3-12, as 99.8% for 1- to 2- $\mu$  particulates.
14. At Morton Ranch, dusting will be controlled by the use of chemical or physical methods during dry seasons. Particulate emissions from the ore piles are expected to be negligible when compared to those from the feeding and grinding stacks, and from other aspects of mill operations. Therefore, no estimates are available specifically concerning particulate emissions from ore stockpiles.

Particulate emissions from the tailings are included in the radiological assessment and the discussion on page 4-1.

15. The spraying of water to decrease dusting will be dependent upon weather conditions. Details of the program are left up to the applicant, provided the applicable maximum permissible concentration limits are not exceeded in the mill vicinity.
16. Ore spillage is not expected to create a significant source term, as the applicant will spray the roads with water to decrease dusting, as indicated in Sec. 3.2.4.1, p. 3-9. Also, the applicant states<sup>3</sup> that ore haulage roads will be cleaned up at the end of mill operations.
17. Land use restrictions to be placed on the tailings disposal site will preclude digging, excavation, or any other intrusive action except for actions approved by the NRC which assure that the residual radioactive materials will be restored to a safe and environmentally sound condition.

Requirements for land use restrictions will be affected by regulations to be issued pursuant to Section 202 of the Uranium Mill Tailings Radiation Control Act of 1978 which added a new section to the Atomic Energy Act, Section 83, "Ownership and Custody of Certain Byproduct Material and Disposal Sites."

18. The blank page in the DES occurred as an error in printing.
19. The staff has concluded that radionuclides will be permanently sequestered in the clay liner and will not enter the groundwater but that anion contaminants such as sulfate and chloride will move with the water (Appendix F). Because of this the applicant has included water quality monitoring in their monitoring program (Table 6.3).
20. The contribution from Po-210 is extremely small relative to the dose commitments from the listed radionuclides.
21. A typographical error was made in the draft statement. The value should be in "rem", not "mrem". The text has been changed to correct the error.
22. The staff is aware of the Rossing Fire, but has not, as yet, been able to obtain reliable information regarding this incident. The details of the incident will be factored into future NRC impact assessments when good information becomes available.
23. The concentrations of the parameters requested have been calculated for the liquid waste effluent of a "typical" uranium mill and are presented in Table 23-1 (on the next page). The composition of the evaporation pond water solution will initially be about the same as that of the tailings solution, but the concentration of solutes will increase as the water evaporates because the solutes are either non-volatile or much less volatile than water. As noted in the response to Comment 19 above, the solutes can be lost by seepage into or through the clay liner at an undetermined rate; thus, no prediction of the evolution of the solute concentrations with time can be provided.

Table 23-1. Chemistry of tailings pond liquids

| Parameter       | Mill Effluent<br>Liquid Waste<br>Concentration<br>(mg/L unless<br>otherwise specified) |
|-----------------|----------------------------------------------------------------------------------------|
| Al              | 2,000                                                                                  |
| As              | 0.2                                                                                    |
| Ca              | 500                                                                                    |
| Cd              | 0.2                                                                                    |
| Cl              | 300                                                                                    |
| Cu              | 50                                                                                     |
| F               | 5                                                                                      |
| Fe              | 1,000                                                                                  |
| Hg              | 0.07                                                                                   |
| Mo              | 100                                                                                    |
| Mn              | 500                                                                                    |
| Na              | 500                                                                                    |
| NH <sub>4</sub> | 500                                                                                    |
| Pb              | 7                                                                                      |
| Se              | 20                                                                                     |
| SO <sub>4</sub> | 30,000                                                                                 |
| V               | 0.1                                                                                    |
| Zn              | 80                                                                                     |
| TDS             | 35,000                                                                                 |
| pH (units)      | 2                                                                                      |

Source: P. H. Rahn and D. L. Mabes, "Seepage from Uranium Tailing Ponds and its Impact on Ground Water," paper presented at the OECD-NEA Seminar on Management, Stabilization and Environmental Impact of Uranium Mill Tailings, Albuquerque, July 24-28, 1978.

24. The doses given include contributions from U-238, U-234, Th-230, and Ra-226. The percentage activities of U-234, Th-230, and Ra-226 relative to U-238 were assumed to be 100%, 5%, and 0.2%, respectively. By taking the yellowcake to be 100% insoluble, the maximum--and thus the most conservative--dose to lung was calculated.
25. Because the number of drums involved in the accident (50) and the amount spilled (5500 kg) are given in the statement, the magnitude of the release is clearly defined. Additional information is now included in the statement, i.e., that 39 of the 50 drums were either destroyed or substantially damaged.

The accident analysis was done for a population density typical of the eastern United States (where yellowcake is transported) and for a density typical of the mining area. For the case of the accident that actually occurred in September 1977, about 3200 kg of yellowcake were spilled onto the ground and were available for windborne dispersion. The staff recognizes that inhalation of yellowcake dust can cause health effects due to the chemical toxicity of uranium. However, no clinical effects were observed among the individuals who were involved with the spill and subsequent cleanup. 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  $\mu\text{g}$  of uranium/liter of urine.

The staff has not used the referenced accident as a typical model for accident analysis, but has briefly described the accident and applied the data since it is the only transportation accident involving a significant release of yellowcake known by the staff to have occurred in 30 years of yellowcake shipments. The accident did prompt an interagency study by DOT and NRC to consider improved containers as well as responsibilities and requirements for emergency action plans. Because the report of the study is expected to be released in the near future with its recommendations, the staff is not requiring as a condition of the license an emergency action plan by the applicant.

26. Refer to response to EPA comment No. 1.
27. The applicant's preoperational groundwater monitoring includes analyses for the standard chemical constituents and selected heavy metals to provide baseline data for operational monitoring.

The alluvium and upper water-bearing units of the Wasatch formation will be drilled. Of the eleven monitoring wells mentioned in Table 6.2, one will be located immediately adjacent to the downgradient side of the evaporation pond; and another will be placed adjacent to the dam and in the alluvium.

The staff agrees that the use of vacuum lysimeters should be considered by the applicant, if the alluvium is found to be dry.

28. The staff has received additional data (Section 6.6.1) from the applicant since the publication of the DES. In addition, the applicant has implemented the preoperational monitoring program presented in Table 6.2 which the staff considers to be a comprehensive program. Six months' data may be obtained prior to starting open pit mining on an operational level. At least one year's data is expected to be obtained prior to mill operation.
29. The preoperational monitoring program, as described in Table 6.2, does not include any gross alpha or gross beta counting. The quantitative value of these types of analyses are indeed questionable. The numbers were included in the text because they indicate the high variability of soil content in the Morton Ranch uranium mining region.
30. Section 6.6.2 contains the operational monitoring program. The applicant's program presented in Table 6.3 provides for three downstream surface water stations and two upstream stations. Mine dewatering effluents are regulated by the NPDES system.

The applicant has not proposed sediment sampling in the operational monitoring program, nor does the staff require it. Surface water, however, will be analyzed for dissolved and suspended radionuclides.

The operational monitoring program (Table 6.3) is quite similar to the preoperational program (Table 6.2). The staff's guidelines for these programs are not identical, however, because their purposes are somewhat different.

31. See response to EPA Comment 27.
32. The potential effects on groundwater and surface water quality are discussed in the response to Question 19 above, and in Appendix F of the FES.
33. The placement of dewatered tailings in mined-out pits lined on the bottom with clay is only an alternative to the applicant's reference design. If the applicant would decide to propose this method of tailings disposal, the staff would conduct an environmental review including the possibility of impacts to the local groundwater wells downgradient from the mill site. A non-rigorous consideration of this disposal method indicates that seepage would not be significantly different from this alternative than from Option L.
34. Revegetation of uranium tailings piles, as required by state law, might be undesirable because of the possible transport by vegetation of radionuclides from the tailings to the surface. It is for this reason that the tailings are to be covered with 1.2 m (4 ft) of overburden, 0.6 m (2 ft) of clay, and another 1.2 m (4 ft) of overburden and 15 to 22 cm (6-9 in.) of soil before being planted with vegetation. If data gathered before or during reclamation indicate that revegetation does significantly increase the release of radionuclides, the staff will require that the program be altered to meet the best available technology. Revegetation cannot be prevented, however, since it will occur naturally.
35. Footnote "e" has been added to page C-3 clarifying precision. The results presented are for individual samples.
36. The staff agrees.
37. Page D-18 has been revised to include this reference and to describe the derivation of the radon-222 dose conversion factor.

#### References

1. Tennessee Valley Authority, "Final Environmental Statement, Morton Ranch Uranium Mining," Chattanooga, Tennessee, January 20, 1976.
2. Merritt, R. C., "The Extractive Metallurgy of Uranium," Table 7-1, Colorado School of Mines Research Institute, Golden, Colorado, 1971.
3. Letter of Plant Superintendent, Wyoming Operations, United Nuclear Corporation, to the Nuclear Regulatory Commission, dated September 13, 1978.

Wyoming Game and Fish Department July 5, 1978

Pp. 4-7, Indirect Impacts: Are any steps being contemplated to prevent wildlife contact with the acidic water in tailings ponds? We have commented on this issue in all NRC documents we have reviewed in the past year and have yet to receive a satisfactory reply about methods to prevent wildlife accidents in these ponds.

Holding ponds must be properly designed and constructed to avoid spillage of toxic and radioactive materials, even after heavy rainstorms. All discharges must comply with the State water quality regulations.

Pp. 8-1, 8-2: The time frames shown for natural revegetation and the return to premining vegetation types are very optimistic and are unsupported by data. Evidence from other areas that suggests that there will ever be a return to premining vegetation composition is nonexistent.

Pp. 9-1: The fact that there is nearby habitat of types similar to that on-site does not alter the irreversible and irretrievable loss of vegetation and wildlife on-site.

Pp. 10-11, Reclamation: The seeding mixture presented here should not be acceptable to the Department of Environmental Quality until created wheatgrass is deleted and big sagebrush is added. Contrary to the statement in paragraph 4, the proposed plan will not "strike a balance between agriculture and wildlife" unless more shrubs than 4-wing saltbrush are used.

Overall, this application's wildlife section is not specific enough to the site being assessed. Suggestions about the speed of recolonization of the area by native wildlife and plants are totally unsubstantiated.

Some data furnished by Wyoming Game and Fish Department has been used. If we can be of further assistance on this project, do not hesitate to contact us.

Sincerely,

*A. Donald Dexter*  
W. Donald Dexter,  
Assistant Director, Operations  
Wyoming Game and Fish

WDD:HBM:kjt

cc: SPC  
Game Division  
Fish Division  
Planning

ED HERSCHLER  
GOVERNOR

Re: 400478  
ES 27

*Game and Fish Department*

CHEYENNE, WYOMING 82002

July 5, 1978



Leland C. Rouse, Chief  
Fuel Processing and Fabrication Branch  
Division of Fuel Cycle and Material Safety  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

Dear Mr. Rouse:

Having reviewed the draft environmental statement (DES) for the proposed issuance of a source material license to United Nuclear Corporation for the construction and operation of a uranium mill on 270 acres of the Morton Ranch property located on Sections 11 and 14, T35N, R7W, Johnson County, Wyoming, we offer the following comments in the interest of the wildlife resource. These comments are arranged in order of pagination of the DES.

Pp. 2-11: The figures for hunting recreation are now much higher than they were in 1973. New data should be used.

Pp. 2-26: Which raptors nest on this site? Will any nests be disturbed during mining and milling? More information should be included on habitat affinities of various animal species, so that impacts of development on wildlife can be assessed.

Pp. 4-6, Vegetation: This section contains the statement, "...the applicant will attempt to restore vegetation..." We believe the law requires vegetation restoration.

Pp. 4-7, Destruction of Habitat: This is a site-specific impact statement. As such, it concerns impacts of development on a specific site. We do not agree with the implication of this section that the total effect of habitat destruction here will be small because there is similar habitat nearby. The total effect on this site will be complete habitat destruction.



THE STATE OF WYOMING

EARL M. THOMAS  
DIRECTOR

NRC RESPONSE TO THE STATE OF WYOMING  
GAME AND FISH DEPARTMENT

P. 2-11

The text has been changed to provide more current information.

P. 2-26

Five species of raptors were observed on the applicant's leased properties during a survey made in July and August 1974: golden eagle (*Aquila chrysaetos*), rough-legged hawk (*Buteo lagopus*), ferruginous hawk (*Buteo regalis*), Swainson's hawk (*Buteo swainsoni*), and marsh hawk (*Circus cyaneus*). These birds prefer to nest on cliffs, in trees, or in marsh areas. Since there are no cliffs, trees, or marshes in the mill and tailings disposal area, it is unlikely that any nests will be disturbed by mill construction and tailings disposal.

P. 4-6

State of Wyoming law requires that reclamation shall restore the land to a condition equal to or greater than the highest previous socioeconomic use. Since the present use is livestock grazing, the applicant will be required to revegetate the land for this purpose. The statement on page 4-6 has been modified by deleting the words "attempt to."

P. 4-7

The loss of habitat will be small only on a comparative-area basis (the area to be disturbed is less than 1/10,000 of Converse County). The text has been modified to show this.

Fencing is the only step being contemplated for the purpose of preventing wildlife contact with the tailings ponds. Additional factors that will reduce the potential of wildlife contact with tailings solution are nearby noise and human activity and the acidity of the water. The acidity of the solution will make it unsuitable for most aquatic organisms and therefore unattractive as a feeding area. Also because of its acidity, it is expected that wildlife will find other water supplies in the area more palatable. Although migrating waterfowl will be attracted to water bodies, we believe that waterfowl will not spend more than a few minutes on the pond due to the irritation caused by the highly acidic tailings solution. The staff is unaware of any studies that have been undertaken to document the use of tailings ponds by waterfowl.

The evaporation/storage dam must meet strict construction standards and freeboard requirements (p. 5-8).

P. 8-1, 8-2

The staff agrees that the estimate of 50 to 100 years for the vegetation to return to the present species composition may be optimistic. It was the staff intent to show that it would take a long time. Studies to date show that there are so many variables (climatic conditions, precipitation, geochemistry and fertility of soil, grazing pressure, insects, genetic variations of plant species, human disturbances, etc.) that it is uncertain if the vegetation will ever return to the present species composition. It is also uncertain if the present species composition is the most desirable for livestock grazing, wildlife habitat, and soil conservation.

P. 9-1

It was the intent of the staff to show that the loss of habitat will be small on a comparative-area basis (see comment above relating to p. 4-7).

P. 10-11

See response to State of Wyoming, Department of Environmental Quality, Land Quality Division, comment on Section 10.4.5.

Site specific survey data was submitted by the applicant and the staff found it sufficient for our assessment when supplemented by our site visit. This information is either presented in Section 2.9 or referenced in Section 2.9. Copies of the referenced material<sup>1,2</sup> were distributed to the Wyoming State Clearinghouse.

1. United Nuclear Corporation, "Applicant's Environmental Report on the Morton Ranch, Wyoming, Uranium Mill," UNC-ER-2 Vols. I and II. 1976.
2. "Supplement to Applicant's Environmental Report on the Morton Ranch, Wyoming, Uranium Mill. Additional Environmental Information and Mill Design Data (Suppl. II)," United Nuclear Corporation, undated (received September 6, 1977).



ED HERSCHLER  
GOVERNOR

## Office of Industrial Piling Administration

RE 600 BOYD BUILDING CHEYENNE, WYOMING 82002 TELEPHONE: 307-777-7288  
May 15, 1978

Director, Division of Fuel Cycle  
and Material Safety  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

Dear Sir:

We have reviewed the "Draft Environmental Statement" related to the operation of the Morton Ranch Uranium Mill, United Nuclear Corporation (NUREG-0439). We consider the DES seriously deficient for several reasons.

The DES fails to address the related mining activities of this project, deferring instead to the Final Environmental Statement prepared by the Tennessee Valley Authority (FES-TVA). However, the magnitude of the proposed mining activity has been expanded greatly beyond that evaluated in FES-TVA. The uranium reserves have increased from 3.4 million tons of ore to 13 million tons of ore. For the amount of ore considered in FES-TVA, a captive mill was not necessary, and several alternative milling arrangements were possible. However, because of the magnitude of the presently proposed mining and because other mills in the area are operating at capacity, the only viable alternative is the construction of the Morton Ranch Uranium Mill. Since construction of the mill will allow the mining of an additional 8.6 million tons of ore not previously evaluated in FES-TVA, and since this ore would most likely not be mined without construction of the mill, the DES should include an evaluation of the associated mining.

Secondly, the DES is deficient in addressing the probable socioeconomic impacts of the Morton Ranch project, including the cumulative socioeconomic impacts of other energy projects in the area; particularly those projects under NRC jurisdiction. For example, the Bear Creek project (NRC Docket No. 40-8452) with 220 employees, the South Powder River Basin project (NRC Docket No. 40-8647), with 870 employees, and the Morton Ranch project with 360 employees will result in a total of 1450 permanent new jobs in the area by 1980. Using a conservative immigration rate of 70%, an induced employment multiplier of 1.5, and a permanent population multiplier of 2.5; these three projects alone will result in a permanent population increase of over 6,300 people by 1980, a 60% increase from the estimated 1976 population. Yet, the DES does not even address the cumulative impact of this and other licensing actions by NRC. In view of the known mineralization of the area, it is probable that other uranium projects yet to be announced will be developed.

Director, Division of Fuel  
Cycle and Material Safety  
Page 2  
May 15, 1978

Our detailed comments on the DES are presented below:

### Section 2.4.1.1

Figure 2.4 referenced here is inaccurate and misleading. The Kerr-McGee project listed here as the proposed Bill Smith Mine actually consists of the existing underground Bill Smith Mine, the surface Reynolds Mine, eight additional proposed underground mines, three additional proposed surface mines, and a mill, currently under review by NRC.

### Section 2.4.1.2

The presumption presented here that neither Glenrock nor Douglas will continue to grow beyond 1980 is unfounded and highly unlikely. Indeed, Table 8.3 in Appendix B of the DES shows that the Converse Area Industrial Association anticipates energy-related immigrating employees to amount to 2,175 in 1981 and 800 in 1982. No projections are given beyond 1982, but it is ridiculous to presume that non-energy-related activities in the area will cease entirely after 1982.

### Section 4.8.1.1

The average of 80 and maximum of 140 jobs for mill construction do not appear reasonable when compared to other, similar projects in the area. For example, Kerr-McGee anticipates a maximum construction work force of 230 in 1978 and 280 in 1979 for construction of the South Powder River Basin Mill (Environmental Report, South Powder River Basin Mill, page 4-2).

The assumption of a 50% immigration rate for permanent employees and induced employment is impossible to support. The extremely low unemployment rate of 2.3% for Converse County (Table 8.9) indicates that it is highly unlikely that currently unemployed workers can be recruited locally. Also, this project is only one of a number of uranium projects in the area competing in a limited local labor pool. Finally, each currently employed resident who switches jobs to fill a position with this project will create a vacancy which will most likely be filled by an immigrant.

### 4.8.1.2

The distribution of newcomers presented in Table 4.5 is virtually meaningless due to the lack of a time frame for the estimate. Furthermore, the assumption that induced employment jobs during the operational phase will be filled by construction-induced employees is tenuous because of the certain overlap in the timing of the hiring of the construction and operation work forces.

### Section 4.8.2.3 Public Services

The assessment of the impact of this project and other concurrent projects on public services is totally inadequate. No attempt has been made to project required service levels due to the population increase or to assess the severity of expected shortfalls.

Director, Division of Fuel  
Cycle and Material Safety  
Page 3  
May 15, 1978

#### Section 4.8.3.2 Public Finances

The ability of the municipalities to respond to demands for new services is summarily dismissed as unknown. Public finances can be estimated, and in fact, were estimated in the "Environmental Statement" for the Bear Creek Project prepared by NRC. This analysis predicted deficits in the budgets of all local units of government. The failure of NRC to reassess this adverse impact on local units of government is inexcusable.

#### 4.8.4.1 Social Impact

The social impacts are dismissed with the astonishing statement that "because communities are always evolving, these changes cannot be considered negative unless they occur faster than the social system can adjust." Yet, nowhere in the DES has NRC attempted to predict the cumulative impact on the social system of energy related projects under its jurisdiction. The analysis for the Bear Creek Project, however, indicates that these changes are occurring faster than the system can adjust, and are therefore negative changes.

#### Section 7.8 Socioeconomic

The strain on public services and the housing market are not unavoidable, adverse impacts. These impacts are amenable to mitigation, provided that each energy company makes an honest attempt to deal with adverse impacts associated with proposed projects. The total absence of proposed mitigation by the developers of the Norton Ranch project causes us a great deal of concern in view of the adverse consequences which will manifest within the affected areas.

Sincerely,

  
Blaine E. Dinger, Director

BED/1p

NRC RESPONSE TO THE STATE OF WYOMING  
OFFICE OF INDUSTRIAL SITING ADMINISTRATION

The section describing the proposed action in FES-TVA states that a production rate of 340,000 MT (375,000 tons) per year is anticipated; and with an increase in the reserves, this production rate could be expanded to 520,000 MT (575,000 tons) per year. The applicant's proposed processing rate of 1800 MT (2000 tons) per day for 330 days per year will require a mine production rate of 600,000 MT (660,000 tons) per year, or about 15% more than the expanded production rate projected in FES-TVA. The staff does not believe that an NRC reassessment of the proposed mining activities is necessary. Since the NRC does not license mines, references to mining are used only as background material and FES-TVA is adequate for this purpose.

Approximately 80 permanent new jobs will be created at the proposed mill for which this environmental impact statement was written. The majority of the new jobs you project are from mining, an activity which is not regulated or licensed by the NRC. Also, the largest percentage (60%) of your projection is for the South Powder River Basin (SPRB) project. An application has been filed with NRC for a mill at that site. Approximately 70 people would be employed at the SPRB mill, and an environmental impact statement will be issued by the staff following our review of the proposed mill. It would be premature to discuss those impacts at this time because we have not concluded our review or decided whether a license should be granted.

The Bear Creek uranium mill was licensed July 1977 and began operations in October 1977. Impacts associated with the influx of construction workers and employees have by now occurred, and the communities have adapted to this increase in population. Also, of the 220 operating personnel projected in the Final Environmental Statement (NUREG-0129) for the Bear Creek project, 75 were mill employees and the balance were involved in mining operations.

#### Section 2.4.1.1

Figure 2.4 has been changed in response to this comment.

#### Section 2.4.1.2

The population projections in Table B.4 show populations peaking in 1980 despite additional immigration in 1981 and 1982. The staff does not believe it to be unlikely that populations in areas such as Glenrock and Douglas will peak out and then recede. The peak may arrive later than 1980, however, because some projects, including Morton Ranch, have been delayed. The population projections in Table B.5 assume that the peak populations are maintained to the year 2005. These figures, as noted in the footnotes, have been provided by the Wyoming Department of Economic Planning and Development and the Water Resource Research Institute, University of Wyoming.

#### Section 4.8.1.1

Estimates of the numbers of mill construction workers have been obtained from documents formally submitted to the NRC. As it is for all information submitted to NRC, these figures are required by law to be accurate or a best estimate of planned activity. It should be noted that the estimated number of workers is only for mill construction, and does not include those people hired for any other related construction activity (i.e., mines).

It is the intention of the applicant to hire half of its future, permanent work force from the local area. The applicant has committed to an in-house training program to teach new skills to local people, and these people may be recruited from the construction force.

#### Section 4.8.1.2

It is not currently known if and when a license may be granted to the applicant and when mill construction would begin. Since such information is necessary to predict the distribution of newcomers in a real time frame, the staff is currently unable to discuss the distribution of workers over time.

Section 4.8.2.3

As mentioned above, there is no method of accurately determining the starting date of construction. Therefore, the impact of the construction force upon the community cannot be assessed in regards to other projects. In addition, a projection of impacts of other projects would require that the distribution of newcomers for all concurrent projects be known in a real time frame. While we recognize that such a comprehensive projection of service needs would be useful to local planners, we do not believe it is necessary for this proposed licensing action. It is not within the scope of this statement to consider all concurrent projects.

Section 4.8.3.2

Many estimates presented in the Bear Creek Project Environmental Impact Statement (NUREG-0129) were substantially invalidated by the length of time required before a license was granted (i.e., other projects has begun; the communities were able to obtain additional financing). The staff concluded that it is not practical to assess public financing since it would thus be limited to only those conditions known today.

Section 4.8.4.1

The staff response to the second paragraph of this letter pertains to this comment as well.

If changes occur faster than the system can adjust, then they would be adverse impacts. However, as stated in Sec. 4.8.4.1, Glenrock and Douglas will have to weigh the demand and financing for new and improved public services. As long as these communities can provide needed public services to newcomers, while maintaining service costs within the reach of existing residents, impacts on the quality of life should be manageable.

Section 7.8

The staff does not believe that the strain on public services and housing market are unavoidable. The staff concludes on p. 7-2, however, that there will be a strain "unless these areas are expanded rapidly . . ."

The applicant is committed to actions that will tend to mitigate impacts on public services and housing. For example, the company has agreed to provide an in-house training program to mitigate the impacts of drawing new people to the area. Furthermore, the applicant is a member of the Converse Area Industrial Association. This organization, which is working with the Converse Area Planning Office, is developing strategies to deal with the migration of people to the area for the jobs created by the Association's members.



THE STATE OF WYOMING

ED HERSCHLER  
Governor

*Department of Environmental Quality  
Water Quality Division*

HATHAWAY BUILDING

CHEYENNE, WYOMING 82002

PHONE 307 777-7781

M E M O R A N D U M

TO: Robert E. Sardin,  
Director  
Department of Environmental Quality

FROM: A. J. Mancini  
Environmental Engineer

DATE: May 16, 1978

SUBJECT: Comments on "Draft Environmental Statement  
Horton Ranch Uranium Mill", U. S. NRC  
Docket No. 40-8602 dated April, 1978 (NREG-0439).

The major thrust of the subject report is, as I view it, a proposal that tailings be disposed of in abandoned mine pits; decanted tailings liquids would be placed in an evaporation pond and the solids in the pits. Tailings slurry would be pumped to various pit areas and, as the tailings settled, the water would be decanted and pumped to an evaporation pond. The pits and pond would be lined with clays. A pit may bottom below the water table before disposal into the pit; impervious clay would be used to line the pit and reduce seepage. Clay would be used as a shaped cover over the tailings, and in turn would be covered with overburden.

This procedure may be acceptable in some instances, but I believe DEQ, Water Quality Division would evaluate each proposal critically because of the potential threat to groundwater resources. Each evaluation would include detailed hydrologic and geologic review, and an in-depth consideration of the application of appropriate parts of the proposed Wyoming groundwater quality standards. In fact, some proposals could be denied at the outset based on requirements of the proposed standards. There isn't enough specific data in the subject ES for an evaluation of the proposal; the data probably would be submitted with the application for a permit to construct, or would be requested by DEQ, Water Quality Division.

A second serious consideration is the design and construction of the cap over the tailings; again, a detailed hydrologic and geologic review of the site would be required as part of DEQ, Water Quality Division's analysis.

Page 2

It is proposed that the decanted tailings liquid be placed in an evaporation pond lined with clay. NRC believes a clay liner will be adequate (some seepage will occur) and the clay will absorb radionuclides. When the application to construct is submitted, DEQ-WQD will make its own independent evaluation on the basis of requirements of the proposed Wyoming groundwater quality standards.

Table 1.1, on page 1-6, is a listing of required permits for the project. The list indicates that an application for a permit for the tailings impoundment has been made to NRC-SE-DEQ-100, and is "In Review". A permit to construct must also be obtained from DEQ-WQD, and application has not yet been made.

On page 3-6, under Sanitary and Other Mill-Waste Systems, the statement is made: "Sewage treatment will be carried out in conformance with the requirements of the Wyoming Department of Health and Social Services.... It should read, "....requirements of the Wyoming Department of Environmental Quality, Water Quality Division....".

Notwithstanding all the safeguards and precautions which are supposed to be incorporated in the operations of the mill, it is possible that accidents involving the release of radioactive materials or harmful chemicals might occur. A spill prevention plan for appropriate storage areas and tanks should be provided.

AJM/sp

NRC RESPONSE TO THE STATE OF WYOMING  
DEPARTMENT OF ENVIRONMENTAL QUALITY, WATER QUALITY DIVISION

Table 1.1, page 1-6

Recent communications with the applicant indicate that UNC will apply for the permit by March 1979.

Page 3-6

The text has been changed in response to this comment.

Spill Prevention

The applicant states that their application for a DEQ-WQD construction permit will include a spill prevention plan compiled in accordance with the State of Wyoming, Department of Environmental Quality, Water Quality Division Rules and Regulations.



STATE OF WYOMING

ED HERSCHLER  
GOVERNOR

## Department of Environmental Quality

### LAND QUALITY DIVISION

STATE OFFICE BUILDING

TELEPHONE 307-777-7756

CHEYENNE WYOMING 82002

### MEMORANDUM

TO: Robert E. Sundin, Director  
FROM: Rebecca L. Mathisen, District I Engineer *RLM*  
DATE: June 1, 1978  
SUBJECT: UNC Mill and Tailings Proposal  
FILE: Mining Permit No. 230C

The following comments refer to the draft environmental statement for the Morton Ranch Uranium Mill (United Nuclear Corporation). These comments are submitted for your consideration in forwarding them to the Nuclear Regulatory Commission by June 12, 1978, as requested by the NRC.

#### 1. Reference 3.2.5, page 3-12

Additional baseline radiation data is needed to determine the pre-construction radiation levels of the mill and tailings areas. After reclamation, the radiation levels must be returned to the baseline levels. Is the burial sequence of 4' overburden, 2' compacted clay, 4' overburden and 6 to 9 inches of topsoil adequate to reduce the radionuclide concentrations on the surface to baseline levels? What steps will be taken if monitoring shows hazardous levels of radioactivity?

#### 2. Reference 4.5.1.2, page 4-5

Deep ripping should occur before the topsoil is spread. Deep ripping of the topsoil would result in mixing of the topsoil with the subsoil and the reduction of the quality of the topsoil. After the topsoil has been spread, shallow ripping or discing will loosen the topsoil for seeding.

#### 3. Reference 4.3, page 4-3

The DES states that common ions such as sulfate and chloride will reach the water table. Samples from water monitoring wells in the areas around the tailings pits must be tested for soluble salts (electrical conductivity).

-2-

#### 4. Reference 2.9.1.1, Table 2.5, page 2-24

The lack of forbs in the referenced table seems strange. About a dozen species of forbs generally occur in samples from grasslands in this area.

#### 5. Reference 10.4.5, page 10-11

Crested wheatgrass is not acceptable for revegetation except for a few situations which are not likely to be encountered at this mill site. Additional shrubs, including sagebrush, will be required in the seed mix for returning acceptable wildlife habitat.

#### 6. Many of the maps showing the lease boundaries are not accurate and are out of date compared to the information contained in our file. The exact lease limits should be shown on maps contained in the Final Environmental Statement.

RLM/db  
cc: Walter C. Ackerman

NRC RESPONSE TO THE STATE OF WYOMING  
DEPARTMENT OF ENVIRONMENTAL QUALITY, LAND QUALITY DIVISION

Reference 3.2.5, page 3-12

The applicant is in the process of gathering additional baseline data, as indicated in this Final Environmental Statement, Section 6.6.1. At least one year's accumulation of such data is expected to be acquired before mill operations begin.

On the surface, the material will be a mixture of subsoil and topsoil found in the surrounding areas and will, by definition, be of baseline concentrations with respect to radionuclides. Present NRC performance objectives for reclamation of uranium mill tailings are to achieve a reduction in the radon emanation rate to twice the background rate and to reduce gamma exposure virtually to background levels. This tailings cover meets these performance objectives.

The NRC will not release the applicant from the requirement to maintain a reclamation bond until monitoring has shown that reclamation has been achieved. If it has not been achieved, then the applicant will be required to take corrective action.

Reference 4.5.1.2, page 4-5

The staff agrees that deep ripping should occur before the topsoil is spread for the reasons stated. The text has been modified accordingly.

Reference 4.3, page 4-3

Conductance is a parameter which has been included in the applicant's monitoring program (Table 6.3).

Reference 2.9.1.1, Table 2.5, page 2-24

Biological surveys were performed on the applicant's leased properties during July and August 1974. Although a total of 24 forbs were found on the properties, only 1-3 species were found at any one study site (ER, Suppl. II, response to Q.20). The percentage of cover attributed to forbs at four quantitative study sites ranged from 0.1 to 2.8; the percentage of total vegetative composition ranged from 9.8 to 30.8. The data given in Table 2.5 are for the study site nearest the proposed mill.

Reference 10.4.5, page 10-11

Since the State of Wyoming law requires that the species chosen be in accordance with the rules, regulations, specifications, and standards adopted by the State Conservation Commission and approved by the Department of Environmental Quality, Land Quality Division, the applicant will be required to use a seed mixture that conforms with these requirements.

Page 10-11 has been revised to include the seed mixture required in the applicant's state mining permit. We understand that future reviews by the Department of Environmental Quality may result in additional revisions to the species included in the revegetation program.

Lease Boundaries

The text has been changed in response to this comment.



STATE OF WYOMING

ED HERSCHLER  
GOVERNOR

*State Conservation Commission*

2219 CAREY AVENUE

PHONE 777-7321

CHEYENNE, WYOMING 82002

THE A. EDGERTON  
CONSERVATION COMMISSION STATE EXECUTIVE  
LIGHT KIMSEY  
308 WATER QUALITY MANAGEMENT

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JOHN HLAND (D.E.F.A.S.)

M E M O R A N D U M

Date: May 24, 1978  
To: Don Daiss  
From: Tim Kautza, District Program Consultant, Wyoming Conservation  
Commission *Tim Kautza*  
Subject: Environmental Statement Related to Operation of Morton Ranch  
Uranium Mill - United Nuclear Corporation.

I have reviewed the "Soils" sections of the draft "Environmental  
Statement Related to Operation of Morton Ranch Uranium Mill - United  
Nuclear Corporation" and offer the following comments for your consideration.

The United Nuclear Corporation has consulted the U. S. Soil  
Conservation Service regarding the nature of the soils in the area and  
seem to be aware of problems that may arise concerning erosion and  
reclamation problems. It is suggested that they contact the LaPrele -  
Glenrock Conservation District, Douglas, Wyoming for specific erosion  
control and revegetation practices and recommendations.

TK/jb/rv

PROTECT OUR HERITAGE  
through the  
Conservation of Wyoming's Natural Resources

NRC RESPONSE TO THE STATE OF WYOMING  
STATE CONSERVATION COMMISSION

The applicant states<sup>1</sup> that they have been in contact with the Wyoming State Conservation Commission regarding state practices and recommendations for erosion control and revegetation. The practices in use at the Morton Ranch project are based on current state regulations and recommendations. The LaPrele - Glenrock Conservation District does not have jurisdiction over this particular project area. However, the applicant has an existing cooperative agreement with the Upper Cheyenne River Conservation District which does have jurisdiction and who supply resource data on soils, range site information erosion control, revegetation practices and assists industry in planning and development of conservation plans by furnishing the required technical assistance.

<sup>1</sup> Letter of Plant Superintendent, Wyoming Operations, United Nuclear Corporation, to U. S. Nuclear Regulatory Commission, dated August 3, 1978.



STATE OF WYOMING

## Wyoming Department of Agriculture

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COLLEGE OF AGRICULTURE  
UNIVERSITY OF WYOMING, LARAMIE

### M E M O R A N D U M

DATE: June 12, 1978

TO: State Planning Coordinator  
Wyoming State Clearinghouse

FROM: Don Daiss, Assistant Commissioner  
and Liaison Officer for E.I.S. Review

SUBJECT: Morton Ranch Uranium Mill, United Nuclear Corp.,  
April 1978, Docket No. 40-8602  
State Identifier Number: 77-132 R/D

Attached are the comments of Dan Hartley, Department of Agriculture  
Ag Economist, and Tim Kautza, Wyoming Conservation Commission, for  
your consideration.

Thank you.

DDjh

"AGRICULTURE—the backbone of Wyoming"



STATE OF WYOMING

## Wyoming Department of Agriculture

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COLLEGE OF AGRICULTURE  
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May 5, 1978

### M E M O R A N D U M

TO: Donald Daiss, Assistant Commissioner of Agriculture

FROM: Daniel R. Hartley, Ag Economist, Division of Ag Planning  
and Development *Daniel R. Hartley*

SUBJECT: MORTON RANCH, URANIUM MILL, ENVIRONMENTAL STATEMENT

I have reviewed the Morton Ranch, Uranium Mill Environmental State-  
ment and offer the following comments for your consideration. Also  
included is a copy of my previous comments on the first draft of the  
Morton Ranch Environmental Study.

This draft environmental statement eliminates all reference to  
agriculture except for a small paragraph and a couple of tables. All the  
comments I made on the previous draft were considered; these areas of  
the statement were eliminated with no reference to agriculture. I  
feel this is a very bad policy by the U.S. Nuclear Regulatory Commission  
to not even consider the agriculture industry. Effects on the agriculture  
industry were not mentioned. Potential agriculture production was not  
considered in the reclamation plan.

This environmental statement is not very representative of the  
area or of the industry for which this area was based on. Once again,  
the Federal government has decided what is best for the people. A  
Federal dictatorship is developing throughout Federal bureaucracy.

DR/mm/11

"AGRICULTURE—the backbone of Wyoming"

July 15, 1977

M E M O R A N D U M

TO: Donald I. Daiss, Assistant Commissioner of Agriculture

FROM: Daniel R. Hartley, Ag Economist, Division of Ag Planning  
and Development *and Neil H. Hartley*

SUBJECT: MORTON RANCH, WYOMING: URANIUM MILL, VOLUME I, ENVIRONMENTAL  
REPORT

I have reviewed the Environmental Report on the Morton Ranch, Wyoming--uranium Mill and offer the following comment for your consideration.

The fallibility of the EIS process is shown in the very first page of the report. The process was designed to ensure the environment was studied and the review process completed before the land is disturbed. The second paragraph of page 1-1 states, "Construction of surface and underground mining facilities has begun and ore production is expected by the middle of 1977." At the present time, (July, 1977) only the assessment report has been finished. The last paragraph on page 1-1 states, "Mill operation is expected to begin in December 1978." The mine and mill will be in full operation by the time all draft and final copies of the EIS have been reviewed. If the process does not do as intended, many people have wasted their time and effort in preparing the report. Those who review have wasted valuable time that could be used elsewhere especially for Federal and State employees who cost the taxpayer time and money.

The next to last paragraph on page 2-7 states, "Converse County contained 1,350,000 head of sheep." This figure should be 100,000 head of stock sheep. The entire state of Wyoming only had 1,190,000 head of stock sheep in 1975.

Section 2.8.4 Pre-Existing Environmental Stress (page 2-73 and 2-82): The first paragraph seems to blame the livestock industry for all pre-existing environmental stresses. I strongly object to this paragraph. Without stress by the livestock industry, food would not be available for every American to enjoy three times a day. The largest majority of the livestock producers realize the damage from overgrazing. They carry on a wise range management program to ensure their own profits and livelihood. Other pre-existing environmental

stresses could have come from hunter stress, recreational stress, pleasure driving stress, exploration for oil, gas and minerals, utility corridor stress, wildlife stress, extreme weather conditions, etc. The agriculture industry should not be used as a scapegoat every time something bad happens to the environment. Ranchers live with the environment day by day and realize their very existence depends upon a good conservation program and management of the environment. I would like to see documents and references to verify that the livestock industry has caused the so-stated pre-existing environmental stresses.

The environmental statement does not include their plan for mine reclamation. I feel this should be a major portion of the statement. I do not even know if the uranium mine and mill plans any reclamation. They may plan to abandon the sites as they have been disturbed and with construction facilities in place. The present reclamation laws require mine reclamation to be carried out. The EIS process has failed again in what the process was designed to achieve. The mine will be in operation without an environmental review and no plan for reclaiming the environment. Somehow the political process has failed or someone is playing politics.

EJ/mn/bm

NRC RESPONSE TO THE STATE OF WYOMING  
WYOMING DEPARTMENT OF AGRICULTURE

Memorandum of May 5, 1978

Soil conditions and low precipitation currently prevent the use of the site for large-scale agricultural purposes, except as rangeland. When reclamation is completed, the disturbed lands will be returned to the highest previous use, which is as rangeland.

No portions of the statement were eliminated. The document you commented on before was the Environmental Report prepared by the applicant in support of their application for an NRC source material license.

Memorandum of July 15, 1977

These comments were considered by the staff in its review of the Morton Ranch Environmental Report.

A final EIS was issued prior to the start of mining (Tennessee Valley Authority, "Final Impact Statement, Morton Ranch Uranium Mining," Chattanooga, Tennessee, January 20, 1976). Mill construction will not begin until after the NEPA review process is completed, including issuance of this final EIS related to mill operation.

# ENVIRONMENTAL COALITION ON NUCLEAR POWER

Philadelphia Office: 4000 Belmont Ave., Philadelphia, Pa. 19104  
 Executive Director: George S. Brown, R.D. #1, P.O. Box 2075, 17543  
 215-584-4342  
 814-227-2900

June 3, 1978

Director, Division of Fuel Cycle and Material Safety  
 U.S. Nuclear Regulatory Commission  
 Washington, D.C. 20555

Dear Madam or Sir:

- (1) The wind roses on page 2-2 do not support the conclusion that data for Casper are sufficiently similar to be used in place of wind data for Morton Ranch Mill on page 2-1. A quick inspection of the roses shows Casper has wind speeds above 21 m.p.h. about 5% of the time, whereas for Morton Ranch Mill, it is above 21 m.p.h. over 20% of the time. With the wind speeds available for such periods, wind generation at the Morton Mill Ranch ought to be discussed as an alternative to uranium mining and milling. Specifically, the capacity of the site for wind generation. Such a comparison should also reflect the number of problems solved by NOT mining the uranium.

- (2) (a) No unnecessary radon-222, thorium-230, or uranium-238 will be released to the environment.

- (b) No high, medium, or low-level radioactive waste will be produced. Most experts, apart from those dedicated to the creation of such wastes, now agree that the radioactive waste problems cannot be solved; at best they can only be managed.

- (c) Since the NRC has yet to acknowledge the problem of radioactive wastes for the duration of their period of toxicity, no cost-benefit analysis yet revealed is credible or factual, since the long-term health effects of all forms of rad-waste, including released thorium and uranium and radon, have yet to be honestly evaluated by the NRC.

- (d) The problem of accidents at nuclear reactors will be eliminated. Since the 5-year period over which the seriously defective Reactor Safety Study will be up before the Morton Ranch Mill begins operation, a new and credible study is needed.

- (3) In a similar vein, the environmental costs of the operation of the mill ought to be discussed in terms of the toxicity periods of the isotopes and quantities of isotopes released, created, or caused to be released as a result of the uranium fuel cycle. If any comparisons with non-project related effects are to be made, as with background radiation or releases of radon, the same comparison must be made on the other side of the ledger. That is, the solar energy incident on the site ought to be compared with the energy "benefits" of the site, but over the time of the toxicity of the released radioactive materials, as uranium-238. Only in this way can a fair and honest comparison be made.

- (4) Also, the period over which solar energy could be exploited at the site, as wind energy, ought to be discussed. Ten thousand years ought to suffice as a starting place.

- (5) On page 2-12, under land ownership, it is suggested that the Morton Ranch is privately held. In order to prevent problems later, some mention of the applicable treaties with the Native Americans ought to be discussed. In fact, a review of the land ownership, or, more properly, stewardship from, say, the year 1750 or 1800 to date might be in order. It may prove embarrassing if the title to the site is attached legally by descendants of the original stewards--the Native Americans.

- (6) On page 2-23, coal is mentioned as a waste material on the Morton Ranch. While western coal may be lower in sulfur than most eastern coals, there is some sulfur. With sulfur, there is the possibility, indeed, the certainty, of oxidation. Some discussion of the formation of sulfurous and sulfuric acid with the subsequent loss of water quality ought to be discussed.

- (7) The table on page 2-24 suggests that the normal quantity of ground cover in the Morton Ranch is only about 27%. This ought to be discussed more in terms of reclamation of the mill tailings piles after the mill ceases operation. With only 12 inches or less of annual rainfall, revegetation efforts cannot be assumed to be easily accomplished.

- (8) The discussion of the natural radiation environment (page 2-28) is very vague and general. There are no specific data for the Morton Ranch. From the information presented, it is impossible to determine just what the radon-222 concentration on the site and in the vicinity is prior to mining uranium.

- (9) On page 3-1, the figure of 2000 tons of ore per day, for 330 days per year @ 0.07% average uranium concentration produces a result of 508 tons of U<sub>308</sub>. This assumes 100% removal of uranium from the ore. Since the recovery rate of uranium from the ore seems to drop with the ore grade, some discussion of why a 97% recovery rate is used is needed. Ninety percent or less may be more accurate (see page 1-1). At any rate, 508 tons of U<sub>308</sub> per year corresponds to about 2.8 AFR's (Annual Fuel Requirements). Radioactive emissions would be more easily comprehensible if referred to an AFR. For instance, the 8300 Ci of radon coming from the "tailings pits" (page 3-12) is a vague number. Does this occur each year of plant operation? Is it a rate for a half-filled pit, or a filled pit? To what quantity of tailings, mine operations, or AFRs does this number apply?

- (10) At the top of page 3-12, it is mentioned that there is a sulfuric acid solution. Since all of the solution is not pumped out, the water is assumed to evaporate. Since the acid does not, what is the fate of this acid? And, is the high ion-exchange capacity attributed to the clay liner affected by the presence of this sulfuric acid?

- (11) The NRC Staff assumes secular equilibrium in the uranium decay chain (page 3-9). Doesn't the Staff know whether or not it has been achieved? Can such a determination be that difficult?

- (12) It is stated that 0.05 kg/hr of yellowcake dust escapes the driers (page 3-11). At 24 hours per day, 330 days per year, this corresponds to over 2.5 ci of uranium. No mention is made of the release of radon-222 from this uranium, nor is any mention made of just how long it will go on, or how

- (13a) much radon-222 will be released. My rough calculation suggests around 150 ci/yr of radon-222 per year. Some discussion of the duration and magnitude of the emissions appears in order.
- (13b) The discussion of mine closing and tailings stability on pages 3-12 and 3-13, and that discussion in Chapter 10 leave a number of questions unanswered. For how long will the stabilization efforts last? This should be discussed in terms of the half-lives of the radioactive materials contained; as thorium-230. Figure 10-1 shows open pits. Are these to be closed? Are all open-pit mines to be sealed? Are all underground mines to be sealed? For how long are the seals to be expected to last. In the context of the half-lives of the long-lived precursors of radon-222? For how long will radium-226 and thorium-230 be kept out of the groundwater? The conclusions of Appendix F do not appear to be supportable for very long. For how long are these conclusions supportable? These questions should be answered in the appreciation of the half-lives of the parents of radon.
- (14) On page 3-13, the notice is made of certain requirements upon the termination of the operating license. Are there any provisions in existing rules or statutes for enforcement of these requirements? Are there any rules or statutes governing the stabilization of mill tailings piles, or sealing open pit or underground mines? Some discussion of enforcement alternatives is appropriate.
- (15) Table 4.3 tests, quite properly, the doses to inhabitants due to the operation of the Mill. However, the relevance of background doses has not been established. Since the "benefits" of the mill do not receive this kind of comparison, the one-sided comparison may lead to confusion. Either both costs and benefits should be compared to their respective naturally occurring backgrounds (that is, natural releases of radon as a background cost, and solar energy incident upon the appropriate area as a naturally occurring benefit), or neither should. More discussion here would be helpful.
- (16) Table 4.9 lists Federal income taxes paid as almost 100 million dollars. To what extent does the fact that TVA, a part owner of the mill, does not pay corporate taxes affect these values?
- (17) The discussion of the economic and social dislocations in Glenrock and Douglas on pages 4-16 and 4-17 is rather sketchy. There is no information on the demands for particular services required for the "newcomer" influx. These demands should be quantified, so that the reader can see how much this "boom" will cost in needed services, or schools, roads, sewers, police and fire protection, and so on. Some discussion of just what these costs are would be appropriate. Similarly, some discussion should be prepared as to who ends up paying for these services, and what benefit those who pay for these services get from the Mill. Perhaps the NRC should discuss with the Mill owners the possibility of the Mill owners paying these costs in full. Why should the residents of Glenrock and Douglas subsidize somebody else's "boom" and their own "bust"?
- (18) On page 5-13, a recent truck accident involving yellowcake is involved. Perhaps some discussion of how much yellowcake was spilled onto the ground, and how much was lost would be appropriate. An estimation of how much would be lost under other conditions is not terribly useful. How much U<sub>238</sub> was lost?
- (19) Financial arrangements for mill decommissioning and tailings stabilization appear to be left to the State of Wyoming (page 6-1). Are there no NRC regulations or even statutes governing mill decommissioning, mine sealing, and tailings stabilization? Are there no criteria or standards establishing how long the final "fix" will last? What provisions are there for actual enforcement of a "fix"? Could, or would the NRC deny future license applications, or suspend current licenses at other facilities to insure a proper decommissioning, sealing, or stabilization takes place for the appropriate time period? What does the NRC propose to do if the promised efforts are carried out, and then fail? The potential doses to the public over long time periods into the future can be enormous from just one year's mill tailings for one AFR. Some discussion of these issues is appropriate.
- (20) The monitoring program outlined in Chapter 6 does not appear to be able to establish with any accuracy what the natural radon release rate is away from the ore areas. Nor does there appear to be any monitoring independent of the mill owners.
- (21) On page 8-2, it is stated that the buried tailings deposits will emit radon at twice the background rate. However, there does not appear to be any existing measurement of, or provision for determining this rate. Again, no mention is made of for how long this "pussy cat" method (the pussy cat method is carried out by scratching a little dirt over the pile and walking away) will keep the radon value at this unknown level of emissions. Elaboration is desirable.
- (22) The performance objectives on page 10-3 neglect to describe how long the proposed "fix" is good for. Without such knowledge, it is impossible to say that public hazards have been avoided or even minimized. Without any discussion of the duration of the lining-stabilization plan, there is little reason to believe that the "pussy cat" method is being applied. Who is going to check on the situation 20, 50, 100, 500, or 1000 years after stabilization? At 1000 years, what percent of the decay has already taken place inside the tailings piles?
- (23) Table 10.1 represents a kind of distortion of reality which can only be described as baffling. It represents how data can be selected—and eliminated—to mislead and confuse. It contains no mention of the solar energy input to the food we eat, fibers we wear, wood we build our homes with, wood we heat our houses with, and the water and air we use to cool our power-plants and automobile engines with. No mention is made of the solar energy input to the biosystem upon which we are totally dependent. Such distortions and manipulations make it possible to then denigrate the contribution of solar energy to our energy mix, as is done on page 10-14. The reliance by the Staff on references 9 and 10 of Chapter 10 is grossly one-sided, and ignores the nature of these references. They were prepared to satisfy the wants of the energy delivery industry for its convenience.
- (24) Since these FEA reports assume that exponential growth will continue indefinitely, some discussion of doubling times and resource limitations is appropriate. Similarly, the last sentence of paragraph 10.5.4 should be reevaluated in the light of electricity consumption in the last few years. At the same time, the NRC Staff is well advised to broaden its horizon from something beyond simply being a rubber stamp agency. There is much more to the literature of energy conservation than FEA reports. The Staff should discuss the cost of energy production when all costs are included, including the long-term health costs from the releases of radioactivity at each step

-5-

with the short-term and  
long-term health costs,  
a number of

in the uranium fuel cycle. These full costs should then be compared ~~to the~~ <sup>with the short-term and long-term health costs, a number of</sup> energy conservation. The truncated discussion of Para. 10.5.4 is neither factual nor informative. A much broader and fuller, and less biased discussion is necessary.

- (25) The statement that the mill is acceptable by current standards (para. 11.3) continues the deception of the Old Atomic Energy Commission and represents what has become known as Walt Disney's Law: "Wishing will ~~make~~ make it so." Since current standards are designed to conceal the long-term health effects of radioactive emissions, and since the NRC continues to conceal them, it is impossible to conduct a full, open and honest cost-benefit analysis of any nuclear facility. As has been repeatedly mentioned, the Staff carefully avoids any mention of the magnitude and duration of the radioactive emissions problems to be caused by the operation of the Morton Ranch Mill.

- (26) Page D-19 contains a very brief discussion of the dosimetry of Radon-222. This brief summary would benefit enormously from a full discussion of the differences between the NRC approach, and that of the EPA in Environmental Analysis of the Uranium Fuel Cycle, Vol. I, EPA 520/9-73-003-B, 1973, pages 63 through 70. There are a number of conversion factors which have different values. It seems more than coincidental that the NRC, which favors this project (see page iii), has neglected to consider the long-term health effects of all long-lived isotopes created or caused to be released due to the uranium fuel cycle, and also just happens to consistently underestimate the effects of radiation on people. The NRC ought to discuss this subject, along with a discussion of who benefits from this project, who pays the costs, and for how long do the costs go on.

- (27) The Draft Statement does not appear to state that all of the ore bodies mined will be refilled with tailings. A Final version should state unequivocally whether or not all will be sealed or filled. It should also state, if all ore not filled, what will be the annual release of radon-222 from the exposed ore surfaces, and for how long this release will go on. The Final version should also candidly discuss how long the expected stabilization efforts are likely to fulfill their tasks, and the consequences of their failure. Such a discussion should be in terms of the half-lives of the longest-lived precursor of radon-222.

- (28) Lastly, the Draft Statement makes no mention of the applicable provisions of the Resource Conservation and Recovery Act of 1976 (Public Law 94-580), and how this law, and its soon to be promulgated regulations, affect the Morton Ranch Mill.

I hope these comments will be helpful.



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## NRC RESPONSE TO THE ENVIRONMENTAL COALITION ON NUCLEAR POWER--C. KEPFORD

1. Discrepancies in the wind speeds for Casper and the Morton Ranch data do exist. However, Casper data were the most representative and complete data available to the staff. The Casper data is from continuous monitoring while the Morton Ranch data is not.
2. The Morton Ranch uranium mill site will be reclaimed after its 20-year anticipated lifetime, at which time the site can be turned to non-mill-related uses, such as wind generation. Wind generation at the Morton Ranch, however, is not considered to be an alternative to uranium mining and milling. At present, the large-scale production of electricity by wind generation is not without economic, engineering, environmental, and other problems; however, if future technological development can make wind generation attractive, such capacity could conceivably be installed on the Morton Ranch site after reclamation is completed.
3. The period of availability of solar energy incident on the site is indeed quite long. Construction and operation of the mill would result in only a very small reduction in the amount of time solar energy benefits could be derived from the site. Thus, the amount of solar energy that can be derived from this site over long time periods is unaffected by this proposed licensing action.
4. See response to preceding comment.
5. The applicant has informed the NRC that UNC leases and has arrangements to buy those tracts on which the mill tailings will be buried. There has not been any suggestion that the previous owners did not have a clear title to the land, or that any irregularities occurred in the transfer of the title from the previous owners to the applicant.

The "Uranium Mill Tailings Radiation Control Act of 1978" requires that in cases where Indian lands are used for tailings disposal, the licensee shall be required to enter into such arrangements with the NRC as may be appropriate to assure the long-term maintenance and monitoring of such lands by the United States.

6. This potential problem of water contamination by sulfurous and sulfuric acid is a part of the mining operation. Page 4.3-4 of the TVA-FES,<sup>1</sup> which deals with the Morton Ranch mining operation, contains a discussion of leaching of contaminants from the overburden by rainwater.
7. The staff agrees that the revegetation program must take into account the generally sparse vegetation and small amount of annual rainfall. The choice of seed, seeding rate, and method and depth of seeding will be based on both onsite and offsite research experience and on the recommendations of the State of Wyoming Department of Environmental Quality. The time of seeding will coincide with spring and fall precipitation (ER, App. VI, pp. A-10, A-12, A-13). If vegetation could not be established then rip rap could be applied.
8. The applicant's preoperational monitoring program has begun, and the first quarter's radon measurements are discussed in Section 6.6.1. Mining had not begun on a full production scale when these measurements were made although some mining had started. This program therefore will not provide onsite premining data. However, an offsite remote background radon sampling location (Table 6.2) should remain unaffected by mining releases.
9. The staff agrees that a 90% recovery rate for ore averaging .077% in  $U_3O_8$  is realistic. The 508 tons (461 MT) of  $U_3O_8$  at 90% recovery corresponds to an expected annual production of 415 MT/yr of  $U_3O_8$ . The staff states in a footnote on page 1-1 that for reasons of conservatism, the impact assessments in the DES are based on the higher values of 0.2%  $U_3O_8$  for the ore and a throughput of 3000 tons (2700 MT) per day. At 330 operating days per year and at the 97% recovery appropriate for an ore grade of 0.2%  $U_3O_8$ , the corresponding annual production would be 1742 MT/yr. It is this higher production which corresponds to a radon

release of 8510 Ci/yr from mill tailings. This release rate is not an annual average; it is the highest annual release rate occurring during mill operations and therefore does not correspond to either a total or an average release per AFR. The area is not assumed to be below ground level, and no distinction is made between filled and half-filled pits.

10. Sulfuric acid actually does evaporate; however, the equilibrium vapor pressure of pure  $H_2SO_4$  is much lower than that of water (e.g., only one mm at a temperature of  $145.8^\circ C$ ).<sup>2</sup> Thus, the staff considers that a more significant pathway by which sulfuric acid could enter the environment is likely to be by slow seepage through the clay liner. Because most soils, including clays, exhibit only cation exchange,<sup>3</sup> anions such as sulfate will move with the water through the clay.<sup>4</sup> The staff has noted in Appendix F of the FES that because of this lack of anion adsorption, the sulfate ions may pass through the liner and reach the groundwater. A recent study<sup>4</sup> of seepage from unlined tailings ponds notes that sulfuric acid will be neutralized in the subsoil before it can reach the water table so that, in effect, sulfate salt ions, e.g.,  $Ca^{+2}$  and  $SO_4^{-2}$ , are the species reaching the water table.

The ion exchange capacity of the clay liner will be affected by the sulfuric acid because the ion-exchange capacity of soil is a function of pH.<sup>3</sup> It is also a function of the particular soil and the ionic species under consideration.<sup>3</sup> Using conservative values of the relevant soil parameters, the staff calculated the rate of movement of ions through the clay liner (DES, App. F) and concluded that radionuclides will be permanently sequestered in the clay and will not enter the groundwater.

11. Equilibrium is assumed for the sake of conservatism. While many ores are in approximate equilibrium, some are not, due to the differential leaching rates of the constituent elements. The staff does not know with certainty the degree of equilibrium.
12. The yellowcake that escapes the drier stack contains approximately 95% of the uranium which was in the ore, 5% of the thorium, and 0.2% of the radium. Because of the small amount of radium, and because of the long half-lives of U-238, Th-230, and Ra-226, the decay of radon over a reasonable time period is extremely small and is considered negligible when compared to the radon released from other sources.
- 13(a). As a result of the stabilization and reclamation program, the tailings area is expected to have long-term stability characteristics similar to that of the existing land. Reclamation of mines (other than those to be used for tailings disposal) is not within the scope of this statement. Reclamation of mines is discussed in FES-TVA.<sup>1</sup> As discussed in FES-TVA, the last one or two surface mines may be left to form lakes; the rest of the open pits will be backfilled, covered with topsoil, and revegetated, and the underground mines will be sealed.
- 13(b). It is concluded in Appendix F that radium and thorium are expected to be retained in the clay liner. The ion front will cease advancing upon cessation of the mill operations following stabilization and reclamation of the open pit; hence, no additional migration is expected to occur after that time.
14. The "Uranium Mill Tailings Radiation Control Act of 1978" contains provisions providing for federal regulation of custody of tailings disposal sites. See also response to comment 19 of this letter.
15. The relevance of background doses is that they provide a benchmark against which to compare impacts. We do not believe that not comparing benefits with background benefits leads to confusion.
16. The applicant for a source material license for the Morton Ranch uranium mill is United Nuclear Corporation (p. 1-1). The Tennessee Valley Authority is not at present a part-owner of the mill, but only has an economic interest in the uranium mines near the mill site.

TVA is negotiating to purchase any future mill at this site. If the TVA were to take control of the mill, it would affect payment of federal taxes due to its status as a Federal Authority.

17. Needed additional housing is projected in Table 4.7 and projected distribution of school age children is presented in Table 4.8. Detailed projections of further needs is not within the scope of this statement.
18. The amount of yellowcake spilled was approximately 3200 kg (7000 lbs) on the ground and 2300 kg (5000 lbs.) in the truck trailer. The spilled material and a layer of the underlying soil were removed and reprocessed to retrieve the uranium values; however, no records are available indicating the amount of uranium recovered. The calculated release (p. 5-13) is from 32 kg (70 lbs) to 85 kg (190 lbs) of  $U_3O_8$ .
19. The NRC's requirements are that adequate surety arrangements be provided to ensure decommissioning, stabilization, and reclamation of the mill site and tailings area. This will be accomplished for this facility by means of a surety bond held by the Wyoming Department of Environmental Quality. The NRC's performance objectives for tailings reclamation are stated in Section 10.4.1 of this statement. These objectives are used by the staff in determining if a tailings management alternative should be accepted or denied. Continued active maintenance should not be required at this site; however, if any were required, it would be the responsibility of the owner. As provided by the Uranium Mill Tailings Radiation Control Act of 1978, ownership of the tailings disposal site will transfer to the federal or state government upon termination of NRC's license for this facility.
20. The applicant's monitoring program includes a control location as indicated in Table 6.3, p. 6-10, and Table 6.2, p. 6-5. There is no monitoring independent of the mill owner's; however, all monitoring is subject to the requirements of the NRC.
21. Radon flux measurements will be performed during the preoperational monitoring program (Table 6.2).
22. See response to comment 13(a) of this letter.
23. Section 10.5 is an abbreviated synopsis of energy sources as they affect federal energy use planning. The discussion is thus directed toward the use of the proposed uranium production, which is to fuel electrical power systems, not the biosystem.
24. Section 10.5.4 has been revised.
25. The text states (Sec. 8.1.7) that the reclaimed tailings will constitute a source of radon emission of about twice the natural background but the impact is minor.
26. The dose conversion factor for radon-222 was developed with consideration of EPA 520/9-73-003-B. Page D-18 has been revised to include this reference and to describe the derivation of the radon-222 dose conversion factor.
27. Refer to response to comment 13(a).
28. The Resource Conservation and Recovery Act of 1976 does not apply directly to uranium mill tailings which are byproduct material. The Uranium Mill Tailings Radiation Control Act of 1978 (UMTA) amended the Atomic Energy Act to define uranium mill tailings as byproduct material and directs the Environmental Protection Agency to promulgate health and environmental standards applicable to uranium mill tailings. Standards promulgated under UMTA are to be consistent with the requirements of the Solid Waste Disposal Act.

References

1. Tennessee Valley Authority, "Final Environmental Statement, Morton Ranch Uranium Mining, Chattanooga, Tennessee, January 20, 1976.
2. Weast, R. A., ed., "CRC Handbook of Chemistry and Physics," 58th Ed., p. D-87, CRC Press, Cleveland, 1977.
3. Hajek, B. F., "Chemical Interactions of Wastewater in a Soil Environment," J. Water Pollut. Control Fed. 41(10):1775-1786, October 1969.
4. Rahn, P. H., and D. L. Mabes, "Seepage from Uranium Tailings Ponds and Its Impact on Ground Water," paper presented at the OECD-NEA Seminar in Management, Stabilization, and Environmental Impact of Uranium Mill Tailings, Albuquerque, July 24-28, 1978.

RADIOLOGICAL IMPACT OF THE  
Morton Ranch Uranium Project

by

William A. Lochstet  
Environmental Coalition on  
Nuclear Power  
June 1978

The Nuclear Regulatory Commission (NRC) has attempted to evaluate the public health consequences of the operation of the proposed Morton Ranch uranium mill and its associated mines (Ref. 1). However, the dose is only integrated over a 50 year period from one year of exposure for people living within an 80 kilometer radius of the plant. I shall evaluate the dose commitment from the mill tailings without an arbitrary cutoff in time or distance.

In 1976 Pohl pointed out that the thorium - 230 in the mill tailings decays to radium - 226, which in turn decays to Radon - 222, with a time scale determined by the  $8 \times 10^4$  year half life of thorium - 230 (Ref. 2). Recently, Keford has pointed out that the uranium - 238 in the mill tailings decays by several steps thru thorium - 230 to radon - 222 and should also be considered (Ref. 3). This position has been supported by the 21 September 1977 memorandum of Dr. Walter H. Jordan of the ASLEP (Ref. 4). These matters have also been reviewed by Dr. R.L. Gotchy of the NRC staff. These arguments will be considered in the case of the Morton Ranch uranium mill and mining operation.

It is estimated that over the life of the mill it will process  $1.2 \times 10^{10}$  kg of ore, containing 0.077%  $U_3O_8$  (Ref. 1, Sec. 5.1.3.2 and Appendix D). In this case the ore will contain  $9.24 \times 10^6$  kg of  $U_3O_8$  which holds  $7.8 \times 10^6$  kg of uranium

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9 June 1978

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Gentlemen:

Enclosed are my comments on the draft NUREG - 0439,

Environmental Statement on the Morton Ranch Uranium Mill.

Sincerely,

*William A. Lochstet*

Wm. A. Lochstet

The NRC suggests that with stabilization, the radon emissions will be reduced to approximately twice background rate (Ref. 1, Sec. 10.4.4). Background is estimated to be  $1.5\text{Ci/m}^2\text{-sec}$  (Ref. 1, Sec. 2.10). For a total pit area of  $6.1 \times 10^5 \text{m}^2$  (Ref. 1, Appendix D), the emission rate would be 29 curies per year. Using a 97% ore recovery, as indicated above to determine the relative quantities of thorium - 230 and Uranium - 238 in the mill tails, the total radon release expected is found to be  $5.6 \times 10^9$  curies. This is about 1/6000 of the actual radon produced. This is only 6 times less than that estimated in the previous paragraph.

The deterioration of the stabilization is recognized by the NRC staff (Ref. 6, P.4). The placement of the mill tailings in pits is a distinct improvement over the above grade piles. It is difficult to imagine the tailings being eroded away in a decade or so. However, the pit area proposed is a local high point with downgrades in each direction except southwest. Erosion by moving water has carved the features of the topography.

In particular there is a stream bed located between the mill site and pit #2114 (See Ref 1, Fig. 2.3 and Fig. 3.5; the quality of Fig 2.3 should be improved), with a grade along the stream bed of about 10:1. This is the stream bed to be used for the evaporation pond. It is difficult to argue that the proposed tailings stabilization will not be eroded away when considered on the  $4.5 \times 10^9$  year time scale of the uranium - 238 decay. It should be noted that the bottom of the tailings in

Pit # 2114 will be 12 m above the stream bed about 800 meters north of it. When erosion takes place it would be difficult to predict how much of the tailings remain on the surface, and how much will be re-buried.

metal. This uranium will be in secular-equilibrium with 134 kg of thorium - 230, which remains in the mill tailings. The ultimate decay of this thorium will result in the production of a total of  $2.0 \times 10^{10}$  curies of radon - 222. The NRC suggests that 97% of the uranium will be recovered from the ore (Ref. 1, Appendix D). This is probably optimistic for ore which is  $0.07\%$   $\text{U}_3\text{O}_8$ , but will be used anyway. With this assumption,  $7.6 \times 10^6 \text{kg}$  uranium will be shipped away as yellowcake, while  $2.4 \times 10^5 \text{kg}$  will remain in the mill tailings. The uranium (99.3% U - 238) in the mill tailings will ultimately decay to produce a total of  $3.4 \times 10^{13}$  curies of radon - 222. Of the  $7.6 \times 10^6 \text{kg}$  of uranium to be sent away,  $6 \times 10^6 \text{kg}$  will end up as depleated uranium of the enrichment tails. The decay of this depleated uranium will eventually decay to produce a total of  $8.7 \times 10^{14}$  curies of radon - 222. These figures are shown in table 1.

The amount of radon actually released into the atmosphere depends on the amount and kind of covering in place over the mill tailings at the time considered. At present some recent mill tailings piles have 2 feet of dirt covering. In this case, the EPA estimate is that 1/20 of the radon escapes into the air (Ref. 5). The EPA also suggest that a 6 meter cover of dirt would reduce the radon emanations by about 90% (Ref. 5, Pl.5). Since the Morton Ranch disposal pits are 18m or 30 m deep (3 to 5 times as the EPA model tailings pile) about 3 to 5 times less radon will escape due to this greater depth. The Morton Ranch pits will be covered with about 3 meters of soils, which is about ~~the~~ half the EPA cover, but a factor of 10 reduction will still be allowed. These simple considerations suggest an overall reduction factor of  $10^3$ , that is that about 1/1000 of the radon produced in the mill tailings will escape to the air.

To reach a compromise, a reduction factor of 1000 will be used for the radon from the thorium in the mill tails, and a reduction factor of 100 for the radon from the uranium therein. These should be considered crude estimates with uncertainties of at least a factor of ten.

The existence of  $6 \times 10^6$  kg of depleted uranium tails from the isotopic enrichment process is a definite result of the Horton Ranch uranium project. At present such material is located in the eastern part of the country, and no method of disposal has been suggested. It is assumed that it will be buried near their present locations. A reduction factor of 100 will also be used for this case. An additional factor of 2 will be used to reduce the health consequences of this release to estimate the effect of the decay of much of this radon over the ocean, rather than populated land areas, as would be the case for a release from a western state.

It is not possible to predict the U.S., or world population thousands of years into the future. To provide a basis for a beginning, it is reasonable to use the present population, and its current distribution. The NRC has recently done this, assuming a U.S. population of 300 million (Ref. 6, P. 3), with the result that the release of 1 curie of radon - 222 from a typical tailings pile in a western state will result in a total dose of 0.56 Person-rem to the bronchial epithelium, for the total population. These total doses are shown in Table 1, and are calculated with the use of the reduction factors determined above.

The NRC estimate of cancer risk is 22.2 deaths per million person-rem for the bronchial epithelium (Ref. 6, P. 7) and is taken from WASH-1400 and GRSO. Even though the estimate is too low, it will be used here. The results, shown in table 1,

are that the thorium in the mill tails would cause 250 deaths, while the uranium therein would cause 4.2 million. The uranium in the enrichment tails would cause 54 million deaths.

The operation of this mill is estimated to result in the deaths of nearly 60 million people, over all time. This is to be compared with the assumed population of 300 million, one in five. Dr. Walter Jordan notes (Ref. 4, p7):

It is very difficult to argue that deaths to future generations are unimportant. But it can be shown that the number is insignificant compared to those due to the radon contribution in natural background.

To show that the environmental impact is less than that due to background is not sufficient to carry out an informed cost-benefit analysis. To do this one must add up all the real costs regardless of whether it might be possible to statistically measure them or not. This is the requirement of the National Environmental Policy Act of 1969, as amended.

The draft environmental statement on the Horton Ranch uranium mill could also be improved in some minor ways. First the quality of Fig. 2.3 could be improved. Some considerations should be

given for plant operations at -40°F, with particular reference to the operation of the lines for the tailings slurry beyond

that in section 3.2.4.5. In light of recent earthen dam problems (Teton) the discussion in section 5.1.3.2 should be expanded,

and the analysis done for the final E.I.S. The description of the stabilization cover in the first paragraph of section 10.4.4 does not agree with that given in the fifth paragraph of

section 3.2.5. In particular, 4 feet is 1.22 meters. Section

4.7.4 states that the private residence closest to the proposed

(2)

(3)

(4)

(5)

(6)

- mill is the Fowler Ranch 11 km (6.8 miles) to the north. Figure 1.2 shows Box Creek Ranch to be about 4 miles north-east.
- (7) The latitude and longitude given in section 1.2 need correcting.

Table 1

Dose Commitments to Humans due to Morton Ranch Project

| Origin of Radon             | Radon Generated Curies | Reduction Factor | Population Dose Bronchial Epithelium Person-rem | Cancer Deaths     |
|-----------------------------|------------------------|------------------|-------------------------------------------------|-------------------|
| Thorium in Mill Tails       | $2.0 \times 10^{10}$   | 1000             | $1.1 \times 10^7$                               | 250               |
| Uranium in Mill Tails       | $3.4 \times 10^{13}$   | 100              | $1.9 \times 10^{11}$                            | $4.2 \times 10^6$ |
| Uranium in Enrichment Tails | $8.7 \times 10^{14}$   | 200              | $2.4 \times 10^{12}$                            | $5.4 \times 10^7$ |

References

- 1 "Draft environmental statement related to operation of Morton Ranch uranium mill, United Nuclear Corporation" NUREG-0439, Draft, U.S. Nuclear Regulatory Commission, (April 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. Kenford, "Health Effects Comparison for Coal and Nuclear Power" in the matter of Three Mile Island Unit 2 (Docket No. 50 - 320) operating license hearings and portions of transcript related, in which the IRC staff supports Kenford's numbers.
- 4 Memorandum of Dr. Walter H. Jordan, Atomic Safety and Licensing Board Panel (ASLBP) to James R. Yore, Chairman, ASLBP, (September 21, 1977)
- 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)
- 6 Affidavit of R.E. Gotchy, "Appendix", "Radiological Impact of Radon - 222 Releases", USNRC, in the matter of Three Mile Island Unit 2, (Docket No. 50 - 320), (January 20, 1978)

## NRC RESPONSE TO THE ENVIRONMENTAL COALITION ON NUCLEAR POWER--W. LOCHSTET

The staff has chosen to limit its radiological assessment to an evaluation of the dose to the population within an 80 kilometer radius of the plant integrated over a 50-year period from one year of exposure for the following reasons:

- (a) The radon dose commitment becomes a very small fraction of the natural background dose beyond 80 kilometers. Table 4.3 of this document shows that the bronchial epithelium population dose within 80 km (82.1 man-rem/year) is only ~0.25% of the bronchial epithelium population dose from natural background (32,200 man-rem/year).
- (b) The calculation of the maximum annual dose from one year of exposure integrated over 50 years provides a realistic estimate that can easily be compared to applicable standards and regulations. The staff does not feel it is realistic or meaningful to consider effects on a time scale of  $4.5 \times 10^9$  years as proposed by the commentor. It should be noted that the  $5.8 \times 10^7$  deaths estimated by the commentor over 4.5 billion years is only 0.013 statistical premature deaths per year.

Also, since the depleted uranium tails from the enrichment process are not necessarily waste and recognizing the NEPA goal of attaining 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 100 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  $4.2 \times 10^6$  deaths estimated by the commentor over 4.5 billion years is only 0.00094 statistical premature deaths per year.

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 hundreds 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."<sup>1</sup>

". . . 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."<sup>2</sup>

This evaluation is supported by the preliminary conclusion in the draft Generic Environmental Impact Statement on Uranium Milling to be issued by the NRC in early 1979.

In response to other comments raised by this commentor:

1. Please note that pit 2114 is no longer included among the pits proposed for tailings disposal.
2. The contours on Figure 2.3 have been darkened.
3. If the tailings lines were to freeze, the tailings would be placed in the evaporation pond. The applicant has committed to maintaining the tailings wet at all times. Upon cessation of milling at the site, all tailings residues will be removed from the evaporation pond and will be properly disposed of by being placed in a mined-out pit.
4. The staff's assessment of freeboard requirements is included on page 5-6. The staff's stability analysis of the dam will be completed prior to licensing.
5. The text in Section 3.2.5 has been changed in response to this comment.
6. Although Box Creek Ranch is closer to the site, it is uninhabited. The radiation dose commitments to individuals are discussed in Section 4.7.4; and since the closest residence is at Fowler Ranch, it is used as the point of reference.
7. The latitude and longitude have been corrected on page 1-1.

#### References

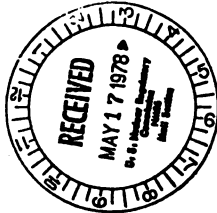
1. The July 24, 1978, Partial Initial Decision of the Atomic Safety and Licensing Board Authorizing Limited Work Authorization, Black Fox Station, Units 1 and 2.
2. The July 14, 1978, Partial Initial Decision of the Atomic Safety and Licensing Board, Perkins Nuclear Station, Units 1, 2, and 3.

RESPONSES WERE NOT NECESSARY TO THE FOLLOWING LETTERS

•

FEDERAL ENERGY REGULATORY COMMISSION  
WASHINGTON, D. C. 20426

May 4, 1978



Director  
Division of Fuel Cycle  
and Material Safety  
U. S. Nuclear Regulatory  
Commission  
Washington, D. C. 20555

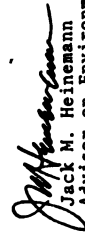
Dear Sir:

I am replying to your request of April 15, 1978 to the Federal Energy Regulatory Commission for comments on the Draft Environmental Impact Statement for the Morton Ranch Uranium Mill, Docket No. 40-8602. This Draft EIS has been reviewed by appropriate FERC staff components upon whose 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



Department of Energy  
Washington, D.C. 20545

JUN 20 1978



Mr. Leland C. Rouse, Chief  
Fuel Processing and Fabrication  
Branch  
Division of Fuel Cycle and  
Material Safety  
Nuclear Regulatory Commission  
Washington, D.C. 20555

Dear Mr. Rouse:

This is in response to your letter dated April 21, 1978, in which you invited the Department of Energy (DOE) to review and comment on the Nuclear Regulatory Commission's draft environmental impact statement related to the operation of the Morton Ranch Uranium Mill, United Nuclear Corporation (NUREG-0439).

We have reviewed the statement and have determined that the proposed action will not conflict with current or known future DOE programs. We have no comments to offer on the statement itself.

Thank you for the opportunity to review and comment on the draft statement.

  
W. H. Pennington, Director  
Division of Program Review  
and Coordination  
Office of NEPA Affairs

UNITED STATES DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE

P.O. Box 2440, Casper, WY 82602

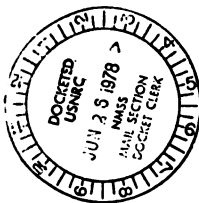


WYOMING  
EXECUTIVE DEPARTMENT  
CNEYENNE

June 12, 1978

ED HERSCHLER  
Commissioner

July 19, 1978



Leland C. Rouse, Chief  
Fuel Processing and Fabrication Branch  
Division of Fuel Cycle and Material Safety  
U. S. Nuclear Regulatory Commission  
Washington, D. C. 20555

Dear Mr. Rouse:

We appreciate the opportunity to review the draft environmental impact statement related to operation of the Horton Ranch Uranium Mill, Converse County, Wyoming. We have no comment.

*Frank S. Dickson*  
Frank S. Dickson  
State Conservationist

cc: K. L. Williams, Director, West Technical Service Center  
Glen Loomis, Director, Environmental Services Division, Washington, D. C.

Mr. Leland C. Rouse, Chief  
Fuel Processing and Fabrication Branch  
Division of Fuel Cycle and Material Safety  
Washington, D.C. 20555

RE: United Nuclear's Morton  
Ranch Uranium Mill--Docket  
No. 40-8602

Dear Mr. Rouse:

In compliance with the National Environmental Protection Act, 1969, Office of Management and Budget Circular A-95 (revised), and the Wyoming State Review Procedures, the State of Wyoming has completed its review of the above mentioned draft environmental statement. Comments from several state agencies are enclosed for your review and inclusion in the final statement.

Thank you for the opportunity to review the draft statement. We are looking forward to reviewing the final statement.

Yours sincerely,

*Ed Herschler*

EH:trg

Enclosure



WYOMING  
EXECUTIVE DEPARTMENT  
CHEYENNE

ED HERSCHLER  
GOVERNOR



THE STATE  
OF WYOMING

# *Wyoming Recreation Commission*

604 EAST 25TH STREET  
CHEYENNE, WYOMING 82002

ED HERSCHLER  
GOVERNOR

JAN L. WILSON  
Acting Director  
777-7895

May 5, 1978

COMMISSION  
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1001 West Avenue  
Cheyenne 82001

Mr. Richard Hartman  
Wyoming Executive Department  
2320 Capitol Avenue  
Cheyenne, Wyoming 82002

Dear Mr. Hartman:  
Reference is to State Identifier Number 77-132 R/D,  
Morton Ranch Uranium Mill, United Nuclear Corporation,  
April 1978, Docket No. 40-8602.

Some time ago we received a copy of this Environmental  
Statement directly from Mr. Scarano, Nuclear Regulatory  
Commission, who desired the comments of the State  
Historic Preservation Officer. Those comments, recom-  
mending cultural-environment clearance for the project,  
were sent to him.

Sincerely,

*Ned Frost*

Ned Frost, Chief  
Historical Division

NF/mr

July 7, 1978

Mr. Leland C. Rouse, Chief  
Fuel Processing and Fabrication Branch  
Division of Fuel Cycle and Material Safety  
Washington, D.C. 20555

Dear Mr. Rouse:

Please find enclosed the comments that were  
omitted in the Governor's letter of June 12, 1978.

Thank you.

Sincerely,

*Dick Hartman*

Dick Hartman  
Natural Resources Policy Analyst

DH:jg

Enclosures



THE STATE OF WYOMING

ED HERSCHLER  
GOVERNOR

## Department of Environmental Quality

LAND QUALITY DIVISION

STATE OFFICE BUILDING

TELEPHONE 307-777-7766

CHEYENNE, WYOMING 82002

August 10, 1978

Mr. Robert J. Flynn  
Division of Environmental Impact Studies  
Argonne National Laboratory  
9700 South Cass Avenue  
Argonne, IL 60439

RE: Permit No. 230C, Flynn letter dated July 31, 1978

Dear Mr. Flynn:

In your letter dated July 31, 1978, you requested further explanation of our position concerning crested wheatgrass. Our plant ecologists contend that crested wheatgrass is a useful forage in the spring and occasionally in the fall, but it is not acceptable for yearlong or season long use. The conditions in which crested wheatgrass is acceptable are limited to (1) critical areas where nothing else can be established, and (2) intensively managed spring pasture.

In place of crested wheatgrass we recommend a mixture of native grasses that could include any combination of the following, depending on the site conditions:

|                         |                            |
|-------------------------|----------------------------|
| Western wheatgrass      | Blue grama grass           |
| Streambank wheatgrass   | June grass                 |
| Thickspike wheatgrass   | Bluestem, Little and Big   |
| Bluebunch wheatgrass    | Prairie Sandreed           |
| Needle and thread grass | Bluegrass, various species |
| Indian ricegrass        |                            |

Please contact me if you have further questions.

Sincerely,

*Rebecca L. Mathison*

Rebecca L. Mathison  
District I Engineer

RLM:sh

LETTERS TO NRC FROM THE APPLICANT

# UNITED NUCLEAR CORPORATION

MINES AND MILLING DIVISION  
WYOMING OPERATIONS  
P.O. BOX 1894  
CAMDEN, WYOMING 82406  
(207) 868-4447

May 4, 1978

U. S. Nuclear Regulatory Commission  
Fuel Processing & Fabrication Branch  
Division of Fuel Cycle & Material Safety  
Washington, D. C. 20555

Attention: Mr. L. M. Rossbach

Re: Docket 40-8602

Gentlemen:

United Nuclear Corporation, Morton Ranch Operations, herein addresses Barium Chloride treatment of waters from the North Morton Ranch mines and from the South Morton mines. Barium Chloride ( $\text{BaCl}_2$ ) and settling basins are used to reduce the Radium 226 concentration to a level below the Maximum Permissible Concentration as set by the Environmental Protection Agency.

We expect the Radium 226 content in our South Morton Mine waters may exceed the 5 pCi/l MPC as now set by the EPA. A dewatering program for future operations and during the life of the South Morton Mines may be required whenever water is encountered in these mines.

Water is currently being pumped from the present shaft and five dewatering wells. Dewatering of the ore horizon in the underground mines has to date produced a maximum of approximately 185 gpm, 24 hours per day, seven days per week. This dewatering program may be required during the life of the underground mines.



U. S. Nuclear Regulatory Commission  
May 4, 1978  
Page Two

Design and engineering of the Barium Chloride treatment facilities are such that the  $\text{BaCl}_2$  can be fed at metered rates dependent upon flow rates and Radium content in the inflowing water. We expect the flow rates to range from zero to 300 gpm on an intermittent basis from the south mines and zero to 1,000 gpm from the north mines. Based on the above rates, the initial reagent addition settings are estimated to range from 0.01 to 0.03 pounds  $\text{BaCl}_2$  per 10,000 gallons  $\text{H}_2\text{O}$  treated to reduce the Radium 226 concentrations in the  $\text{H}_2\text{O}$  to well below 5 pCi/l.

The three sedimentation basins initially installed at the North Morton Mines each have a capacity of 45,400 cubic feet or 339, 650 gallons. Retention time in each basin at an inflow rate of 185 gpm, 24 hours/day, 7 days/week is 30.6 hours.

The three sedimentation basins presently planned for installation at the South Mines will each have a capacity of 85,489 cubic feet or 639,450 gallons. Retention in each basin at an inflow rate of 130 gpm over 24 hours/day, 7 days/week is 81.98 hours.

Typical current data on the North shows about 185 gpm average from all sources (wells and mines) of water containing approximately 6.5 pCi/l of Radium 226. Current data on the South shows a potential of about 130 gpm average of water from these mines containing approximately 8.0 pCi/l of Radium 226.

U. S. Nuclear Regulatory Commission  
 May 4, 1978  
 Page Three

The Radium 226 should be evenly distributed throughout the solids settled in the basins. It is proposed that when these basins are cleaned the solids would be disposed of at the planned milling facility. The basins on the south will be receiving essentially clear water whereas those on the north will not, that is the shaft water will be higher in solids but the water from the wells will be clear. As soon as drifts are driven away from the shaft station and specific drainage programs initiated, solids will be decreased by dilution to a point of lower turbidity as compared to the initial solids content in these waters. During decantation and subsequent evaporation of a basin, removal of the sediment, disposal of the sediment, and eventual decommissioning and abandonment, effective dust control measures will be utilized to virtually eliminate any dust problems.

Very truly yours,

UNITED NUCLEAR CORPORATION  
 Mining and Milling Division

  
 C. E. Molyneux  
 Plant Superintendent  
 Wyoming Operations

CEM/AMM/del

cc: A. M. Woods  
 J. R. Brooks  
 A. W. Shafer  
 C. H. Likins

## APPENDIX B. SOCIOECONOMIC STATISTICS FOR THE PROJECT AREA

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Table B.1. Population Changes for Converse County and Nearby Towns, 1950-1976

|                 | 1950 | 1960 | 1970 | 1976   | % Change<br>1970-1976 |
|-----------------|------|------|------|--------|-----------------------|
| Glenrock Area   | 1110 | 1584 | 1515 | 2,500  | 65.0                  |
| Douglas Area    | 2544 | 2822 | 2677 | 6,200  | 131.6                 |
| Converse County | 5933 | 6366 | 5938 | 10,500 | 76.8                  |

Sources: "Census of Population," Bureau of the Census, U.S. Department of Commerce.  
 "Population Projections for Converse County and the Towns of Douglas and Glenrock," Converse Area Planning Office, March 11, 1977.

Table B.2. Population in the Vicinity of the Morton Ranch Site

| Ranch or Community | Population         |
|--------------------|--------------------|
| Box Creek Ranch    | 4 *                |
| Fowler Ranch       | 3<br>(5 in summer) |
| Vollman Ranch      | 8                  |
| Bill               | 5                  |
| Orpha              | 20                 |

Source: ER, Section 2.2.2 and Table 2.2-4.

\*Summer residence only

Table B.3. Five-Year Projection of Energy-Related Immigrating Employees<sup>a</sup>

| Year | Permanent Employment |               | Construction-Force Employment |
|------|----------------------|---------------|-------------------------------|
|      | Douglas Area         | Glenrock Area | Glenrock and Douglas Area     |
| 1978 | 157                  | 107           | 500                           |
| 1979 | 48                   | 48            | 1000                          |
| 1980 | 50                   | 24            | 2700                          |
| 1981 | 475                  | 0             | 1700                          |
| 1982 | 300                  | 0             | 500                           |

<sup>a</sup>Source: Converse Area Industrial Association, January 1977.

Table B.4. Five-Year Population Projections for Glenrock and Douglas<sup>a</sup>

|                 | Permanent<br>Employees <sup>b</sup> | Induced-<br>Service<br>Sector <sup>c</sup> | Additional<br>Permanent<br>Population <sup>d</sup> | Construction<br>Employee <sup>e</sup> | Induced-<br>Service<br>Sector<br>Employment <sup>f</sup> | Additional<br>Construction-<br>Related<br>Population <sup>g</sup> | Aggregate<br>Population<br>Level <sup>h</sup> |
|-----------------|-------------------------------------|--------------------------------------------|----------------------------------------------------|---------------------------------------|----------------------------------------------------------|-------------------------------------------------------------------|-----------------------------------------------|
| <b>Glenrock</b> |                                     |                                            |                                                    |                                       |                                                          |                                                                   |                                               |
| 1978            | 107                                 | 160                                        | 668                                                | 77                                    | 19                                                       | 192                                                               | 4,360                                         |
| 1979            | 48                                  | 72                                         | 300                                                | 118                                   | 30                                                       | 296                                                               | 4,764                                         |
| 1980            | 24                                  | 36                                         | 150                                                | 308                                   | 77                                                       | 770                                                               | 5,388                                         |
| 1981            | 0                                   | 0                                          | 0                                                  | 205                                   | 51                                                       | 512                                                               | 5,130                                         |
| 1982            | 0                                   | 0                                          | 0                                                  | 55                                    | 14                                                       | 138                                                               | 4,756                                         |
| <b>Douglas</b>  |                                     |                                            |                                                    |                                       |                                                          |                                                                   |                                               |
| 1978            | 157                                 | 236                                        | 590                                                | 423                                   | 106                                                      | 1058                                                              | 8,848                                         |
| 1979            | 48                                  | 72                                         | 180                                                | 882                                   | 221                                                      | 2206                                                              | 10,176                                        |
| 1980            | 50                                  | 75                                         | 125                                                | 2392                                  | 598                                                      | 5980                                                              | 14,075                                        |
| 1981            | 475                                 | 713                                        | 1783                                               | 1545                                  | 386                                                      | 3862                                                              | 13,470                                        |
| 1982            | 300                                 | 450                                        | 1875                                               | 445                                   | 111                                                      | 1112                                                              | 12,865                                        |

<sup>a</sup>Source: "Population Projections for Converse County and the Towns of Douglas and Glenrock," Converse Area Planning Office, March 11, 1977.

<sup>b</sup>Given by the Converse Area Industrial Association (CAIA). See Table B.3.

<sup>c</sup>For every permanent base job there are created additional jobs in the service sector, i.e., teachers, clerks, retail store owners, doctors, etc. The multiplier for this is 1.5; therefore, induced-service sector employees = permanent employees × permanent service multiplier.

<sup>d</sup>Consists of permanent employees + induced-service employees × permanent population multiplier (2.5).

<sup>e</sup>Given by the CAIA. It is assumed that most of the construction employees will seek housing in the local community. The CAIA has not committed itself to a plan for construction housing at the plant sites.

<sup>f</sup>The multiplier for construction-induced service employees is considerably less than for the permanent sector. Therefore, induced-service sector employment = construction employees × construction service multiplier (0.25).

<sup>g</sup>This population should be more transitory than the permanent sector. Additionally, many people working on construction will not bring their families to the area. Construction employees + construction-induced service employees × construction-related population multiplier (2.0) = additional construction-related population.

<sup>h</sup>Current population + cumulative total of additional permanent population + annual additional construction-related population figure.

Table B.5. Population Estimates and Projections to 2005  
(for Radiological Dose Assessment)

|                 | 1970                | 1976                | 1980                | 2005                |
|-----------------|---------------------|---------------------|---------------------|---------------------|
| Glenrock        | 1,515 <sup>a</sup>  | 2,500 <sup>b</sup>  | 5,388 <sup>c</sup>  | 5,388               |
| Douglas         | 2,677 <sup>a</sup>  | 6,200 <sup>b</sup>  | 14,075 <sup>c</sup> | 14,075              |
| Converse County | 5,938 <sup>a</sup>  | 10,500 <sup>b</sup> | 21,662 <sup>d</sup> | 22,120 <sup>e</sup> |
| Casper          | 39,500 <sup>f</sup> | 47,039 <sup>g</sup> | N.A. <sup>h</sup>   | 83,500 <sup>i</sup> |

<sup>a</sup>U.S. Bureau of Census, from Table B.1.<sup>b</sup>Converse Area Planning Office, from Table B.1.<sup>c</sup>From Converse Area Planning Office, including project-related employment.<sup>d</sup>From Wyoming Department of Economic Planning and Development for Alternative Future III (high growth), assuming development of coal and uranium resources (ER, Table 2.2-7).<sup>e</sup>From Water Resource Research Institute, University of Wyoming, Scenario III (high growth) assuming coal development (ER, Table 2.2-7).<sup>f</sup>From U.S. Bureau of Census (from ER, Table 2.2-3).<sup>g</sup>From the Casper Chamber of Commerce (ER, Table 2.2-3).<sup>h</sup>Data not available.<sup>i</sup>Assumes 2% growth rate for Casper area, about twice the growth rate for the Bear Creek Mill area ("Final Environmental Statement Related to Rocky Mountain Energy Co.'s Bear Creek Project," NUREG-0129 U. S. Nuclear Regulatory Commission, June 1977--Tables 2.16 and 2.17, p. 2-39).<sup>1</sup>Table B.6. Public Attitudes Regarding Improvements  
Needed in Campbell County<sup>a</sup>

| Improvements                                               | Percent Responding            |          |
|------------------------------------------------------------|-------------------------------|----------|
|                                                            | Mineral-Related<br>Employment | Ranching |
| More entertainment,<br>recreational activities             | 38                            | 22       |
| Retail stores                                              | 34                            | 14       |
| Better streets and roads                                   | 30                            | 16       |
| Medical facilities and services                            | 19                            | 19       |
| More quality housing                                       | 15                            | --       |
| Updated local administration                               | 11                            | --       |
| Fire, police, transportation,<br>and other public services | 8                             | --       |
| Nothing                                                    | --                            | 11       |
| No more new people; no new town                            | --                            | 10       |

<sup>a</sup>Source: Responses to questionnaires in a study conducted by the Denver Research Institute, "Socio-Economic Impacts of Proposed Burlington Northern and Chicago North Western Rail Line in Campbell-Converse Counties, Wyoming," March 1974.

Table B.7. Indicators of Societal Change--Converse County, Wyoming<sup>a</sup>

| Indicators                      | Characteristics of Society--1976                                                                                                                                                                                                                                                                                                                            | Characteristics of Society--1985                                                                                                                                                                                                                                          |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b><u>Social Structure</u></b>  |                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                           |
| Economy                         | Total employment--3,150<br>Balanced economic base--<br>Agriculture is 39% of basic employment. Mining and processing is 35%. Retired individuals comprise 32.4% of population.<br>Expanding job opportunities within county since 1970; gain of population since 1970 vs. a loss of population in the 1960's.                                               | Total employment--6,600<br>Single industry economic base--<br>Agriculture is now 15% of basic employment. Mining and processing is now 73%.<br>Job opportunities will continue to draw new residents, they may also help stem outmigration of young people from the area. |
| Technology                      | Agriculture technology fairly advanced; large power plant and several mines.                                                                                                                                                                                                                                                                                | Advanced mining and processing technology; more specialized; more diversified and sophisticated; improved technical, educational and professional services in the area.                                                                                                   |
| Occupational structure          | Rancher and blue collar workers roughly equally.                                                                                                                                                                                                                                                                                                            | Blue collar dominated.                                                                                                                                                                                                                                                    |
| <b><u>Polity</u></b>            |                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                           |
| Regulates distribution of power | Rancher dominated counties (the 3 county commissioners are ranchers); county which has traditionally been antiplanning is now establishing and stressing more comprehensive planning mechanisms.                                                                                                                                                            | Changes in occupational structure, technology, and economy must be dealt with and will change constituencies urban centers will be larger and more complex, will require more planning and administration.                                                                |
| Adjudicates conflict and claims | Legislature is rural dominated; county government deals with few conflicts, largely between revenues (taxes) and expenditures (service requirements).                                                                                                                                                                                                       | New conflicts: newcomer vs. old-timer, more urban vs. rural strain; interindustry and environmental conflicts more common; more concern with and need for Federal intervention with more urbanization; unions probably more of issue and possibly a political force.      |
| <b><u>Culture</u></b>           |                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                           |
| Expressive symbolism            | Protestant Christian values--United Methodist, Baptist, Episcopal--37.5% of county population are church adherents (the national average is 50%).<br>Emphasis on independence and self-reliance--80% of the farms (and ranches) are owner occupied (the national average is 62%); 20% of all the work force is self-employed (the national average is 11%). | ?<br>More emphasis on political, social, and economic groups.                                                                                                                                                                                                             |
| <b><u>Institutions</u></b>      |                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                           |
| Family                          | Attitude of permanence--attachment to the area is high (76% of 1970 residents had lived in county for 5 years or more).<br>1972 divorce rate--4.26/1,000 population, an increase in the 1970 rate of 3.03/1,000.                                                                                                                                            | Presence of a large population who view themselves as temporary.<br>?                                                                                                                                                                                                     |
| Education                       | Low dropout rate of 7.2% (the national average is 25%).                                                                                                                                                                                                                                                                                                     | Dropout rate may come closer to the national average as the county becomes more industrial.                                                                                                                                                                               |

Table B.7. Continued

| Indicators                  | Characteristics of Society--1976                                                                                                                                                                                          | Characteristics of Society--1985                                                                                                                                                 |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <u>Institutions (cont.)</u> |                                                                                                                                                                                                                           |                                                                                                                                                                                  |
| Communities                 | Two very small service center towns; high proportion of permanent housing.                                                                                                                                                | Growth, more diversity in the two service centers, increase in the proportion of temporary housing; possible degradation of services and overcrowding to accompany rapid growth. |
| <u>Summary</u>              | Traditionally an agrarian society, recent increase in the number of miners and construction workers; county now dominated by ranchers and employees of the energy industry; includes service and governmental components. | More urban, complex society, including new extractive and processing components; county now dominated by the energy industry.                                                    |

<sup>a</sup>Among the sources used for this table are: Daniel Bell, "The Coming of Post-Industrial Society," Basic Books, New York (1973); Bureau of the Census, 1970 Census of the Population, Characteristics of the Population of Wyoming, Washington, D. C., GPO, 1972; Bureau of the Census, 1970 Census of Housing, Detailed Characteristics of Wyoming, Washington, D. C., GPO, 1972; System for Social Research and Development, Wyoming Social Economic Data for 1972, Exchange Measure 1970-1972, University of Denver Research Institute 1974; Wyoming Dept. of Education; County Clerk of Converse County, Wyoming; Douglas W. Johnson, Paul R. Picard, and Bernard Quinn (eds.), "Churches and Church Membership in the U. S.," Lyndon Blendmary Research Center, Washington, D. C., 1974; Julie M. Uhlmann, Robert Kimble and David Throgmorton, "A Study of Two Wyoming Communities Undergoing the Initial Success of Energy Resource Development in Powder River Basin: Buffalo and Douglas, Wyoming - 1975," Laramie: U. of Wyoming, Dept. of Anthropology, 1976. The table is reprinted from "Final Environmental Statement related to the Rocky Mountain Energy Company's Bear Creek Project (Converse County, Wyoming)," NUREG-0129, U. S. Nuclear Regulatory Commission, Washington, D. C., June 1977 (Table 2.23).

Table B.8. Converse County School Enrollment

|                                | Average Daily Attendance<br>1976-1977 | Estimated Capacity<br>1977-1978 |
|--------------------------------|---------------------------------------|---------------------------------|
| District One                   |                                       |                                 |
| Kindergarten                   | <sup>a</sup>                          | 200 <sup>b</sup>                |
| 1 - 2                          | 276                                   | 350                             |
| 3 - 6                          | 558                                   | 600                             |
| 7 - 12                         | 650                                   | 800 <sup>c</sup>                |
| Rural Schools                  | 53                                    | 80                              |
| Total                          | 1537                                  | 2030                            |
| District Two                   |                                       |                                 |
| Kindergarten - 6               | 406                                   | 600                             |
| 7 - 8                          | 128                                   | 150                             |
| 9 - 12                         | 238                                   | 275 <sup>d</sup>                |
| Rural Schools                  | 14                                    | 25                              |
| Special Education <sup>e</sup> | 4                                     | 15                              |
| Total                          | 790                                   | 1065                            |

<sup>a</sup>Figure not separately provided.

<sup>b</sup>Located at the State Fairgrounds, Arts and Crafts Building.

<sup>c</sup>Remodeling of bus garage into four classrooms.

<sup>d</sup>Four new temporary classrooms.

<sup>e</sup>District One did not list Special Education separately.

Table B.9. Converse County Labor Force, 1972-1976<sup>a</sup>

|                                                                    | 1972            | 1973            | 1974            | 1975            | 1976            |
|--------------------------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| <b>Total Labor Force<sup>b</sup></b>                               |                 |                 |                 |                 |                 |
| Employment                                                         | 2966            | 2835            | 3183            | 3952            | 4516            |
| Unemployment                                                       | 2864            | 2750            | 3096            | 3826            | 4411            |
| Unemployment Rate, %                                               | 102             | 85              | 87              | 116             | 105             |
|                                                                    | 3.4             | 3.0             | 2.7             | 2.9             | 2.3             |
| <b>State Unemployment Insurance Covered Employment<sup>c</sup></b> |                 |                 |                 |                 |                 |
| Manufacturing                                                      | 1545            | 1463            | 1753            | 2302            | 2792            |
| Non-manufacturing                                                  | 16              | 19              | 39              | 44              | 42              |
| Agriculture                                                        | 1529            | 1444            | 1714            | 2258            | 2750            |
| Mining                                                             | 27              | 26              | 26              | 4               | 9               |
| Construction                                                       | 245             | 305             | 431             | 686             | 886             |
| Transportation, communications, and utilities                      | 347             | 144             | 192             | 307             | 418             |
| Trade                                                              | 351             | 372             | 363             | 381             | 413             |
| Financial, insurance, and real estate                              | 352             | 365             | 433             | 539             | 617             |
| Services                                                           | 58              | 74              | 79              | 102             | 109             |
| State and local government                                         | 158             | 156             | 188             | 238             | 298             |
|                                                                    | 1               | 2               | 2               | 1d              | ---             |
| <b>Average Weekly Wage - Covered Employment</b>                    | <b>\$168.40</b> | <b>\$165.70</b> | <b>\$185.58</b> | <b>\$214.39</b> | <b>\$236.59</b> |

<sup>a</sup>Source: Research and Analysis Section of the Employment Security Commission of Wyoming.<sup>b</sup>Benchmarked to the Current Population Survey.<sup>c</sup>Not benchmarked to the Current Population Survey.<sup>d</sup>Covered state and local government, no longer listed separately.

Table B.10. Seasonal Employment in Converse County<sup>a</sup>

| Industry                        | 1975    |       |      |      |           | 1976     |         |       |      |      |           |
|---------------------------------|---------|-------|------|------|-----------|----------|---------|-------|------|------|-----------|
|                                 | January | March | May  | July | September | November | January | March | May  | July | September |
| Agriculture                     | 2       | 1     | 2    | 14   | 2         | 6        | 2       | 2     | 16   | 18   | 18        |
| Mining                          | 563     | 652   | 687  | 676  | 711       | 719      | 789     | 787   | 815  | 958  | 910       |
| Construction                    | 199     | 218   | 297  | 388  | 419       | 301      | 240     | 244   | 380  | 964  | 558       |
| Manufacturing                   |         | 44    | 49   | 47   | 37        | 39       | 44      | 40    | 44   | 45   | 38        |
| Transportation<br>and utilities | 374     | 367   | 388  | 379  | 373       | 393      | 400     | 405   | 410  | 417  | 412       |
| Wholesale trade                 | 35      | 37    | 66   | 69   | 75        | 82       | 70      | 83    | 62   | 80   | 84        |
| Retail trade                    | 405     | 425   | 442  | 510  | 531       | 538      | 478     | 475   | 536  | 573  | 569       |
| Finance                         | 86      | 85    | 114  | 102  | 104       | 102      | 109     | 109   | 111  | 109  | 115       |
| Services                        | 204     | 205   | 236  | 235  | 265       | 250      | 276     | 286   | 283  | 284  | 317       |
| Public<br>administration        | 3       | 2     | 2    | --   | --        | --       | 0       | 0     | 0    | 0    | 0         |
| Total                           | 1871    | 2036  | 2283 | 2420 | 2517      | 2430     | 2408    | 2431  | 2657 | 3448 | 3021      |

<sup>a</sup>Source: Converse Area Planning Office.Table B.11. New Home Construction in Converse County, 1970-1977<sup>a</sup>

|          | 1970          |      |                 |      | 1977          |      |                 |      |
|----------|---------------|------|-----------------|------|---------------|------|-----------------|------|
|          | Single Family |      | Multiple Family |      | Single Family |      | Multiple Family |      |
|          | No.           | %    | No.             | %    | No.           | %    | No.             | %    |
| Douglas  | 767           | 71.9 | 179             | 16.8 | 1232          | 68.9 | 207             | 11.6 |
| Glenrock | 359           | 69.8 | 52              | 10.1 | 429           | 66.4 | 63              | 9.5  |
| County   | 615           | 86.5 | 23              | 3.2  | 670           | 58.1 | 37              | 3.2  |
| Total    | 1741          | 76.0 | 254             | 11.1 | 2341          | 65.0 | 307             | 8.5  |
|          |               |      |                 |      |               |      | 955             | 26.5 |

<sup>a</sup>Source: Converse Area Planning Office.

Table B.12. Converse County Camping and Picnicking Sites<sup>a</sup>

|                                               | Site, ha |       | Number of<br>Camping Spaces |        |         | Picnic<br>Tables | Activities at Site |            |         |          |         |
|-----------------------------------------------|----------|-------|-----------------------------|--------|---------|------------------|--------------------|------------|---------|----------|---------|
|                                               | Land     | Water | Total                       | Tent   | Trailer | Total            | Camping            | Picnicking | Boating | Swimming | Fishing |
| <u>Federal (U.S.F.S.)</u>                     |          |       |                             |        |         |                  |                    |            |         |          |         |
| Canal Creek                                   | 1.21     |       | 1.21                        |        |         | 8                | x                  | x          |         |          | x       |
| Curtis Gulch                                  | 0.40     |       | 0.40                        |        |         | 4                | x                  | x          |         |          | x       |
| Esterbrook                                    | 4.05     |       | 4.05                        |        |         | 12               | x                  | x          |         |          |         |
| <u>State (Wyo.<br/>Recreation Commission)</u> |          |       |                             |        |         |                  |                    |            |         |          |         |
| Fort Fetterman                                | 24.28    |       | 24.28                       | --     | --      | 1                |                    |            | x       |          |         |
| <u>County</u>                                 |          |       |                             |        |         |                  |                    |            |         |          |         |
| Ayer's (Nat. Bridge)<br>Park                  | 8.09     |       | 8.09                        | 5      | 20      | 25               | x                  | x          |         |          | x       |
| Boxelder County Park                          | 0.81     |       | 0.81                        | unltd. | 2       | unltd.           | x                  |            | x       |          | x       |
| <u>Municipal</u>                              |          |       |                             |        |         |                  |                    |            |         |          |         |
| Glenrock City Park                            | 4.05     |       | 4.05                        | --     | --      | 40               |                    | x          |         | x        | x       |
| Douglas Riverside Park                        | 1.21     |       | 1.21                        |        |         | 75               | x                  | x          |         |          | x       |
| Douglas Washington Park<br>Picnic Ground      | 3.64     |       | 3.64                        | --     | --      | 15               |                    | x          |         |          |         |
| <u>Private</u>                                |          |       |                             |        |         |                  |                    |            |         |          |         |
| Jackalope KOA                                 |          |       |                             | 25     | 40      | 65               | x                  |            |         |          |         |

<sup>a</sup>Source: "An Outdoor Recreation Plan for Wyoming," Wyoming Recreation Commission, Cheyenne, Wyoming, June 1975.

Table B.13. Converse County Parks and Playgrounds

| Town            | Land,<br>ha | Open<br>Areas | Trees<br>and/or<br>Shrubs | Rest<br>Rooms | Playground<br>Equipment | Baseball<br>or Softball | Tennis<br>Courts |
|-----------------|-------------|---------------|---------------------------|---------------|-------------------------|-------------------------|------------------|
| <b>Douglas</b>  |             |               |                           |               |                         |                         |                  |
| Washington Park | 2.43        | x             | x                         | x             | x                       |                         | x                |
| Riverside       | 2.34        | x             | x                         | x             |                         |                         |                  |
| Schools         | 7.08        | x             | x                         | x             | x                       | x                       |                  |
| Ayers Bridge    | 6.07        | x             | x                         | x             |                         |                         |                  |
| <b>Glenrock</b> |             |               |                           |               |                         |                         |                  |
| Town Park       | 13.36       | x             | x                         | x             | x                       | x                       |                  |
| Schools         | 3.24        |               |                           |               |                         |                         |                  |
| Boxelder Park   | 843.39      | x             | x                         | x             | x                       | x                       | x                |
| <b>Shawnee</b>  |             |               |                           |               |                         |                         |                  |
| School          | 0.40        |               |                           | x             | x                       | x                       |                  |

<sup>a</sup>Source: "An Outdoor Recreation Plan for Wyoming," Wyoming Recreation Commission, Cheyenne, Wyoming, June 1975.

Table B.14. Converse County Estimated Total Outdoor Recreation Participation, 1970 and 1990

|                                   | 1970   | 1990   | % Change        |
|-----------------------------------|--------|--------|-----------------|
| Persons attending athletic events | 16,381 | 26,716 | 63              |
| Boating and canoeing              | 4,635  | 18,312 | 295             |
| Camping                           | 21,558 | 45,257 | 110             |
| Fishing                           | 24,490 | 53,440 | 118             |
| Golfing                           | 13,557 | 26,408 | 95              |
| Hiking                            | 26,017 | 40,716 | 56              |
| Hunting                           | 13,303 | 28,497 | 114             |
| Ice skating                       | 3,625  | 10,424 | NA <sup>b</sup> |
| Picnicking                        | 11,267 | 22,468 | 99              |
| Rodeos                            | 20,527 | 39,050 | 90              |
| Sightseeing and pleasure drives   | 40,705 | 94,735 | 133             |
| Skiing                            | 0      | 9,159  | NA              |
| Sledding and tobogganing          | 1,518  | 4,363  | NA              |
| Snowmobiling                      | 4,670  | 5,838  | NA              |
| Softball and baseball             | 8,935  | 25,780 | NA              |
| Swimming                          | 24,978 | 38,078 | 52              |
| Water skiing                      | 2,636  | 6,533  | 148             |
| Tennis                            | 2,107  | 6,120  | NA              |

<sup>a</sup>Source: "An Outdoor Recreation Plan for Wyoming," Wyoming Recreation Commission, Cheyenne, Wyoming, June, 1975.

<sup>b</sup>NA: not available.

Table B.15. Land Ownership in Converse County<sup>a</sup>

| Area                      | Total Hectares | % of Total |
|---------------------------|----------------|------------|
| Total area                | 1,109,331.2    |            |
| Water surface             | 364.23         |            |
| Land                      | 1,108,967.     |            |
| Federal ownership         | 149,743.04     | 13.5       |
| State and local ownership | 134,485.85     | 12.1       |
| Indian lands              | 0              | 0          |
| Private ownership         | 824,738.13     | 74.4       |

<sup>a</sup>Source: "An Outdoor Recreation Plan for Wyoming," Wyoming Recreation Commission, Cheyenne, June 1975.

Table B.16. Inventory of Livestock in Converse County

|                       | 1972    | 1973    | 1974    | 1975    | 1976   |
|-----------------------|---------|---------|---------|---------|--------|
| All cattle and calves | 74,900  | 76,500  | 76,500  | 80,000  | 75,000 |
| Stock sheep           | 112,700 | 132,500 | 112,000 | 100,000 | 98,000 |
| Hogs                  | 1,600   | 1,300   | 1,100   | 900     | 620    |

Source: "Wyoming Agricultural Statistics 1976," Wyoming Crop and Livestock Reporting Services, Wyoming Department of Agriculture.

Table B.17. Converse County Agricultural Statistics<sup>a</sup>

| Crop                           | Hectares Planted |           |
|--------------------------------|------------------|-----------|
|                                | 1974             | 1975      |
| Dry beans                      | 242.82           | 404.70    |
| Corn <sup>b</sup>              | 465.41           | 445.17    |
| Wheat (all types)              | 1,072.46         | 1,578.33  |
| Barley                         | 1,416.45         | 971.28    |
| Oats                           | 1,375.98         | 1,173.63  |
| Sugar beets                    | 6,054.31         | 6,827.29  |
| Hay (all types) <sup>b</sup>   | 13,962.15        | 14,002.62 |
| Total                          | 24,589.58        | 25,403.02 |
| % of Total County <sup>c</sup> | 2.21             | 2.29      |

<sup>a</sup>Source: "Wyoming Agricultural Statistics: 1976," Wyoming Crop and Livestock Reporting Service, Wyoming Department of Agriculture.

<sup>b</sup>Hectares harvested.

<sup>c</sup>Converse County = 1,109,331.2 hectares.



## APPENDIX C. MORTON RANCH MILL AREA WATER-QUALITY ANALYSES

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Table C.1. Summary of Sampling and Field Analyses of Surface Water, Morton Ranch Property<sup>a</sup>

| Location                          | Sample Number      | Date                          | Source                                             | Field Analyses   |     |                                  |                                |                                  | Laboratory Analyses Performed <sup>b</sup> |          |
|-----------------------------------|--------------------|-------------------------------|----------------------------------------------------|------------------|-----|----------------------------------|--------------------------------|----------------------------------|--------------------------------------------|----------|
|                                   |                    |                               |                                                    | Temp., °C        | pH  | HCO <sub>3</sub> , ppm           | Specific Conductance, μmhos/cm | Alkalinity, as CaCO <sub>3</sub> |                                            | Chloride |
| Proposed Under-ground Mining Site | TVA-1              | 10/74 <sup>c</sup>            | Stagnant spring in creek bottom                    | 9                | 7.5 | 146                              | 890                            | --                               | --                                         | R        |
|                                   | TVA-2              | 10/74                         | Playa, stagnant                                    | 13               | 9.7 | 25 CO <sub>3</sub> <sup>=</sup>  | 205                            | --                               | --                                         | R        |
|                                   | TVA-3              | 10/74                         | Stagnant impoundment                               | 20               | 9.3 | 25 HCO <sub>3</sub> <sup>=</sup> | 150                            | --                               | --                                         | R        |
|                                   |                    |                               |                                                    |                  |     | 16 CO <sub>3</sub> <sup>=</sup>  |                                |                                  |                                            |          |
| Proposed Open-Pit Mining Sites    | TVA-4              | 10/74                         | Slightly flowing spring in Box Creek bottom        | 10               | 7.5 | 138                              | 925                            | --                               | --                                         | R        |
|                                   | TVA-5              | 10/74                         |                                                    | 20               | 7.8 | 130                              | 2200                           | --                               | --                                         | R        |
|                                   | TVA-6              | 10/74                         |                                                    | 19               | 7.6 | 276                              | 3000                           | --                               | --                                         | R        |
|                                   | TVA-7              | 10/74                         |                                                    | 12               | 8.0 | 130                              | 1800                           | --                               | --                                         | SS,R     |
|                                   | TVA-8              | 10/74                         | Slightly flowing spring in south fork of Box Creek | 11               | 7.9 | 158                              | 2200                           | --                               | --                                         | R        |
|                                   | TVA-10             | 10/74                         |                                                    | 9                | 7.8 | 138                              | 620                            | --                               | --                                         | R,U      |
|                                   | TVA-12             | 10/74                         |                                                    | 11               | 7.5 | 102                              | 405                            | --                               | --                                         | R,U,AA   |
|                                   | TVA-13             | 10/74                         |                                                    | 7                | 7.0 | 244                              | 640                            | --                               | --                                         | R,U,AA   |
|                                   | TVA-18             | 10/74                         | Stagnant spring                                    | 13               | 7.7 | 57                               | 360                            | --                               | --                                         | R,U,AA   |
|                                   | TVA-19             | 10/74                         | Stagnant spring                                    | 14               | 7.2 | 105                              | 520                            | --                               | --                                         | R,U,AA   |
| TVA-1A                            | 12/74 <sup>d</sup> | Flowing spring near TVA-4     | 2.5                                                | 8.3 <sup>e</sup> | --  | 775                              | 342                            | 22.7                             | R,U,AA                                     |          |
| TVA-2A                            | 12/74              | Flowing spring; same as TVA-5 | 2.5                                                | 7.7 <sup>e</sup> | --  | 1500                             | 410                            | 30.3                             | R,U,AA                                     |          |

<sup>a</sup>Source: FES-TVA, Table 3.4-2.<sup>b</sup>Legend: R = radiologic; U = uranium; SS = spark source; AA = atomic absorption, selected trace elements.<sup>c</sup>October sampling was done October 18-20, 1974.<sup>d</sup>December sampling was done December 18-21, 1974.<sup>e</sup>Analyzed in laboratory.

Table C.2. Summary of Ra-226, Th-230, and Uranium Analyses: Morton Ranch Property, October-December 1974<sup>a</sup>

| Location <sup>b</sup>            | Sample Number        | Source <sup>c</sup> | Uranium, ppb | Radium-226 ± precision, <sup>e</sup> pCi/L | Thorium-230 ± precision, pCi/L |
|----------------------------------|----------------------|---------------------|--------------|--------------------------------------------|--------------------------------|
| Proposed Underground Mining Site | TVA-1                | Surface water       | --           | 0.1±0.5                                    | --                             |
|                                  | TVA-2                | Surface water       | --           | 0.0±0.5                                    | --                             |
|                                  | TVA-3                | Surface water       | --           | 0.3±0.6                                    | --                             |
|                                  | 2685A                | Groundwater         | 7.0          | 0.7±0.7                                    | 0.4±0.5                        |
|                                  | 2685B                | Groundwater         | <1.5         | 0.7±0.7                                    | 0.3±0.5                        |
|                                  | 2685                 | Groundwater         | 30           | 18±3                                       | 1.4±0.7                        |
|                                  | 2686A                | Groundwater         | 28           | 1.2±0.9                                    | 0.7±0.6                        |
|                                  | 2686B                | Groundwater         | <1.5         | 0.4±0.7                                    | 0.4±0.5                        |
|                                  | 2686                 | Groundwater         | 94           | 5.4±2.0                                    | 0.4±0.5                        |
| Proposed Open-Pit Mining Sites   | TVA-1A <sup>d</sup>  | Surface water       | 69           | 0.5±0.6                                    | 0.2±0.4                        |
|                                  | TVA-4 <sup>d</sup>   | Surface water       | --           | 0.1±0.5                                    | --                             |
|                                  | TVA-5 <sup>d</sup>   | Surface water       | --           | 0.0±0.4                                    | --                             |
|                                  | TVA-2A <sup>d</sup>  | Surface water       | 48           | 0.2±0.4                                    | 0.4±0.5                        |
|                                  | TVA-6                | Surface water       | --           | 0.2±0.5                                    | --                             |
|                                  | TVA-7                | Surface water       | 68           | --                                         | 0.1±0.5                        |
|                                  | TVA-8                | Surface water       | --           | 0.5±0.6                                    | --                             |
|                                  | TVA-9A               | Groundwater         | 38           | 0.2±0.5                                    | --                             |
|                                  | TVA-9B               | Groundwater         | 26           | 0.3±0.6                                    | --                             |
|                                  | TVA-10               | Surface water       | 94           | 1.0±1.1                                    | --                             |
|                                  | TVA-11 <sup>d</sup>  | Groundwater         | 200          | 1.2±0.5                                    | 0.1±0.4                        |
|                                  | TVA-11 <sup>d</sup>  | Groundwater         | --           | --                                         | 0.2±0.5                        |
|                                  | TVA-12               | Surface water       | 105          | 0.8±0.6                                    | --                             |
|                                  | TVA-13               | Surface water       | 337          | --                                         | --                             |
|                                  | TVA-14 <sup>d</sup>  | Groundwater         | 66           | 2.3±1.8                                    | --                             |
|                                  | MX-6401 <sup>d</sup> | Groundwater         | 22,700       | 1.2±0.9                                    | 0.4±0.5                        |
|                                  | TVA-15               | Groundwater         | 670          | 0.5±0.5                                    | --                             |
|                                  | TVA-16 <sup>d</sup>  | Groundwater         | --           | 21±7                                       | --                             |
|                                  | MX-6403 <sup>d</sup> | Groundwater         | 117          | 15±3                                       | 0.9±0.6                        |
|                                  | TVA-18               | Surface water       | 101          | 0.5±0.7                                    | --                             |
|                                  | TVA-19               | Surface water       | 26           | 0.8±0.7                                    | --                             |
|                                  | TVA-20               | Groundwater         | 20           | 0.2±0.5                                    | --                             |
|                                  | MX-6402              | Groundwater         | 50,200       | 7.2±2.0                                    | 0.9±0.6                        |
|                                  | TH-2                 | Groundwater         | 90           | 0.5±0.6                                    | 0.0±0.3                        |
|                                  | TH-4                 | Groundwater         | 62           | 1.0±0.8                                    | 0.7±0.6                        |
|                                  | Th-5                 | Groundwater         | 493          | 1.4±0.9                                    | 1.5±0.5                        |

<sup>a</sup>Source: FES-TVA, Table 3.9-4.<sup>b</sup>Shown in FES-TVA, Figure 3.4-7.<sup>c</sup>See Tables C.1 and C.3.<sup>d</sup>Duplicate samples.<sup>e</sup>Variability of the radioactive disintegration process (counting error) at the 95 percent confidence level, 1.96σ.

Table C.3. Summary of Sampling and Field Analyses of Groundwater, Morton Ranch Property<sup>a</sup>

| Location                          | Sample Number                 | Date               | Source                                     | Temp., °C          | pH                  | HCO <sub>3</sub> , ppm | Field Analyses                     |                                  |          |        | Laboratory Analyses Performed <sup>b</sup> |
|-----------------------------------|-------------------------------|--------------------|--------------------------------------------|--------------------|---------------------|------------------------|------------------------------------|----------------------------------|----------|--------|--------------------------------------------|
|                                   |                               |                    |                                            |                    |                     |                        | Specific Conductance $\mu$ mhos/cm | Alkalinity, as CaCO <sub>3</sub> | Chloride |        |                                            |
| Proposed Open-Pit Mining Sites    | TVA-9A                        | 10/74 <sup>c</sup> | Windmill                                   | 11                 | 7.3                 | 98                     | 360                                | --                               | --       | R,U,AA |                                            |
|                                   | TVA-9B                        | 10/74              | Cattle tank, fed from windmill             | 9                  | 7.9                 | 98                     | 385                                | --                               | --       | R,U,AA |                                            |
|                                   | TVA-11                        | 10/74              | Pumping well                               | 12                 | 7.4                 | 130                    | 430                                | --                               | --       | SS     |                                            |
|                                   | TVA-14 <sup>d</sup> (MX-6401) | 10/74              | Observation well                           | 13                 | 7.6                 | 158                    | 2000                               | --                               | --       | R,U    |                                            |
|                                   | TVA-15                        | 10/74              | Windmill                                   | 13                 | 7.5                 | 98                     | 285                                | --                               | --       | R,U    |                                            |
|                                   | TVA-16 <sup>d</sup> (MX-6403) | 10/74              | Observation well                           | 12                 | 7.3                 | 150                    | 2200                               | --                               | --       | R      |                                            |
|                                   | TVA-17                        | 10/74              | Windmill                                   | 19                 | 8.0                 | 73                     | 760                                | --                               | --       | SS     |                                            |
|                                   | TVA-20                        | 10/74              | Windmill                                   | 13                 | 7.9                 | 121                    | 775                                | --                               | --       | R,U    |                                            |
|                                   |                               |                    | Total Depth to Well, ft                    | Depth to Water, ft | Production Zone, ft |                        |                                    |                                  |          |        |                                            |
|                                   | MX-6401 (TVA-14)              | 12/74 <sup>e</sup> | 260                                        | 147                | 171-253             | 9                      | 340                                | 305                              | 15.2     | R,U,AA |                                            |
| Proposed Under-ground Mining Site | MX-6402                       | 12/74              | 240                                        | 124                | 203-237             | 10                     | 675                                | 154                              | 22.7     | R,U,AA |                                            |
|                                   | MX-6403 (TVA-16)              | 12/74              | 130                                        | 84                 | 108-130             | 10                     | 260                                | 223                              | 22.7     | R,U,AA |                                            |
|                                   | TH-2                          | 12/74              | 260                                        | 145                | 175-260             | 9                      | 360                                | 205                              | 15.2     | R,U,AA |                                            |
|                                   | TH-4                          | 12/74              | 180                                        | 107                | 116-159             | 9                      | 260                                | 171                              | 11.4     | R,U,AA |                                            |
|                                   | TH-5                          | 12/74              | 265                                        | 101                | 181-253             | 10                     | 420                                | 222                              | 15.2     | R,U,AA |                                            |
|                                   | TVA-11                        | 12/74              | Resample of October 18-20 sampling program |                    |                     | --                     | --                                 | --                               | --       | R      |                                            |
|                                   | MX2685A                       | 12/74              | 180                                        | 120                | 122-164             | 10                     | 1200                               | 205                              | 15.2     | R,U,AA |                                            |
|                                   | MX2685B                       | 12/74              | 475                                        | 293                | 365-472             | 11.5                   | 410                                | 154                              | 22.7     | R,U,AA |                                            |
|                                   | MX2685                        | 12/74              | 560                                        | 337                | 496-539             | 11                     | 625                                | 154                              | 15.2     | R,U,AA |                                            |
|                                   | MX2686A                       | 12/74              | 180                                        | 99                 | 115-173             | 10                     | 710                                | 240                              | 30.3     | R,U,AA |                                            |
| MX2686B                           | 12/74                         | 360                | 122                                        | 330-353            | 10.5                | 322                    | 188                                | 22.7                             | R,U,AA   |        |                                            |
| MX2686                            | 12/74                         | 620                | 253                                        | 543-590            | 11                  | 510                    | 137                                | 15.2                             | R,U,AA   |        |                                            |

<sup>a</sup>Source: FES-TVA, Table 3.4-1.<sup>b</sup>Legend: R = radiologic; U = uranium; SS = spark source; AA = atomic absorption, selected trace elements.<sup>c</sup>October sampling was done October 18-20, 1974.<sup>d</sup>Sample contaminated with drilling mud.<sup>e</sup>December sampling was done December 18-21, 1974.

Table C.4. Well and Pond Sample Data<sup>a</sup>

| Sample Location     | Collection Date               | pCi/L Soluble Ra-226 | mg/L Total U     | mg/L TSS  | mg/L Ba      | mg/L TDS                       | mg/L Oil & Grease | pCi/L Sr-90 | pCi/L Alpha | pCi/L Beta | mg/L Molybdenum | pH          | mg/L SO <sub>4</sub> | Selenium |
|---------------------|-------------------------------|----------------------|------------------|-----------|--------------|--------------------------------|-------------------|-------------|-------------|------------|-----------------|-------------|----------------------|----------|
| Well 1              | 6-19-75<br>1-7-76<br>3-16-76  | 1.54<br>31.1         | 0.064<br>0.0650  | 2<br>2    | <0.1<br><0.1 | 565 <sup>b</sup><br>496<br>480 | 2.4<br>1.         | 0.00        | 58.8        | 9.0        |                 | 8.1<br>7.2  | 250<br>214           |          |
| Well 4              | 6-24-75<br>3-16-76            | 19.6                 | 0.0755           | 3         | <0.1         | 650 <sup>b</sup><br>534        | 3.1               |             |             |            |                 | 8.0         | 305                  | 0.002    |
| Well 5              | 6-24-75<br>1-12-76<br>3-16-76 | 10.2<br>15.6         | 0.061<br>0.0716  | 3.0<br>2  | <0.1<br><0.1 | 625 <sup>b</sup><br>517<br>489 | 21.4<br>3.2       |             | 23.5        | 8.4        |                 | 8.0<br>8.1  | 285<br>205           |          |
| Well 6              | 6-24-76<br>1-7-76<br>3-16-76  | 14.1<br>4.85         | 0.0669<br>0.0650 | 25.0<br>2 | <0.1<br><0.1 | 620 <sup>b</sup><br>497<br>511 | 2.2<br>6.6        | 0.00        | 35.2        | 13.7       |                 | 8.2<br>8.14 | 300<br>210           |          |
| Well 8              | 1-12-76<br>6-24-76            | 3.52                 | 0.050            | 1.0       | 0.1          | 543<br>680                     | 26.6              |             | 45.6        | 13.8       |                 | 8.02<br>8.2 | 236<br>320           |          |
| Pond 1 <sup>c</sup> | 4-8-76<br>5-3-76<br>7/6/76    | 2.43<br>1.98<br>0.00 | 0.0544<br>0.0650 |           |              |                                |                   |             |             |            |                 |             |                      |          |
| Pond 3 <sup>d</sup> | 2-16-76                       | 1.71                 | 0.0503           |           |              |                                |                   | 0.00        | 17.1        | 10.7       | <0.001          |             |                      |          |
| Pond 2 <sup>e</sup> | 2-16-76                       | 0.00                 | 0.0379           |           |              |                                |                   | 0.00        | 20.0        | 16.2       | <0.001          |             |                      |          |
| Pond 4 <sup>f</sup> |                               | 6.12                 | 0.0628           |           |              |                                |                   | 1.1         | 24.5        | 13.0       | <0.001          |             |                      |          |

<sup>a</sup>Source: UNC-ER-2, Table 2.10-1.<sup>b</sup>Calculated value.<sup>c</sup>Receives discharge from Wells 1 and 4.<sup>d</sup>Receives discharge from Well 5.<sup>e</sup>Receives discharge from Well 6.<sup>f</sup>Receives discharge from Well 8.

Table C.5. State of Wyoming Water-Quality Standards

| Chemical Constituents                                                                             | Drinking Water Quality Standards <sup>a</sup>            |                                           |                                                  | U.S. EPA <sup>b</sup> and Wyoming <sup>c</sup><br>Effluent Limitations (mg/L) |                                                              |
|---------------------------------------------------------------------------------------------------|----------------------------------------------------------|-------------------------------------------|--------------------------------------------------|-------------------------------------------------------------------------------|--------------------------------------------------------------|
|                                                                                                   | Recommended<br>Limit (mg/L<br>unless noted<br>otherwise) | Maximum<br>Permissible<br>Limit<br>(mg/L) | Reason for<br>Limit                              | Maximum for<br>Any 1 day                                                      | Average Daily<br>Value for 30<br>Days Shall<br>Not Exceed -- |
| Arsenic                                                                                           | 0.01                                                     | 0.05                                      | Poisoning                                        | 1.0                                                                           | 0.5                                                          |
| Barium                                                                                            |                                                          | 1.0                                       | Poisoning                                        |                                                                               |                                                              |
| Cadmium                                                                                           |                                                          | 0.01                                      | Poisoning                                        | 0.10                                                                          | 0.05                                                         |
| Chloride                                                                                          | 250.0                                                    |                                           | Taste & laxative<br>properties                   |                                                                               |                                                              |
| Chromium                                                                                          |                                                          | 0.05                                      | Poisoning                                        |                                                                               |                                                              |
| Copper                                                                                            | 1.0                                                      |                                           | Taste                                            |                                                                               |                                                              |
| Cyanide                                                                                           | 0.01                                                     | 0.2                                       | Poisoning                                        |                                                                               |                                                              |
| Fluoride                                                                                          | 0.8-1.7                                                  | 1.4-2.4                                   | Mottling of teeth                                |                                                                               |                                                              |
| Iron                                                                                              | 0.3                                                      |                                           | Staining, taste                                  |                                                                               |                                                              |
| Lead                                                                                              |                                                          | 0.05                                      | Poisoning                                        |                                                                               |                                                              |
| Manganese                                                                                         | 0.05                                                     |                                           | Staining, taste                                  |                                                                               |                                                              |
| Mercury                                                                                           |                                                          | 0.002                                     |                                                  |                                                                               |                                                              |
| Nitrate (as N)                                                                                    |                                                          | 10.0                                      | Methemoglobinemia<br>in infants (blue<br>babies) |                                                                               |                                                              |
| Phenols                                                                                           | 0.001                                                    |                                           | Taste                                            |                                                                               |                                                              |
| Strontium-90 (pCi/L)                                                                              |                                                          | 10.0                                      | Poisoning                                        |                                                                               |                                                              |
| Selenium                                                                                          |                                                          | 0.01                                      | Poisoning                                        |                                                                               |                                                              |
| Silver                                                                                            |                                                          | 0.05                                      | Poisoning,<br>discoloration                      |                                                                               |                                                              |
| Sulfate                                                                                           |                                                          | 250.0                                     | Taste & laxative<br>properties                   |                                                                               |                                                              |
| Zinc                                                                                              | 5.0                                                      |                                           | Taste                                            | 1.0                                                                           | 0.5                                                          |
| Total dissolved solids                                                                            |                                                          | 500.0                                     | Taste & laxative<br>properties                   |                                                                               |                                                              |
| Suspended solids                                                                                  |                                                          |                                           |                                                  | 30.0                                                                          | 20.0                                                         |
| pH (units)                                                                                        |                                                          |                                           |                                                  | 6-9                                                                           | 6-9                                                          |
| Radium-226 and radium-228<br>combined (pCi/L)                                                     |                                                          | 5.0                                       |                                                  | 10.0                                                                          | 3.0                                                          |
| Gross alpha (including<br>radium-226 but excluding<br>radon and uranium)(pCi/L)                   | 15                                                       |                                           |                                                  |                                                                               |                                                              |
| Gross beta and photon<br>radioactivity (total body<br>or internal organ dose in<br>millirem/year) | 4                                                        |                                           |                                                  |                                                                               |                                                              |
| Uranium                                                                                           |                                                          |                                           |                                                  | 4.0                                                                           | 2.0                                                          |
| Chemical oxygen demand                                                                            |                                                          |                                           |                                                  | 200                                                                           | 100                                                          |

<sup>a</sup>According to the Wyoming Water Quality Rules and Regulations, the quality of public water supplies "will be such that after conventional water treatment, the treated water will meet the most recent Federal Drinking Water Standards, published by the U.S. Public Health Service, the U.S. Environmental Protection Agency, or their successor" (Wyoming Department of Environmental Quality, 1974). In 1962, the U.S. Public Health Service published drinking water standards (U.S. Public Health Service Publication 956) that set recommended limits and maximum permissible limits for all the chemical constituents given except for mercury, gross alpha, gross beta, and photon radioactivity. In 1975, the EPA updated the maximum permissible limits for arsenic, barium, cadmium, chromium, fluoride, lead, nitrate, selenium, silver, and radium-226/radium-228, as well as setting limits for mercury, gross alpha, gross beta, and photon radioactivity (40 CFR 141; 40 FR 59565, December 1975; amended by 41 FR 28402, July 1975). In light of the Wyoming regulations, the water quality standards are based on a combination of EPA and U.S. Public Health Service standards.

<sup>b</sup>U.S. Environmental Protection Agency, 40 CFR 400 - 41 FR 21191, May 1976.

<sup>c</sup>Wyoming Department of Environmental Quality, 1974, Wyoming Water Quality Rules and Regulations.

Table C.6. EPA Criteria for Water Quality<sup>a,b</sup>

| Constituent                        | Livestock Consumption                                                                                | Wildlife Consumption        |
|------------------------------------|------------------------------------------------------------------------------------------------------|-----------------------------|
| pH                                 | ---                                                                                                  | 6.0 - 9.0                   |
| Alkalinity                         | ---                                                                                                  | 30 - 130                    |
| As                                 | 0.2                                                                                                  | ---                         |
| Be                                 | No Limit                                                                                             | ---                         |
| B                                  | 5.0                                                                                                  | ---                         |
| Cd ( $\mu\text{g/L}$ )             | 50                                                                                                   | ---                         |
| Cr                                 | 1.0                                                                                                  | ---                         |
| Cu                                 | 0.5                                                                                                  | ---                         |
| Fe                                 | No Limit                                                                                             | ---                         |
| Pb                                 | 0.1                                                                                                  | ---                         |
| Mn                                 | No Limit                                                                                             | ---                         |
| Hg - Inorganic ( $\mu\text{g/L}$ ) | 1.0                                                                                                  | 0.5 $\mu\text{g/g}$ in fish |
| NO <sub>3</sub>                    | 100 combined NO <sub>3</sub> and NO <sub>2</sub>                                                     | ---                         |
| NO <sub>2</sub>                    | 10                                                                                                   | ---                         |
| Se                                 | 0.05                                                                                                 | ---                         |
| Zn                                 | 25                                                                                                   | ---                         |
| Microorganisms                     | 5000 coliforms/100 mL average of a minimum of two samples per month; 20,000/100 mL individual sample | 2000/100 mL                 |
| Fecal coliforms                    | 1000/100 mL average of a minimum of two samples per month; 4000/100 mL individual sample             | 2000/100 mL                 |
| Radioactivity                      | Same as Federal Drinking Water Standards                                                             | ---                         |

<sup>a</sup>Source: "Quality Criteria for Water," EPA 440/a-76-0.23, July 1976.

<sup>b</sup>Criteria are given in mg/L unless otherwise indicated.

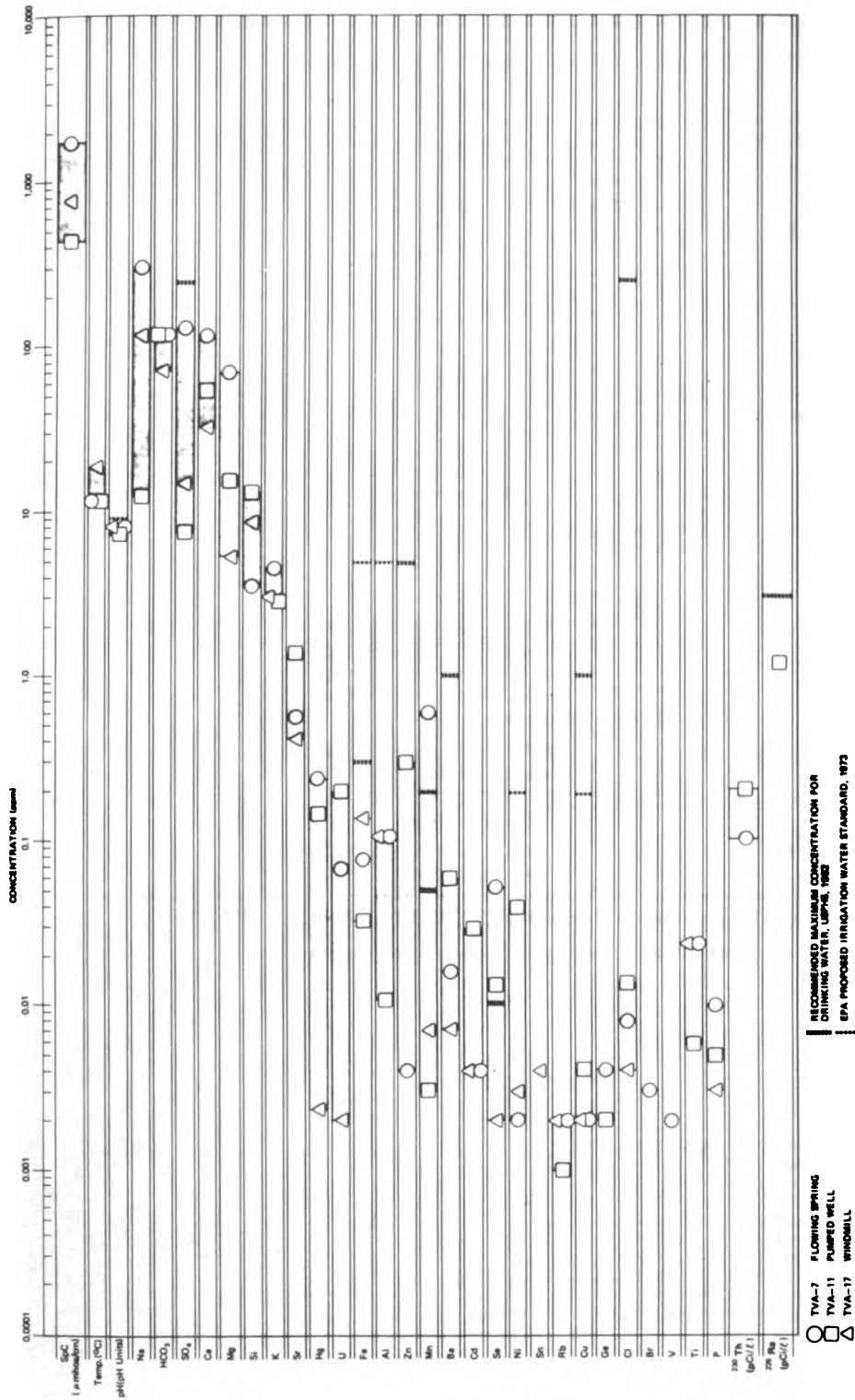


Fig. C.1. Concentrations of Elements in Water Samples Representative of Those Collected During October Field Program (from FES-TVA, Fig. 3.4-9).

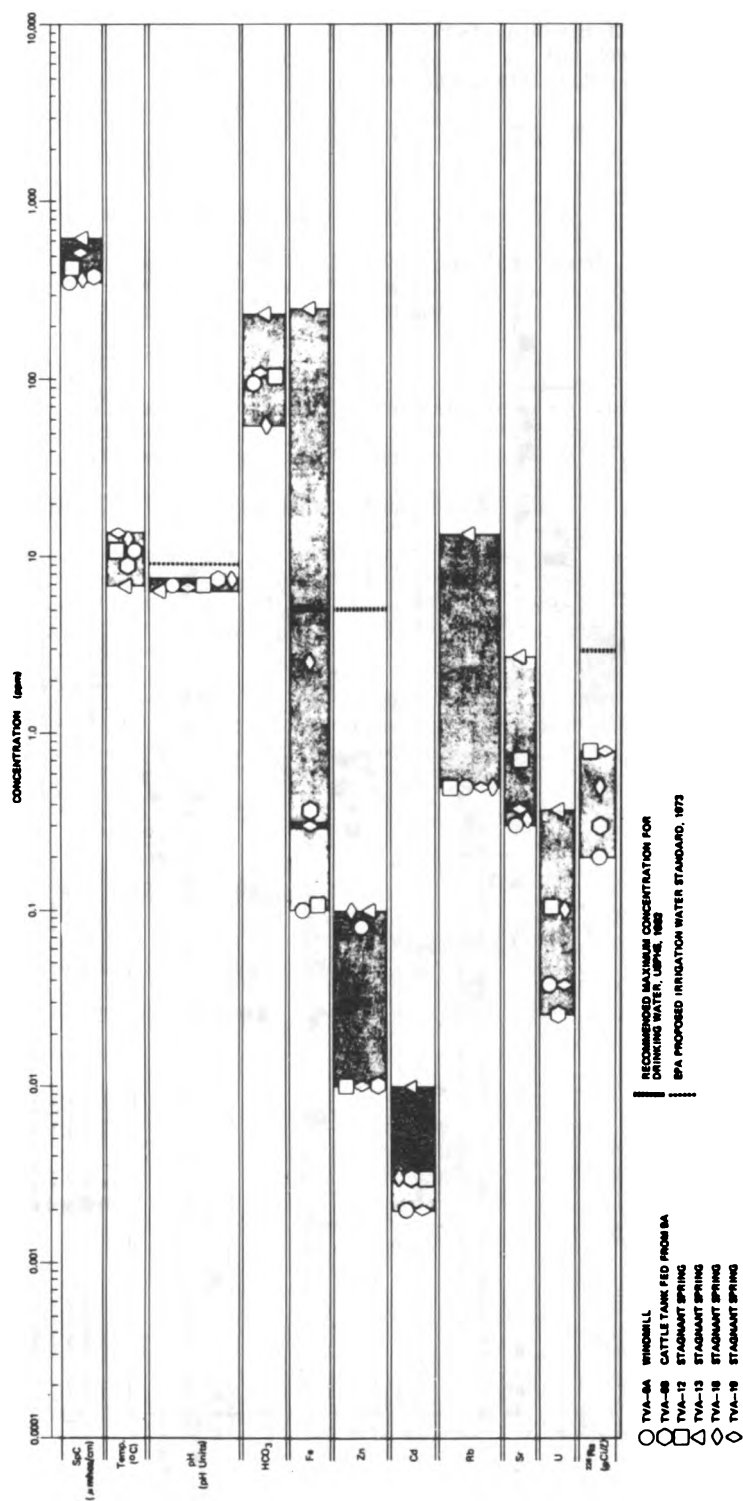


Fig. C.2. Water-Quality Analyses for Samples Collected at Six Sites During October Field Program (from FES-TVA, Fig. 3.4-8).

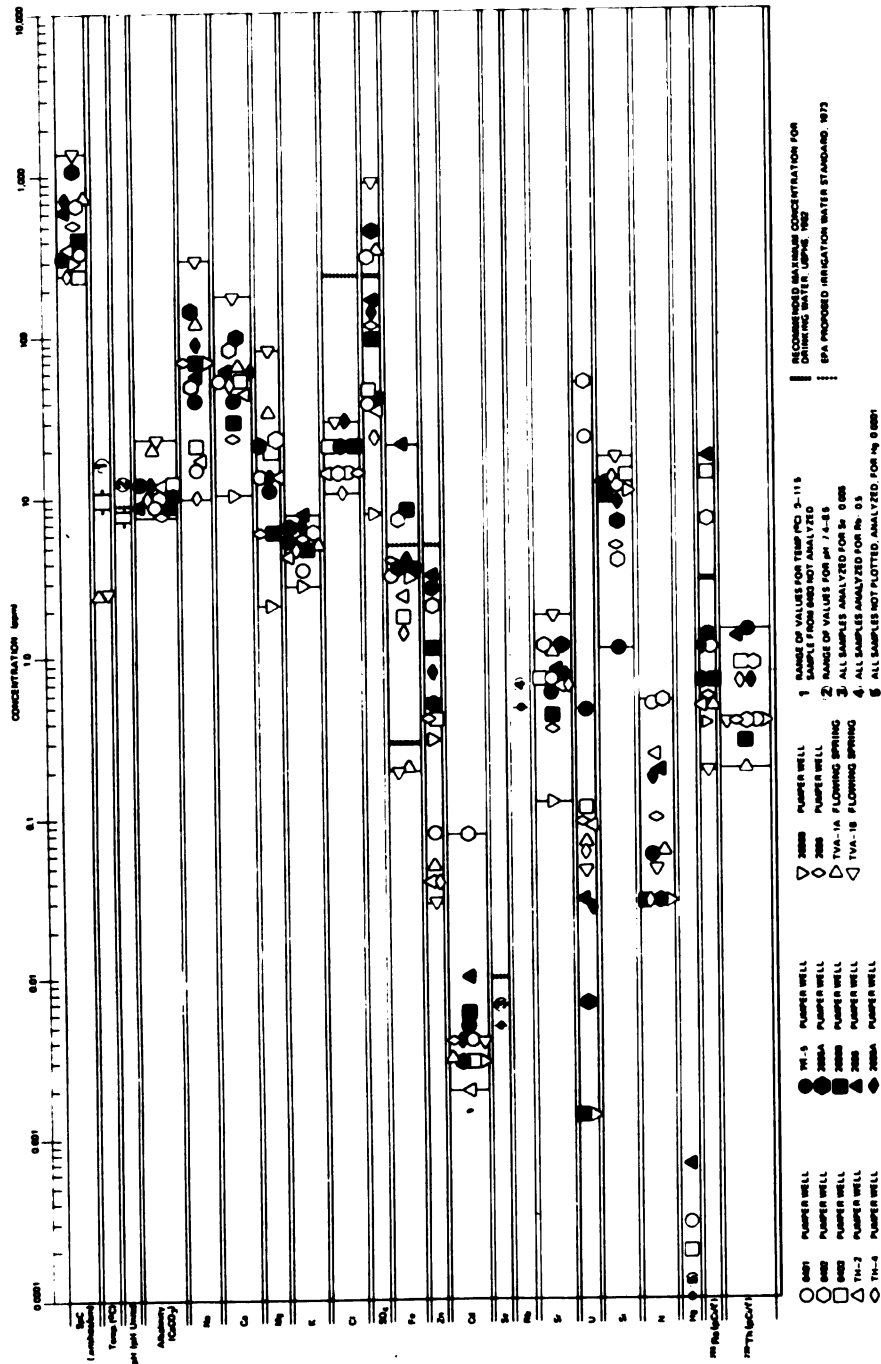


Fig. C.3. Water-Quality Analysis for Samples Collected During December Field Program (from FES-TVA, Fig. 3.4-10).

## APPENDIX D. DETAILED RADIOLOGICAL ASSESSMENT

The data presented in Appendix D, together with information given in Sections 3.2.5 and 4.7, permit detailed analysis of the radiological implications of the Morton Ranch project. This information is given here to allow complete review and verification of the radiological assessment by qualified radiological scientists.

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## APPENDIX D-1. AIRBORNE EMISSIONS FROM THE MILLING OPERATIONS

The calculations for the emission source terms used in the dose assessment are presented here. The calculations are based on parameters given in Table D-1.1. The source terms are summarized in Table D-1.2. The results of the dose assessment for external exposure to, and inhalation of, the radioisotopes U-238, Th-230, Ra-226, and Pb-210 are given in Appendix D-3. These calculations are considered by the staff to be conservative because the tailings particulate source term is below ground level and fewer particles are expected to be suspended in the air than from the ground-level or aboveground source on which the particulate release was modeled. These calculations are also conservative because it is highly unlikely that the ore grade will increase from 0.077%  $U_3O_8$  (the current average) to the 0.20% used in these calculations.

Table D-1.1. Principal Parameters Used in the Radiological Assessment

| Parameters                                     | Value                                |
|------------------------------------------------|--------------------------------------|
| <b>Mill Process, General</b>                   |                                      |
| Ore quality, $U_3O_8$                          | 0.2%                                 |
| Ore recovery, $U_3O_8$                         | 97%                                  |
| Ore activity, U-238                            | 563 pCi/g                            |
| Ore process rate                               | $9.92 \times 10^5$ MT/yr             |
| Ore pad area                                   | $4.0 \times 10^4$ m <sup>2</sup>     |
| Ore storage time                               | 50 days                              |
| Average haul distance, mine to mill            | 6.3 km                               |
| Yellowcake yield                               | $2.02 \times 10^3$ MT/yr             |
| Yellowcake quality, $U_3O_8$                   | 95%                                  |
| Yellowcake drying and packaging stack effluent | $5.08 \times 10^{-2}$ kg/hr          |
| Mill water throughput                          | $1.5 \times 10^6$ m <sup>3</sup> /yr |
| Operating days per year                        | 365 days                             |
| <b>Option L</b>                                |                                      |
| Total pit area (3-m liner)                     | $6.10 \times 10^5$ m <sup>2</sup>    |
| Area of largest pit surface                    | $1.63 \times 10^5$ m <sup>2</sup>    |

Table D-1.2. Radioactive Effluents from Mill Operations, Ci/yr<sup>a</sup>

| Source                      | Radionuclides         |                       |                       |                    |                       |
|-----------------------------|-----------------------|-----------------------|-----------------------|--------------------|-----------------------|
|                             | U-238 <sup>b</sup>    | Th-230                | Ra-226                | Rn-222             | Pb-210                |
| Ore pad, feed, and grinding | $6.28 \times 10^{-5}$ | $6.28 \times 10^{-5}$ | $6.28 \times 10^{-5}$ | 112                | $6.28 \times 10^{-5}$ |
| Yellowcake stacks           | $1.20 \times 10^{-1}$ | $6.00 \times 10^{-3}$ | $2.40 \times 10^{-4}$ | 0                  | $2.40 \times 10^{-4}$ |
| Tailings                    | $2.73 \times 10^{-3}$ | $5.18 \times 10^{-2}$ | $5.46 \times 10^{-2}$ | $8.51 \times 10^3$ | $5.46 \times 10^{-2}$ |

<sup>a</sup>Option L.

<sup>b</sup>U-234 activities are expected to be equal to U-238 activities.

## D-1.1 ORE PAD AND GRINDING PROCESS

Radon

The activity of Rn-222, built up from the decay of Ra-226 during storage on the ore pad, will be:

$$E = C_{Ra} (1 - e^{-\lambda t})$$

where E = emanating power, 0.2

$C_{Ra}$  = concentration of Ra-226 in ore, 563 pCi/g

$\lambda$  = the decay constant for Rn-222,  $0.181 \text{ day}^{-1}$

t = storage time on ore pad, 50 days

$$0.2 \times 563 (1 - e^{-0.181 \times 50}) \frac{\text{pCi}}{\text{g}} \times 9.92 \times 10^5 \frac{\text{MT}}{\text{yr}} \times 10^6 \frac{\text{g}}{\text{MT}} \times 10^{-12} \frac{\text{Ci}}{\text{pCi}} = 112 \text{ Ci Rn-222/yr.}$$

Particulates

Ore will be moist when mined and placed on the storage pad; 50 days of storage may dry out the surface layer of the ore. The applicant will use chemical or physical means to reduce dusting from dried areas; particulate emissions are not expected to be significant.

The grinding of ore is expected to release some particulates. Ore dust loss from grinding is expected to be  $1 \times 10^{-4}\%$  of the ore processed.<sup>1</sup>

$$\text{Annual loss} = \frac{1 \times 10^{-4}}{100} \times 9.92 \times 10^5 \frac{\text{MT}}{\text{yr}} \times \frac{10^6 \text{g}}{\text{MT}} = 9.92 \times 10^5 \text{ g/yr.}$$

The fine dust is expected to contain 2.25 times more activity than the ore; the dust collector is expected to be 95% efficient. Therefore, the annual activity release of U-238, Th-230, Ra-226, and Pb-210 would be:

$$9.92 \times 10^5 \frac{\text{g}}{\text{yr}} \times 2.25 \times 563 \frac{\text{pCi}}{\text{g}} \times 10^{-12} \frac{\text{Ci}}{\text{pCi}} \times 0.05 = 6.28 \times 10^{-5} \text{ Ci/yr.}$$

## D-1.2 YELLOWCAKE DRYING AND PACKING

Radon

The radon release for drying and packaging is expected to be negligible.

Particulates

Yellowcake is expected to contain U-238, Th-230, Ra-226, and Pb-210 in the following ratios: 1:0.05:0.002:0.002.

Dust emission is estimated to be  $5.08 \times 10^{-2} \text{ kg/hr}$  (based on ER, Table 3.3.1, p. 3-16).

$$0.12 \frac{\text{Ci}}{\text{yr}} \text{ U-238} \times 3.7 \times \frac{10^{10} \text{ dis}}{\text{s} - \text{Ci}} \times \frac{238 \text{ g U-238}}{6.02 \times 10^{23}} \times \frac{4.5 \times 10^9 \text{ yr}}{0.693} \times \frac{3600 \text{ s}}{\text{hr}} \times \frac{1 \text{ g U}_3\text{O}_8}{0.85 \text{ g U-238}}$$

$$= 50.8 \text{ g U}_3\text{O}_8/\text{hr.}$$

Th-230 activity would be:

$$1.2 \times 10^{-1} \text{ Ci/yr} \times 0.05 = 6.0 \times 10^{-3} \text{ Ci/yr.}$$

Ra-226 and Pb-210 activity would be:

$$1.2 \times 10^{-1} \text{ Ci/yr} \times 0.002 = 2.4 \times 10^{-4} \text{ Ci/yr.}$$

Table D.1-3. Dose Commitments<sup>a</sup> from Inhalation, mrem/yr (Option L)

| Receptor Organ | Radionuclides         |                       |                       |                       |                       |                       |
|----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
|                | U-238                 | U-234                 | Th-230                | Ra-226                | Pb-210                | Total                 |
| Site Boundary  |                       |                       |                       |                       |                       |                       |
| Whole body     | $4.01 \times 10^{-3}$ | $4.57 \times 10^{-3}$ | $2.00 \times 10^{-1}$ | $2.05 \times 10^{-1}$ | $7.68 \times 10^{-3}$ | $4.21 \times 10^{-1}$ |
| Bone           | $6.77 \times 10^{-2}$ | $7.39 \times 10^{-2}$ | 7.15                  | 1.99                  | $2.39 \times 10^{-1}$ | 9.52                  |
| Lung           | 7.00                  | 7.97                  | 3.35                  | $7.26 \times 10^{-1}$ | $1.68 \times 10^{-1}$ | $1.92 \times 10^1$    |
| Fowler Ranch   |                       |                       |                       |                       |                       |                       |
| Whole body     | $5.16 \times 10^{-5}$ | $5.88 \times 10^{-5}$ | $6.50 \times 10^{-4}$ | $4.17 \times 10^{-4}$ | $1.66 \times 10^{-4}$ | $1.34 \times 10^{-3}$ |
| Bone           | $8.71 \times 10^{-4}$ | $9.50 \times 10^{-4}$ | $2.32 \times 10^{-2}$ | $4.05 \times 10^{-3}$ | $5.15 \times 10^{-3}$ | $3.43 \times 10^{-2}$ |
| Lung           | $9.00 \times 10^{-2}$ | $1.03 \times 10^{-1}$ | $1.09 \times 10^{-2}$ | $1.48 \times 10^{-3}$ | $5.53 \times 10^{-3}$ | $2.10 \times 10^{-1}$ |

<sup>a</sup>Dose equivalent is integrated over a 50-year period resulting from a one-year exposure.

### D-1.3 TAILINGS PIT (Option L)

Concentrations of uranium and radium in the water decanted from the tailings pit are expected to be small when compared to the solid tailings fraction. The thorium content in the solution is expected to be similar in both the solution and the solid fraction of the tailings.<sup>2,3</sup> Because the evaporation pond would be covered with water (liquid or ice) for the period of mill operation, the evaporation pond has not been considered as a separate source term. At the end of mill operations the slimes in the evaporation pond will be transported to the tailings pits. The tailings pit area is assumed to contain this fraction for purposes of calculating the radioactive effluent from the mill.

#### Radon

As the staff has no data currently available to them concerning the schedule by which lined mine pits would be reclaimed under Option L, certain assumptions have been made concerning reclamation time schedules. In a previous uranium mill environmental statement<sup>4</sup> (Lucky Mc mill, Sec. 10.3.2.1) it was estimated that six years must take place at that site (central Wyoming) before a tailings-pond surface would support the heavy machinery used in reclamation. In the case of pit disposal, evaporation and settling will take a longer time owing to the increased depth and the decreased surface area, as well as the low seepage characteristics due to a 0.9-m (3-ft) clay liner. The staff has estimated that reclamation would take place ten years after the pits are filled. If a yearly mean pit area of

$$\sum_{i=1}^7 p_i / 20 \text{ yr is assumed, where } p_i \text{ is the area of tailings pit } i,$$

the maximum area available for radon emanation in any one year is half the total area. The total area of the refilled pits will be  $6.10 \times 10^5 \text{ m}^2$ .

The tailings are assumed to be dry, and the Rn-222 emanation rate, conservatively, to be the infinite depth radon flux ( $\phi_\infty$ ) reported<sup>5</sup> for tailings:  $1.6 \text{ pCi Rn-222/m}^2\text{-s}$  per  $\text{pCi Ra-226/g}$  of tailings. The Rn-222 emissions are expected to be:

$$(0.5) 6.10 \times 10^5 \text{ m}^2 \times 1.6 \times 10^{-12} \frac{\text{Ci Rn-222}}{\text{m}^2 \cdot \text{s}} \times \frac{1 \text{ g tailings}}{1 \text{ pCi Ra-226}} \times \frac{1 \text{ g ore}}{\text{g tailings}} \times 3.15 \times \frac{10^7 \text{ s}}{\text{yr}} \times \frac{563 \text{ pCi Ra-226}}{\text{g ore}} = 8.51 \times 10^3 \text{ Ci Rn-222/yr.}$$

#### Particulates

The mathematical model used for particulate effluent movement by the wind is dependent upon wind velocity, tailings properties (i.e., density, mean diameter), and the nature of the tailings surface.<sup>6-10</sup>

The area for tailings particulate dispersion is assumed to be the same as that for random emanation,  $3.05 \times 10^5 \text{ m}^2$ . Ten percent of the available particulates are assumed to be dispersed; 90% are expected to be suppressed by physical or chemical means.

Casper meteorological data were used in computing particulate dispersion. A particle size distribution of from 0 to  $80\mu^5$  was assumed.

#### References for Appendix D-1

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APPENDIX D-2. EFFECTIVE DISPERSION FACTORS

Table D-2.1. Effective Dispersion Factors (sec/m<sup>3</sup>) for Particulates from the Yellowcake Dryer at the Morton Ranch Mill Site

| Distance, km | Direction from Point Source (dryer) |          |          |          |          |          |          |          |  |  |
|--------------|-------------------------------------|----------|----------|----------|----------|----------|----------|----------|--|--|
|              | N                                   | NNE      | NE       | ENE      | E        | ESE      | SE       | SSE      |  |  |
| 0.10         | 7.48E-06                            | 1.35E-05 | 2.44E-05 | 2.26E-05 | 1.77E-05 | 8.81E-06 | 6.16E-06 | 8.12E-06 |  |  |
| 0.50         | 1.33E-06                            | 2.72E-06 | 5.07E-06 | 6.59E-06 | 6.48E-06 | 2.85E-06 | 2.21E-06 | 2.70E-06 |  |  |
| 1.00         | 3.69E-07                            | 8.11E-07 | 1.53E-06 | 1.98E-06 | 1.89E-06 | 8.20E-07 | 6.39E-07 | 7.71E-07 |  |  |
| 2.00         | 9.97E-08                            | 2.41E-07 | 4.63E-07 | 5.83E-07 | 5.32E-07 | 2.28E-07 | 1.78E-07 | 2.12E-07 |  |  |
| 3.00         | 4.70E-08                            | 1.21E-07 | 2.33E-07 | 2.91E-07 | 2.58E-07 | 1.09E-07 | 8.53E-08 | 1.01E-07 |  |  |
| 4.00         | 2.78E-08                            | 7.44E-08 | 1.45E-07 | 1.79E-07 | 1.56E-07 | 6.57E-08 | 5.13E-08 | 6.04E-08 |  |  |
| 5.00         | 1.86E-08                            | 5.14E-08 | 1.00E-07 | 1.24E-07 | 1.06E-07 | 4.44E-08 | 3.47E-08 | 4.06E-08 |  |  |
| 10.00        | 5.58E-09                            | 1.66E-08 | 3.26E-08 | 4.00E-08 | 3.31E-08 | 1.35E-08 | 1.05E-08 | 1.21E-08 |  |  |
| 20.00        | 1.69E-09                            | 5.34E-09 | 1.06E-08 | 1.29E-08 | 1.02E-08 | 4.03E-09 | 3.12E-09 | 3.54E-09 |  |  |
| 30.00        | 8.47E-10                            | 2.74E-09 | 5.44E-09 | 6.49E-09 | 4.99E-09 | 1.94E-09 | 1.48E-09 | 1.67E-09 |  |  |
| 40.00        | 5.11E-10                            | 1.68E-09 | 3.35E-09 | 3.91E-09 | 2.92E-09 | 1.12E-09 | 8.49E-10 | 9.46E-10 |  |  |
| 50.00        | 3.42E-10                            | 1.15E-09 | 2.28E-09 | 2.59E-09 | 1.89E-09 | 7.22E-10 | 5.38E-10 | 5.97E-10 |  |  |
| 60.00        | 2.45E-10                            | 8.34E-10 | 1.65E-09 | 1.83E-09 | 1.31E-09 | 4.96E-10 | 3.65E-10 | 4.04E-10 |  |  |
| 70.00        | 1.85E-10                            | 6.40E-10 | 1.26E-09 | 1.36E-09 | 9.48E-10 | 3.61E-10 | 2.62E-10 | 2.89E-10 |  |  |
| 80.00        | 1.46E-10                            | 5.15E-10 | 1.01E-09 | 1.06E-09 | 7.20E-10 | 2.75E-10 | 1.97E-10 | 2.16E-10 |  |  |

| Distance, km | Direction from Point Source (dryer) |          |          |          |          |          |          |          |  |  |
|--------------|-------------------------------------|----------|----------|----------|----------|----------|----------|----------|--|--|
|              | S                                   | SSW      | SW       | WSW      | W        | WNW      | NW       | NNW      |  |  |
| 0.10         | 1.11E-05                            | 1.28E-05 | 9.23E-06 | 7.73E-06 | 1.10E-05 | 6.97E-06 | 5.77E-06 | 4.51E-06 |  |  |
| 0.50         | 3.63E-06                            | 3.12E-06 | 2.34E-06 | 1.92E-06 | 2.48E-06 | 1.60E-06 | 1.09E-06 | 7.26E-07 |  |  |
| 1.00         | 1.04E-06                            | 9.14E-07 | 6.84E-07 | 5.58E-07 | 7.18E-07 | 4.61E-07 | 3.09E-07 | 2.01E-07 |  |  |
| 2.00         | 2.89E-07                            | 2.62E-07 | 1.95E-07 | 1.59E-07 | 2.03E-07 | 1.29E-07 | 8.58E-08 | 5.44E-08 |  |  |
| 3.00         | 1.39E-07                            | 1.28E-07 | 9.51E-08 | 7.74E-08 | 9.86E-08 | 6.26E-08 | 4.11E-08 | 2.57E-08 |  |  |
| 4.00         | 8.30E-08                            | 7.80E-08 | 5.76E-08 | 4.69E-08 | 5.97E-08 | 3.77E-08 | 2.47E-08 | 1.52E-08 |  |  |
| 5.00         | 5.60E-08                            | 5.32E-08 | 3.92E-08 | 3.19E-08 | 4.06E-08 | 2.56E-08 | 1.67E-08 | 1.03E-08 |  |  |
| 10.00        | 1.68E-08                            | 1.65E-08 | 1.20E-08 | 9.85E-09 | 1.26E-08 | 7.86E-09 | 5.10E-09 | 3.17E-09 |  |  |
| 20.00        | 4.94E-09                            | 5.01E-09 | 3.65E-09 | 2.99E-09 | 3.87E-09 | 2.40E-09 | 1.56E-09 | 9.90E-10 |  |  |
| 30.00        | 2.36E-09                            | 2.44E-09 | 1.77E-09 | 1.46E-09 | 1.91E-09 | 1.19E-09 | 7.73E-10 | 4.99E-10 |  |  |
| 40.00        | 1.36E-09                            | 1.43E-09 | 1.04E-09 | 8.53E-10 | 1.13E-09 | 7.05E-10 | 4.60E-10 | 3.02E-10 |  |  |
| 50.00        | 8.74E-10                            | 9.34E-10 | 6.76E-10 | 5.54E-10 | 7.44E-10 | 4.64E-10 | 3.03E-10 | 2.02E-10 |  |  |
| 60.00        | 6.02E-10                            | 6.52E-10 | 4.71E-10 | 3.85E-10 | 5.23E-10 | 3.26E-10 | 2.13E-10 | 1.44E-10 |  |  |
| 70.00        | 4.38E-10                            | 4.82E-10 | 3.48E-10 | 2.82E-10 | 3.87E-10 | 2.42E-10 | 1.59E-10 | 1.08E-10 |  |  |
| 80.00        | 3.36E-10                            | 3.74E-10 | 2.69E-10 | 2.17E-10 | 3.00E-10 | 1.87E-10 | 1.23E-10 | 8.41E-11 |  |  |

Table D-2.2. Effective Dispersion Factors (sec/m<sup>2</sup>) for Rn-222 from Morton Ranch Tailings

| Distance, km | Direction from yellowcake dryer |          |          |          |          |          |          |          |  |  |
|--------------|---------------------------------|----------|----------|----------|----------|----------|----------|----------|--|--|
|              | N                               | NNE      | NE       | ENE      | E        | ESE      | SE       | SSE      |  |  |
| 0.10         | 2.69E-07                        | 2.84E-07 | 3.01E-07 | 3.23E-07 | 3.46E-07 | 3.66E-07 | 3.78E-07 | 3.91E-07 |  |  |
| 0.50         | 1.60E-07                        | 1.94E-07 | 2.56E-07 | 3.77E-07 | 5.99E-07 | 9.49E-07 | 1.26E-06 | 1.42E-06 |  |  |
| 1.00         | 1.03E-07                        | 1.45E-07 | 2.39E-07 | 4.52E-07 | 1.05E-06 | 4.47E-06 | 6.91E-06 | 3.64E-06 |  |  |
| 2.00         | 5.82E-08                        | 1.01E-07 | 1.86E-07 | 4.09E-07 | 9.19E-07 | 1.43E-06 | 1.33E-06 | 1.80E-06 |  |  |
| 3.00         | 4.05E-08                        | 7.40E-08 | 1.42E-07 | 2.75E-07 | 4.75E-07 | 5.05E-07 | 3.67E-07 | 3.90E-07 |  |  |
| 4.00         | 3.03E-08                        | 5.74E-08 | 1.11E-07 | 2.01E-07 | 2.97E-07 | 2.67E-07 | 1.66E-07 | 1.93E-07 |  |  |
| 5.00         | 2.38E-08                        | 4.57E-08 | 8.89E-08 | 1.53E-07 | 2.10E-07 | 1.67E-07 | 1.01E-07 | 1.21E-07 |  |  |
| 10.00        | 1.10E-08                        | 2.06E-08 | 3.92E-08 | 6.20E-08 | 7.52E-08 | 4.48E-08 | 2.97E-08 | 3.56E-08 |  |  |
| 20.00        | 4.88E-09                        | 8.72E-09 | 1.63E-08 | 2.55E-08 | 2.96E-08 | 1.49E-08 | 1.08E-08 | 1.31E-08 |  |  |
| 30.00        | 3.05E-09                        | 5.24E-09 | 9.69E-09 | 1.54E-08 | 1.78E-08 | 8.41E-09 | 6.39E-09 | 7.71E-09 |  |  |
| 40.00        | 2.18E-09                        | 3.64E-09 | 6.71E-09 | 1.09E-08 | 1.26E-08 | 5.73E-09 | 4.47E-09 | 5.38E-09 |  |  |
| 50.00        | 1.68E-09                        | 2.75E-09 | 5.05E-09 | 8.33E-09 | 9.61E-09 | 4.29E-09 | 3.40E-09 | 4.09E-09 |  |  |
| 60.00        | 1.35E-09                        | 2.19E-09 | 4.00E-09 | 6.70E-09 | 7.74E-09 | 3.41E-09 | 2.73E-09 | 3.28E-09 |  |  |
| 70.00        | 1.12E-09                        | 1.82E-09 | 3.31E-09 | 5.59E-09 | 6.45E-09 | 2.81E-09 | 2.26E-09 | 2.72E-09 |  |  |
| 80.00        | 9.59E-10                        | 1.55E-09 | 2.83E-09 | 4.79E-09 | 5.51E-09 | 2.39E-09 | 1.93E-09 | 2.32E-09 |  |  |
| Distance, km | Direction from yellowcake dryer |          |          |          |          |          |          |          |  |  |
|              | S                               | SSW      | SW       | WSW      | W        | WNW      | NW       | NNW      |  |  |
| 0.10         | 3.89E-07                        | 3.65E-07 | 3.39E-07 | 3.14E-07 | 2.96E-07 | 2.73E-07 | 2.62E-07 | 2.63E-07 |  |  |
| 0.50         | 8.48E-07                        | 5.80E-07 | 4.01E-07 | 2.95E-07 | 2.21E-07 | 1.83E-07 | 1.58E-07 | 1.53E-07 |  |  |
| 1.00         | 1.42E-06                        | 6.24E-07 | 3.82E-07 | 2.51E-07 | 1.69E-07 | 1.21E-07 | 1.00E-07 | 9.24E-08 |  |  |
| 2.00         | 4.66E-06                        | 5.85E-07 | 2.74E-07 | 1.73E-07 | 1.12E-07 | 7.36E-08 | 5.31E-08 | 4.67E-08 |  |  |
| 3.00         | 5.04E-07                        | 2.40E-07 | 1.49E-07 | 1.19E-07 | 7.90E-08 | 5.05E-08 | 3.56E-08 | 2.93E-08 |  |  |
| 4.00         | 2.37E-07                        | 1.48E-07 | 9.02E-08 | 8.27E-08 | 5.92E-08 | 3.81E-08 | 2.60E-08 | 2.06E-08 |  |  |
| 5.00         | 1.48E-07                        | 1.02E-07 | 6.56E-08 | 6.02E-08 | 4.72E-08 | 3.01E-08 | 2.02E-08 | 1.56E-08 |  |  |
| 10.00        | 4.52E-08                        | 3.41E-08 | 2.46E-08 | 2.15E-08 | 2.14E-08 | 1.36E-08 | 9.02E-09 | 6.53E-09 |  |  |
| 20.00        | 1.69E-08                        | 1.28E-08 | 9.55E-09 | 8.10E-09 | 9.24E-09 | 5.95E-09 | 3.94E-09 | 2.78E-09 |  |  |
| 30.00        | 1.00E-08                        | 7.48E-09 | 5.64E-09 | 4.72E-09 | 5.67E-09 | 3.68E-09 | 2.45E-09 | 1.72E-09 |  |  |
| 40.00        | 6.98E-09                        | 5.16E-09 | 3.90E-09 | 3.25E-09 | 4.02E-09 | 2.61E-09 | 1.75E-09 | 1.22E-09 |  |  |
| 50.00        | 5.30E-09                        | 3.89E-09 | 2.95E-09 | 2.44E-09 | 3.08E-09 | 1.60E-09 | 1.34E-09 | 9.45E-10 |  |  |
| 60.00        | 4.24E-09                        | 3.10E-09 | 2.34E-09 | 1.94E-09 | 2.48E-09 | 1.61E-09 | 1.08E-09 | 7.64E-10 |  |  |
| 70.00        | 3.51E-09                        | 2.57E-09 | 1.94E-09 | 1.61E-09 | 2.06E-09 | 1.34E-09 | 9.03E-10 | 6.38E-10 |  |  |
| 80.00        | 2.99E-09                        | 2.19E-09 | 1.66E-09 | 1.37E-09 | 1.76E-09 | 1.15E-09 | 7.73E-10 | 5.46E-10 |  |  |

APPENDIX D-3. RADIONUCLIDE DISPERSION AND DEPOSITION, BASED ON UDAD\* CODE

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\*M. H. Momeni, "Argonne National Laboratory Steady-State Uranium Dispersion and Dosimetry (UDAD) Code," (to be published).

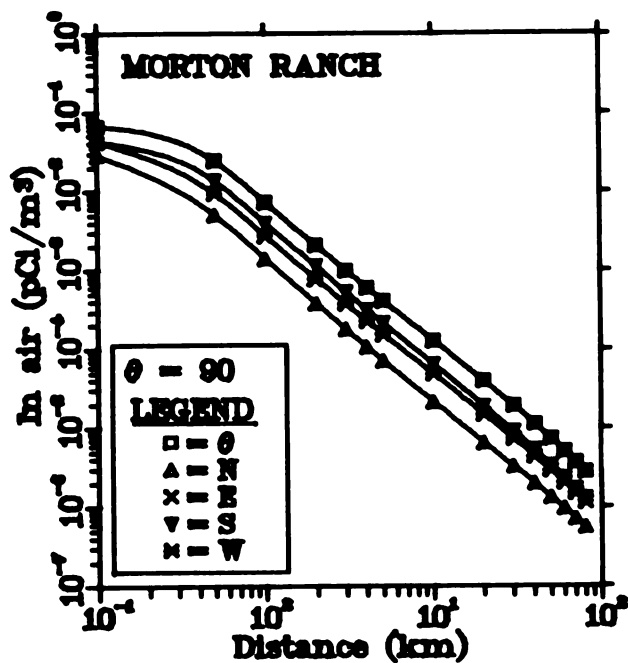


Fig. D-3.1. Computed Concentrations of U-238 in Air (U-234 concentration is equivalent to U-238 concentration).

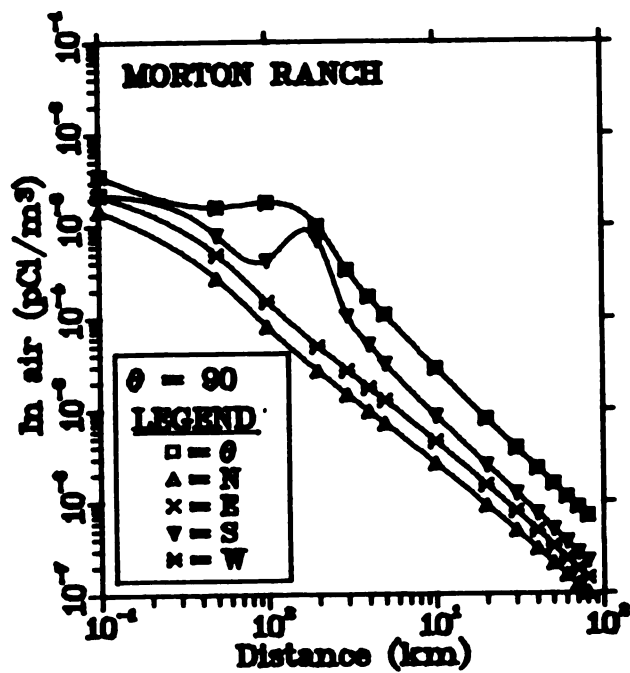


Fig. D-3.2. Computed Concentrations of Th-230 in Air.

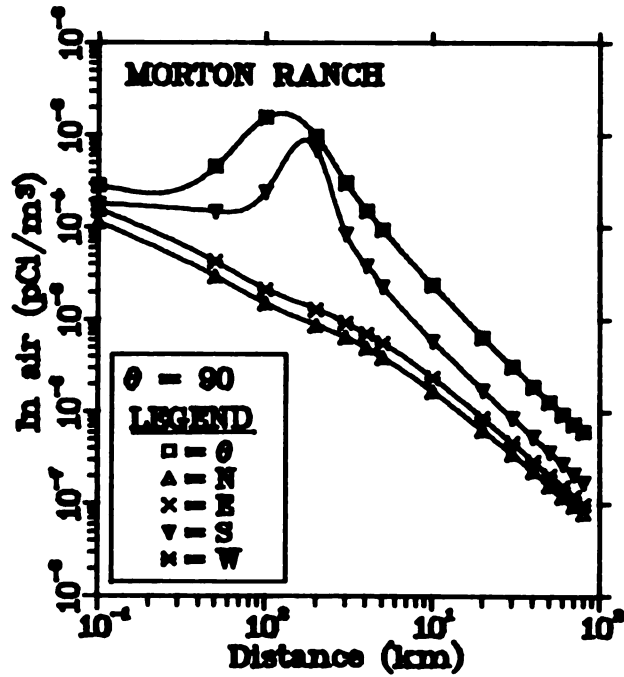


Fig. D-3.3. Computed Concentrations of Ra-226 in Air.

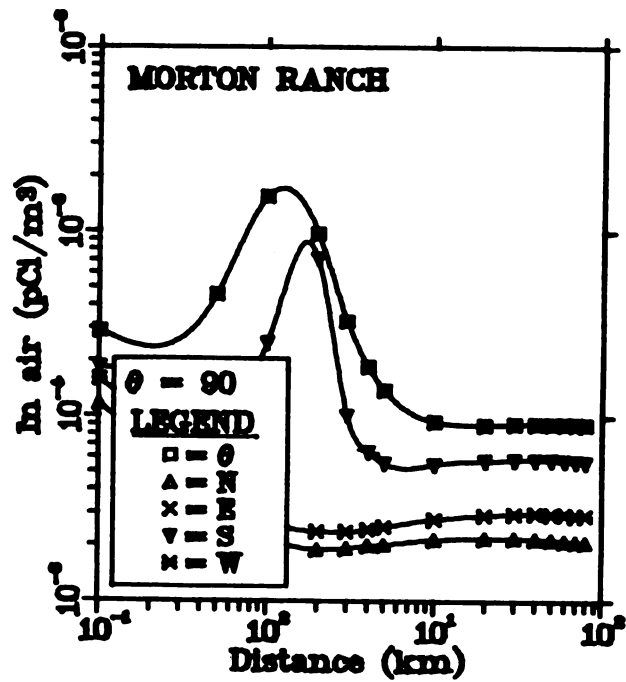


Fig. D-3.4. Computed Concentrations of Pb-210 in Air.

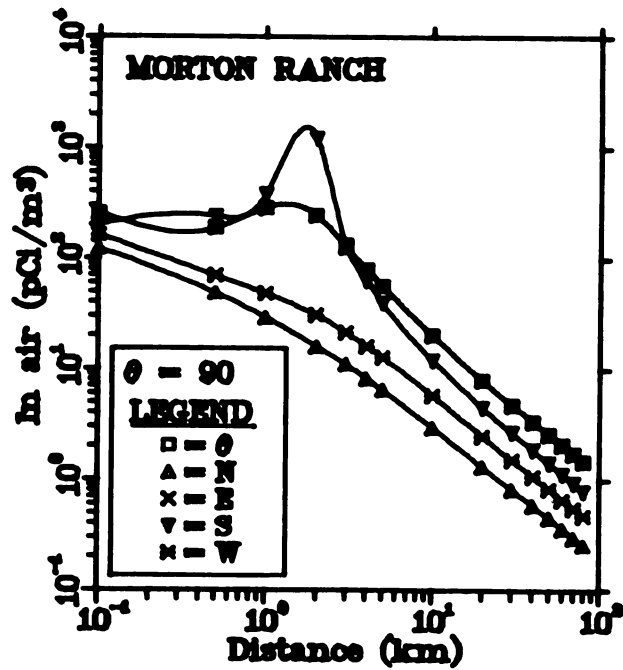


Fig. D-3.5. Computed Concentrations of Rn-222 in Air.

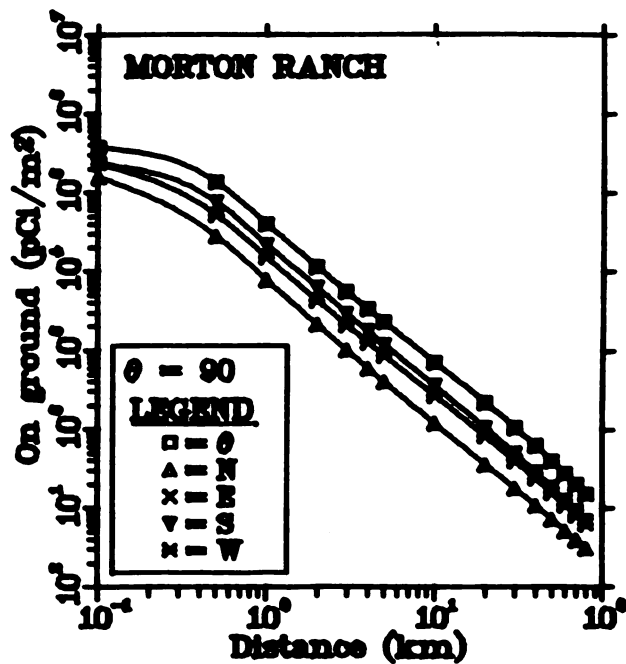


Fig. D-3.6. Computed Concentrations of U-238 Deposited on the Ground (U-234 concentration is equivalent to U-238 concentration).

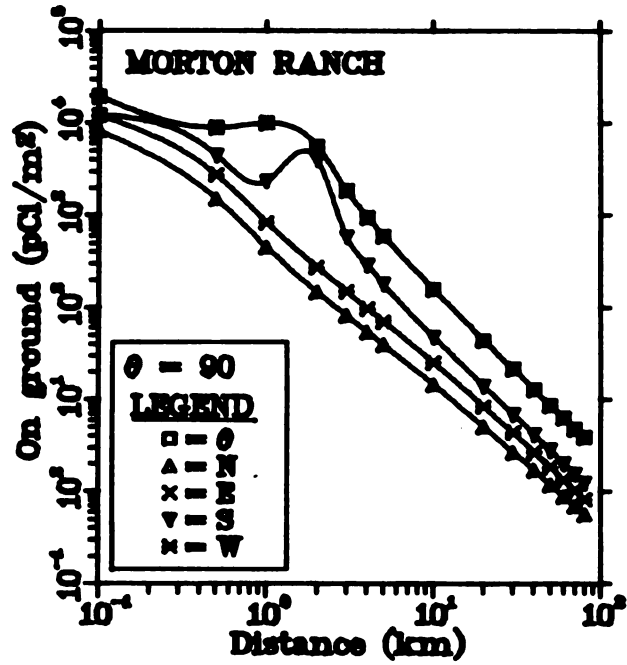


Fig. D-3.7. Computed Concentrations of Th-230 Deposited on the Ground.

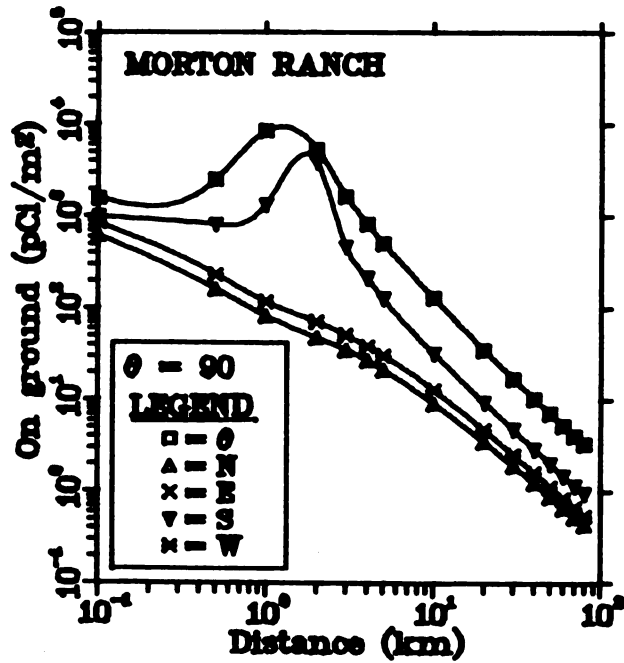


Fig. D-3.8. Computed Concentrations of Ra-226 Deposited on the Ground.

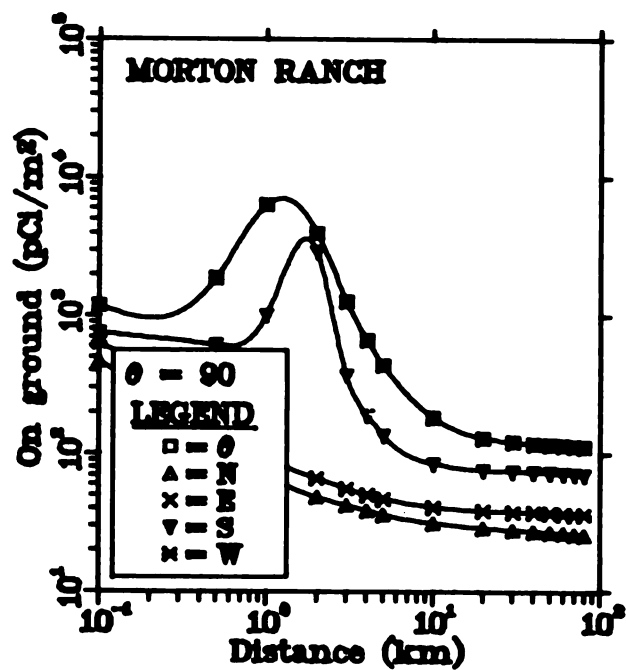


Fig. D-3.9. Computed Concentrations of Pb-210 Deposited on the Ground.

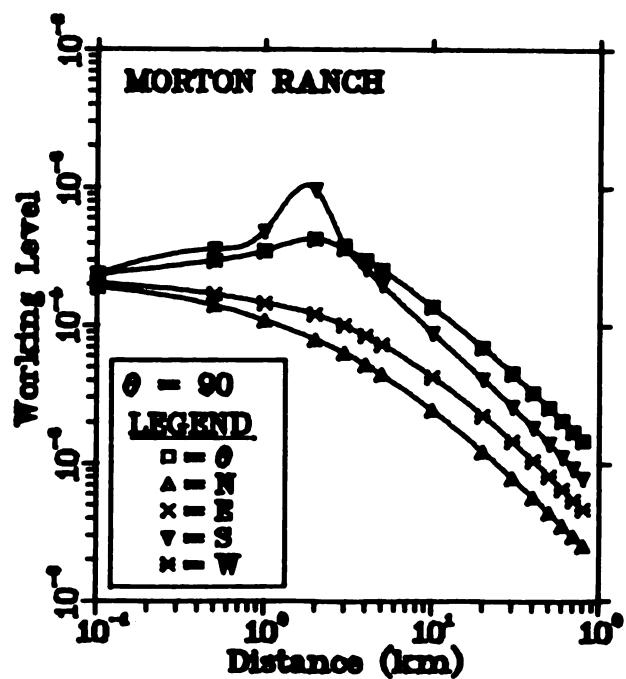


Fig. D-3.10. Working Level for Rn-222 and Daughters.

## APPENDIX D-4. FOOD PATHWAY

## D-4.1 FOOD PATHWAY - MEAT

Radioisotopes can enter the human body through the ingestion of meat containing radioactive materials. Radioisotopes enter the meat-ingestion pathway by direct deposition on, and by uptake through the roots of, grass used as feed for beef cattle.

Calculations were made for an integrated dose received by a person eating local beef in the fifteenth year of mill operations and receiving radiation dose from residual nuclides in his body for 50 years immediately after mill shutdown. The dosage was calculated on the basis of the following assumptions:

- Soil density = 1.5 g/cm<sup>3</sup>
- Soil depth for mixing = top 8 inches (20 cm)
- Total mixing-layer density thickness = 30 g/cm<sup>2</sup>
- Weathering-removal half-life of deposited radioisotopes = 13 days
- Percentage of deposition total taken up by grass = 30%
- Grass density = 440 g/m<sup>2</sup>
- Average exposure period of grass prior to being consumed by cattle = 90 days
- Fraction of year cattle graze on this pasture = 0.5
- Individual daily intake of beef by area resident = 250 g/day.

The concentration of isotopes in pasture grass resulting from deposition on the soil is estimated as:

$$C_{sv} = \frac{C_s \times B_{sv}}{\rho_s} \quad (1)$$

where:

$C_{sv}$  = concentration of isotopes from soil in the grass, pCi/g;

$C_s$  = concentration of isotopes on the soil, pCi/m<sup>2</sup>;

$\rho_s$  = soil surface density =  $3 \times 10^5$  g/m<sup>2</sup>; and

$B_{sv}$  = the transfer factor given in Table D.4.1 for transfer of isotopes from soil to grass, pCi/g-grass/pCi/g-soil.

The expression for the concentration on grasses is:

$$C_{av} = 8.64 \times 10^4 \times \frac{C_a V_d f_v [1 - \exp(-\lambda_{wr} t_c)]}{D_v (\lambda_{wr})} \quad (2)$$

where:

$C_{av}$  = concentration of isotope in grass from direct deposition, pCi/g;

$C_a$  = concentration of isotope in air, pCi/m<sup>3</sup>;

$\lambda_{wr} = \lambda_r + \lambda_w$  = effective removal rate, day<sup>-1</sup>;

$D_v$  = grass density = 440 g/m<sup>2</sup>;

$f_v$  = fraction taken up by grasses, 0.3;

$t_c$  = average grass exposure period, 90 days;

$V_d$  = deposition velocity, 0.01 m/sec; and

$8.64 \times 10^4$  = conversion factor from day to second, sec-day<sup>-1</sup>.

For a given location and animal feed consumption pattern, the concentration of isotope in a cow's feed is estimated as:

$$C_f = f_p f_g C_v \exp(-\lambda_r t_e) + (1 - f_p f_g) C_t \exp(-\lambda_r t_s) \quad (3)$$

where:

$C_f$  = concentration of isotope in the cattle feed, pCi/g;

$C_v = C_{sv} + C_{av}$  = concentration of isotope in pasture grass, pCi/g;

$f_p$  = fraction of pasture grass in daily feed of grazing animal = 1.0;

$f_g$  = fraction of the year that cattle graze on pasture = 0.5;

$C_t$  = concentration in feed at time of storage, pCi/g = 0.0;

$t_e$  = delay time between deposition on pasture grass and consumption by cattle = 0.0; and

$t_s$  = delay time between harvest of stored grass and consumption by cattle = 90 days.

The concentrations in beef are then given by:

$$C_b = F_f R_c C_f \exp(-\lambda_r t_t) \quad (4)$$

where:

$C_b$  = concentration of isotope in meat, pCi/g;

$F_f$  = feed to beef product transfer factor, given in Table D-4.1, pCi/kg/pCi/D;

$R_c$  = animals's rate of feed consumption = 50 kg/day for beef cattle; and

$t_t$  = transport time from food production to consumption by man = 0.0.

The doses to man resulting from the consumption of meat containing radioactive materials are calculated on the basis of an ICRP publication on permissible doses of internal radiation.<sup>1</sup>

Table D-4.1. Stable Element Transfer Factors<sup>a</sup>

|              | U                    | Th                   | Ra                   | Pb                   |
|--------------|----------------------|----------------------|----------------------|----------------------|
| $B_{sv}$     | $2.5 \times 10^{-3}$ | $4.2 \times 10^{-3}$ | $3.1 \times 10^{-4}$ | $6.8 \times 10^{-2}$ |
| $F_f$ (D/kg) | $3.4 \times 10^{-4}$ | $2.0 \times 10^{-4}$ | $3.4 \times 10^{-2}$ | $2.9 \times 10^{-4}$ |

<sup>a</sup>From Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," U. S. Nuclear Regulatory Commission, 1976.

#### D-4.2 FOOD PATHWAY - VEGETATION

Radioisotopes can enter the human body through the ingestion of vegetables containing radioactive materials. Radioisotopes enter the vegetation-ingestion pathway by direct deposition on, and by uptake through the roots of, plants used as food by man.

The following calculations were made for an integrated dose received by a person eating vegetables grown locally in the twentieth year of mill operations and receiving radiation doses from residual nuclides for 50 years immediately after mill shutdown.

The concentration of radioactive materials in vegetation from deposition onto the plant foliage and from uptake of activity deposited on the ground is given by

$$C_v^a = x V_d \left[ \frac{F_v (1 - e^{-\lambda_E t_e})}{Y_v \lambda_E} + \frac{B_v (1 - e^{-\lambda_G t_b})}{G \lambda_G} \right] e^{-\lambda_r t_p}$$

where  $C_v^a$  = concentration of radionuclide in aboveground vegetation

$x$  = concentration of radionuclide in air, pCi/m<sup>3</sup>

$V_d$  = deposition velocity, m/sec

$F_v$  = fraction of deposited particles retained on vegetation, 0.2

$Y_v$  = vegetation yield,  $Y_v = 2.0$  kg/m<sup>2</sup> for crops, and

$= 0.75$  kg/m<sup>2</sup> for pasture grasses

$t_e$  = vegetation exposure time; 60 days for crops and 30 days for pasture grass

$\lambda_E$  = effective removal rate constant for vegetation;  $\lambda_E = \lambda_r + \lambda_\omega$ , where

$\lambda_r$  = radioactive decay constant, and

$\lambda_\omega$  = removal rate constant for physical loss by weathering. For example, with a weathering removal half-life of 14 days,  $\lambda_\omega = 0.0495$  day<sup>-1</sup>

$B_v$  = the concentration factors for uptake of radionuclides from soils by edible parts of vegetation (see Table D-4.2)

$G$  = the effective surface density of soil. Assuming a uniform mixing of all radionuclides in a plow layer of 20 cm depth,  $G = 300$  kg/m<sup>2</sup>

$t_b$  = soil exposure time

$\lambda_G$  = the effective removal rate constant from soil.  $\lambda_G = \lambda_r + \lambda_p$  where  $\lambda_p$  = is the removal rate constant for physical loss from the soil. For example, a soil removal half-life of 50 years would give a value for  $\lambda_p$  of 0.01386 year<sup>-1</sup>

$t_p$  = the holdup time between harvest and consumption of food.  $t_p = 60$  days for crops, and  $t_p = 0$  days for pasture grasses

For vegetation consumed by man a decontamination factor of 0.5 is used to allow for physical methods of decontamination such as washing, peeling, shelling, etc.

Table D-4.2. Concentration Factors ( $B_v$ ) for Uptake of Radionuclides from Soil to Vegetation<sup>a</sup>

| U                    | Th                   | Ra                   | Pb                   | Po                   |
|----------------------|----------------------|----------------------|----------------------|----------------------|
| $2.5 \times 10^{-3}$ | $4.2 \times 10^{-3}$ | $3.1 \times 10^{-4}$ | $6.8 \times 10^{-2}$ | $1.5 \times 10^{-1}$ |

<sup>a</sup>Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," U. S. Nuclear Regulatory Commission, 1977.

#### Reference for Appendix D-4

1. International Commission on Radiological Protection, "Report of Committee II on Permissible Dose for Internal Radiation," 1959.

## APPENDIX D-5. 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<sup>3</sup> is approximately  $5.0 \times 10^{-6}$  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.  $5 \times 10^{-6}$  WL per pCi/m<sup>3</sup> 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 D-5

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.

## APPENDIX E. SEEPAGE, WATER, AND MASS BALANCE

Twelve alternative methods for tailings disposal (Options A-L) are discussed in Section 10.4. Several are similar, differing only in the schedule for dam construction (Options A and C; Options B and D). Others differ only in the material used to inhibit seepage through the side walls of the mine pits that would be used for tailings disposal (Options E through G). Finally, two others differ only in location (Options I and J). Basic to a viable tailings-disposal option is the capacity to store the solid and liquid effluent from a projected 20 years of mill operations. In this appendix it will be shown that the storage capacity provided by several of the options is insufficient to contain tailings over 20 years of operation at an ore-processing rate of  $1.81 \times 10^6$  kg/24-hour day (2000 tons/day) for an average of 330 days per year--i.e.,  $11.93 \times 10^9$  kg ( $13.2 \times 10^6$  tons) of ore (UNC-LA-2, p. 1-2). Of the options, the applicant's preferred alternative (Option L) is considered by the staff to be the best because, using the most current estimates (Table E.3) for pit volumes, the staff calculates that all but about 8% of the tailings solids could be contained in pits. The applicant will be required to provide adequate pit storage volume for all tailings produced during the lifetime of the mill. Estimates of the maximum seepage rate will be given for the options discussed, even though they are not likely to be used because of insufficient storage capacity.

### E.1 SEEPAGE

The seepage rate of water through a clay liner can be estimated from Darcy's law:

$$Q_{\text{seep}} = KA \frac{H}{L} \quad (\text{E-1})$$

where  $K$  = hydraulic conductivity of the liner, m/s

$A$  = area through which seepage takes place,  $\text{m}^2$

$L$  = thickness of liner, m

$H$  = head loss (distance from free water surface to the bottom of the liner), m

The hydraulic conductivity assumed for the clay liner used in all options except Option K is  $K = 1.9 \times 10^{-10}$  m/sec (0.02 ft/yr). This value--the average of the two values quoted in ER Supplement II, response to Q. 12--was used in all calculations made here.

The applicant proposes a 0.61-m (2-ft) thick clay liner for options A through J; however, a 0.91-m (3-ft) liner will be required by the staff for all options utilizing clay liners, on the basis of stability. The seepage will be calculated for both thicknesses.

### E.2 ENTRAINED WATER

A certain fraction of the net water discharged to the tailings-disposal area would be entrained by the sands and slimes. This function can be determined by computing the void ratio,  $e$  (ratio of the volume of the voids to the volume of the solids), and then assuming that these voids are filled with water.

The void ratio is defined by

$$e = \frac{G\alpha_w}{\alpha_d} - 1 = 0.91 \quad (\text{E-2})$$

where  $G$  = specific gravity of the tailings = 2.65

$\alpha_w$  = density of water =  $10^3$  kg/ $\text{m}^3$

$\alpha_d$  = density of dry tailings =  $1.39 \times 10^3$  kg/ $\text{m}^3$

With a mill design throughput of  $1.82 \times 10^6$  kg/day (2000 tons/day) (ER Suppl. II, p. 3-1) and the values given for  $G$  and  $\alpha_w$ ,  $687 \text{ m}^3/\text{day}$  of solids are delivered to the disposal area. Multiplying by the void ratio,  $e$ , yields the rate of accumulation of the entrained water, 7.2 Lps ( $625 \text{ m}^3/\text{day}$  or 115 gpm).

### E.3 OPTION D

As discussed in Section 10.4, Option D is a slight modification (in construction schedule) of Option B. The seepage,  $Q_{\text{seep}}$ , through the clay-lined bottom is estimated from Eq. E-1 with  $K$  as given in Section D.1 ( $1.9 \times 10^{-10} \text{ m/s}$ ) and

$$A = 6.9 \times 10^5 \text{ m}^2 \text{ (171 acres)*}$$

$$L = 0.61 \text{ m (2 ft)**}$$

$$H = 10.1 + 0.61 \text{ m (33.2}^\dagger + 2.0 \text{ ft)}$$

$$Q_{\text{seep}} = 2.3 \text{ Lps.}$$

For 0.91 m (3 ft) of clay,  $Q_{\text{seep}} = 1.6 \text{ Lps.}$

Report section 10.4.3 indicates that more tailings will be produced than can be contained in a south tailings pond (Option B).

### E.4 OPTIONS E THROUGH H

As discussed in Section 10.4, Options E through H involve the use of seven mine pits for tailings disposal (pits 2105; 1801; 1805; 1802 and 1803; 1804 and 2114) and Option L adds four additional pits (2103, 2104, 2112, and 2113; actually, one large pit) to hold excess water not returned to the mill circuit. Figure 10.3.1 shows the location of these pits; Table E-1 summarizes their design.

Table E-1. Mine Pit Parameters

| Pit No.          | Area of Pit, $10^5 \text{ m}^2$ <sup>a</sup> |                     |                     | Average Depth, m | Pit Storage Capacity, $10^6 \text{ m}^3$ <sup>a</sup> |
|------------------|----------------------------------------------|---------------------|---------------------|------------------|-------------------------------------------------------|
|                  | Minimum Usable Area                          | Maximum Usable Area | Average Usable Area |                  |                                                       |
| 2105             | 0.567                                        | 0.791               | 0.679               | 18.3             | 1.24                                                  |
| 1801             | 0.769                                        | 0.994               | 0.881               | 18.3             | 1.61                                                  |
| 1805             | 0.416                                        | 0.624               | 0.520               | 18.3             | 0.952                                                 |
| 1802-3           | 0.692                                        | 0.978               | 0.835               | 18.3             | 1.53                                                  |
| 1804             | 0.250                                        | 0.411               | 0.331               | 18.3             | 0.605                                                 |
| 2114             | 0.469                                        | 0.670               | 0.570               | 18.3             | 1.04                                                  |
| Subtotal         |                                              |                     |                     |                  | 6.977                                                 |
| 2112-3<br>2103-4 | 1.004                                        | 1.627               | 1.316               | 30.5             | 4.01                                                  |
| Total            |                                              |                     |                     |                  | 10.987                                                |

<sup>a</sup>Above a 0.61-m clay liner, allowing for a 1.52-m freeboard.

\*ER Suppl. I, p. 5-3.

\*\*ER Suppl. I, p. 5-1.

<sup>†</sup>From the footnote above, the average depth above the liner is the total volume divided by the maximum surface area.

In options E and H the applicant proposes to line the pits with 0.61 m (2 ft) of clay. However, the minimum staff requirement of 0.91 m (3 ft) of clay in the liner will be necessary for stability.<sup>1</sup> The capacities for 0.61-m clay-lined pits are included in Table E-1. The total capacity of all the pits decreases by less than one percent when an additional 0.305 m (1 ft) of clay is required, and is therefore not listed in the table.

The storage area required for the  $11.93 \times 10^9$  kg ( $13.2 \times 10^6$  tons) of tailings to be produced during the life of the mill is  $8.63 \times 10^6$  m<sup>3</sup>; it can be seen from Table E-1 that only  $6.977 \times 10^6$  m<sup>3</sup> will be available from the seven pits indicated.

If the volume of the pits designated for water storage is included in the volume for tailings solids, there would then be available  $10.987 \times 10^6$  m<sup>3</sup>, sufficient volume to contain all tailings produced. However, this is still not a viable solution: The total volume of liquid delivered to the pits after accounting for water returned to the mill circuit and water entrained in the tailings would be 17.6 Lps. The total volume of tailings produced would be 1308 m<sup>3</sup>/day. The staff has determined that there is no way by which the pits could be fully utilized for tailings solids storage, as such large volumes of water would not evaporate from the pits quickly enough in the climate where the mill site is proposed.

#### E.5 OPTIONS I or J: EXPANSION OF AN EXISTING PIT

Use of Options I or J would result in a circular pit 30.5 m (100 ft) deep with a top radius of 701 m (2300 ft), a side slope of 30°, and a 0.61 m (2 ft) thick clay liner. The staff has calculated the pit capacity to be  $4.05 \times 10^7$  m<sup>3</sup>. This pit would have more than enough capacity to contain all tailings (solids and liquids) plus precipitation, even if evaporation is neglected.

The maximum possible seepage from a completely filled pit through a 0.6-m (2-ft) liner, given a bottom area of  $2.78 \times 10^5$  m<sup>2</sup>, is  $Q_{\text{seep}} = 2.69$  Lps; as explained previously, seepage through a 0.9-m (3-ft) liner would be slightly less (see Table E-2). (Again, seepage through the sides has been ignored because the thickness of the side wall clay liner is an order of magnitude more than the bottom and the average total head and side wall surface is less.)

Table E-2. Maximum Seepage from Pits and Evaporation Pond

| Pit No.             | Seepage Rate, Lps<br>0.6-m Liner | Seepage Rate, Lps<br>0.9-m Liner | Years to<br>Fill with<br>Tailings <sup>a</sup> |
|---------------------|----------------------------------|----------------------------------|------------------------------------------------|
| 2105                | 0.33                             | 0.22                             | 2.9                                            |
| 1801                | 0.45                             | 0.30                             | 3.7                                            |
| 1805                | 0.25                             | 0.17                             | 2.2                                            |
| 1802-3              | 0.41                             | 0.27                             | 3.5                                            |
| 1804                | 0.15                             | 0.10                             | 1.4                                            |
| 2114                | 0.28                             | 0.19                             | 2.4                                            |
| 2112-3              | 0.97                             | 0.65                             | 9.3                                            |
| 2103-4              |                                  |                                  |                                                |
| Evaporation<br>pond | 1.40                             | 0.95                             | 20                                             |

<sup>a</sup>Assumed filled to capacity.

#### E.6 OPTION L\*

In order to make tailings solids storage in these pits possible, Option L has been proposed in which excess water would be stored in and evaporated from a surface pond at the locations stipulated in Option B. The applicant has stated<sup>2</sup> that the initial size of the pond would be 150,000 m<sup>2</sup> (37 acres). However, staff calculations indicate that a pond with a surface area o

approximately  $4.45 \times 10^5 \text{ m}^2$  (110 acres) would eventually be required to contain all unevaporated water remaining after 20 years of operation. More than 10 years would be required for most of this pond of water to evaporate, but some water will never evaporate because of the sulfuric acid present in the liquid.

Table E-3 summarizes the latest pit designs provided by the applicant. Using these values, the staff calculates that the pit storage capacity,  $8.02 \times 10^6 \text{ m}^3$ , will be about 8% less than the  $8.63 \times 10^6 \text{ m}^3$  required for tailings solids disposal. It is probable that the pit designs will continue to change as mining progresses. Furthermore, uncertainties exist in predicting parameters such as the bulk density of the tailings. These, in turn, produce uncertainties in the required storage volume (of approximately the same magnitude as the calculated shortfall of 8%). In any case, the applicant will be required to provide adequate pit volume for tailings storage throughout the operational life of the mill.

Table E-3. Most Current Estimates of Mine Pit Parameters<sup>a</sup>

| Pit No.           | Usable Area of Pit, $10^5 \text{ m}^2$ |         |         | Average Depth, m | Pit Storage Capacity, $10^6 \text{ m}^3$ | Years to Fill with Tailings | Seepage Rate Lps, 0.9 m Liner |
|-------------------|----------------------------------------|---------|---------|------------------|------------------------------------------|-----------------------------|-------------------------------|
|                   | Maximum                                | Minimum | Average |                  |                                          |                             |                               |
| 1802              | 0.65                                   | 0.45    | 0.53    | 15.2             | 1.32                                     | 3.0                         | 0.15                          |
| 1803              | 0.40                                   | 0.32    | 0.36    | 15.2             |                                          |                             | 0.11                          |
| 1804              | 0.49                                   | 0.20    | 0.32    | 21.3             | 1.58                                     | 3.6                         | 0.09                          |
| 1805              | 0.45                                   | 0.36    | 0.40    | 21.3             |                                          |                             | 0.16                          |
| 1801              | 0.61                                   | 0.40    | 0.49    | 15.2             | 1.54                                     | 3.5                         | 0.13                          |
| 2105              | 0.97                                   | 0.32    | 0.65    | 15.2             |                                          |                             | 0.11                          |
| 2112-13           | 1.7                                    | 0.12    | 0.89    | 21.3             | 1.91                                     | 4.4                         | 0.41 <sup>b</sup>             |
| 2103              | 0.53                                   | 0.04    | 0.28    | 29.0             | 1.67                                     | 3.9                         | 0.17 <sup>b</sup>             |
| 2104              | 0.32                                   | 0.20    | 0.24    | 42.7             |                                          |                             | 0.18                          |
| Total Pit Seepage |                                        |         |         |                  | 8.02                                     |                             | 1.51                          |
| Evaporation Pond  |                                        |         |         |                  |                                          |                             | 0.95                          |
| Total Seepage     |                                        |         |         |                  |                                          |                             | 2.46                          |

<sup>a</sup>Communication from Plant Superintendent, Wyoming Operations, United Nuclear Corporation, to U. S. Nuclear Regulatory Commission, dated 17 August 1978.

<sup>b</sup>Staff calculations of seepage from these pits assume the average usable area instead of the minimum, because it is now expected that small but deeper ore bodies will be mined within these pits, resulting in the minimum usable areas listed, which are smaller than usually expected.

Calculated seepage rates for each pit and the evaporation pond, assuming a 0.9-m liner, are also listed in Table E-3. Seepage through the clay-lined sides has been ignored because the thickness of the side wall clay liner averages an order of magnitude more than the bottom, and because the average total head and side wall surface area is less. The filling times for the pits are also listed. It should be noted that the pits could become filled before 20 years if their total capacity proves to be about 8% too low to contain all the tailings. In this case, additional lined pit capacity would have to be provided.

\*Since the issuance of the Draft Environmental Statement, the applicant's estimated number and sizes of the pits have changed. For this reason, the most current values (Table E-3) are used for staff calculations when assessing Option L.

References for Appendix E

1. Letter of R. A. Scarano, U. S. Nuclear Regulatory Commission to Vice President, Division of Mining and Milling, Wyoming Operations, United Nuclear Corporation, dated 31 January 1978.
2. Letter of Vice President, Division of Mining and Milling, Wyoming Operations, United Nuclear Corporation, to U. S. Nuclear Regulatory Commission, dated 13 January 1975.



## APPENDIX F. MOVEMENT OF CONTAMINANTS FROM THE TAILINGS DISPOSAL ALTERNATIVES - STAFF CALCULATIONS

### F.1 INTRODUCTION

The rate of movement of ions through soil is related to the distribution coefficient,  $K_d$ , which is a laboratory measure of the ratio of the number of ions adsorbed onto the soil divided by the number remaining in solution. The distribution coefficient for some ions, such as sulfate and chloride, is essentially zero, whereas other ions, particularly cations, are readily precipitated or exchanged in the soils (especially clayey soils) by more soluble ions.<sup>1</sup>

The equation for the movement of an ion, is:<sup>2</sup>

$$V_i = \frac{V_w}{1 + \frac{K_d \rho_b}{n}} \quad (F-1)$$

where  $V_i$  = velocity of the ionic species (m/yr)

$V_w$  = velocity of the water (m/yr)

$\rho_b$  = bulk density of the media

$n$  = porosity

The seepage velocity,  $V_d$ , is determined from Darcy's law:

$$V_d = K_v \frac{H}{L} \quad (F-2)$$

where  $K_v$  = vertical hydraulic conductivity (m/yr)

$H$  = head loss (m)

$L$  = thickness of subsoil (liner), (m)

The true velocity of water traveling in a porous medium is equal to Darcy's law velocity divided by the porosity,  $n_e$ .

$$V_w = \frac{V_d}{n} \quad (F-3)$$

Typical values for the porosity and bulk density of clays such as those present at the Morton Ranch site are:

$$n = 0.45$$

$$\gamma = 1.6 \text{ gm/cm}^3.$$

The distribution coefficient is a variable that is uniquely determined for only a single set of physical and chemical conditions, i.e., it is dependent on the chemistry of the tailings effluent and the soil or liner through which it is seeping. For radium,  $K_d$  can vary by at least two orders of magnitude and probably more (8 mL/g at Sweetwater mill in Wyoming,<sup>3</sup> 289 mL/g at the Atlas mill in Utah,<sup>4</sup> and up to 650 mL/g at the Sherwood Uranium Project in Washington<sup>5</sup>).

It can be seen from Eq. F-1 that the smaller the value of  $K_d$ , the larger the ion velocity (less retardation). Because the value of  $K_d$  for radium at Morton Ranch is not known, the extremely

conservative value of 8 mL/g will be used. Then, the ion velocity is

$$V_i = \frac{V_w}{1 + \frac{8 \times 1.6}{0.45}} = \frac{V_w}{29}, \quad (\text{F-4})$$

i.e., the radium front moves at  $\frac{1}{29}$  the velocity of the water (if  $K_d = 100$ ,  $V_i = \frac{V_w}{350}$ ).

The movement of thorium is much less, as  $K_d$  for this species ranges from 1000 to 10,000.<sup>5,6</sup>

The movement of contaminants for each of the alternative tailings-disposal options discussed in Appendix E will now be estimated.

## F.2 OPTION B or L - TAILINGS IMPOUNDMENT OR EVAPORATION IMPOUNDMENT

Using the values for K, H, and L given in Appendix E for a pond with a 0.61-m (2-ft) clay liner after 20 years of operation,

$$V_w = 1.9 \times 10^{-10} \text{ m/s} \times \frac{10.71 \text{ m}}{0.61 \text{ m} \times 0.45} = 7.4 \times 10^{-9} \text{ m/s} = 0.233 \text{ m/yr.}$$

It must be stressed that this is the maximum velocity, and would actually vary from zero at mill startup to 0.233 m/yr after 20 years of operation. If this maximum value is used, additional conservatism is added to the calculation. The velocity of the radium ions is obtained from Eq. F-5:

$$V_{ra} = \frac{0.233}{29} = 0.0080 \text{ m/yr.} \quad (\text{F-5})$$

After 20 years, the radium (and thorium) will have moved less than 0.16 m (0.5 ft), and will therefore be located in the clay liner. For a 0.91-m (3-ft) liner, the movement would be even less. The tailings stabilization and management plan will prevent additional water from entering the tailings and carrying ions downward through the clay. Thus, the radionuclides will be permanently sequestered in the clay and will not enter the groundwater.

Because anion contaminants such as sulfate and chloride move with the water, they will eventually pass through the liner and the potential exists for these contaminants to reach the groundwater.

## F.3 OPTIONS E-H, I, L - OPEN PITS

The deepest pit involved in all open pit options would be 30.5 m (100 ft). As the potential for contamination would be from the deepest pit (due to the hydraulic head) a 30.5 m pit will be discussed here.

For a 30.5-m (100-ft) deep pit with a 0.61-m (2-ft) clay liner,

$$V_w = 1.9 \times 10^{-10} \text{ m/s} \times \frac{31.1}{0.61 \times 0.45} = 21.6 \times 10^{-9} \text{ m/s} = 0.69 \text{ m/yr}$$

$$V_{ra} = 0.024 \text{ m/yr.}$$

If the liner thickness is increased to 0.91 m (3 ft), then

$$V_w = 0.45 \text{ m/yr and } V_{ra} = 0.016 \text{ m/yr.}$$

Radium (and thorium) are expected by the staff to be retained in the clay liner of the pit after termination of mill operation. In this option, however, it is expected that some sulfate and chloride could enter the groundwater. For Options I or J, the seepage rate is only 2.69 Lps for a 0.61-m liner and 1.79 Lps for a 0.91-m liner, the amount of contamination would be very small. The contamination from the shallower pits would be even smaller, due to the smaller hydraulic head. For the other options, the seepage is less (see Appendix E).

#### F.4 CONCLUSIONS

Using very conservative values for the distribution coefficient and assuming that the clay liner will remain undisturbed, the staff believes that during the 20-year operation of the mill, radium and thorium will be retained by the clay liner and not contaminate the groundwater. Upon mill abandonment, these radionuclides should remain isolated in the liner. Some dissolved contaminants such as sulfates and chlorides will pass through the liner and could reach the groundwater. However, as seepage rates will be very small, any contamination will also be minimal.

#### References for Appendix F

1. B. F. Hajek, "Chemical Characteristics of Wastewater in a Soil Environment," Water Pollution Control Federation 41(10):1775-86, 1969.
2. S. N. Davis and R. S. M. De Wiest, "Hydrogeology," New York, John Wiley and Sons, 1966.
3. Dames & Moore, Appendix C, "Radiochemical Contaminant Migration Analysis," in: "Supplement to Environmental Report, Analysis of Tailings Disposal Alternatives, Sweetwater Uranium Project, Sweetwater County, Wyoming, for Minerals Exploration Co.," Docket 40-8584, April 27, 1977.
4. Atlas Minerals, "Environmental Report," Suppl. 3, Table 2.1, August 28, 1975.
5. "Final Environmental Statement, Sherwood Uranium Project," U. S. Dept. of Interior, August 19, 1976.
6. 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," Oak Ridge National Laboratory, ORNL-TM-4903, Vol. 1, May 1975.



## APPENDIX G. BASIS FOR NRC EVALUATION OF THE MORTON RANCH MILL PROPOSAL

### 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 (U-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 (U-235, U-238, Pu) from fission products (waste), with concurrent separation of uranium from plutonium.
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<sup>1</sup> as a necessary part of the cycle. U. S. commitment to advanced nuclear technologies based on the use of plutonium recovered by the reprocessing of spent LWR fuel has also been deferred. These policy statements enter into the staff's evaluation of the need for the project, because without reprocessing, all LWR fuel must be derived from the mining and milling of new  $U_3O_8$  from projects such as the Morton Ranch mines and mill.

This cycle, as defined by current policy, is portrayed in Figure G.1.

Nuclear reactor operation converts about 75% of the fissionable isotope (U-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 spent fuel. 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.

### USE OF NUCLEAR FUEL IN REACTORS

Two types of reactors are currently used to generate essentially all of the nuclear energy sold in the U. S.: 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

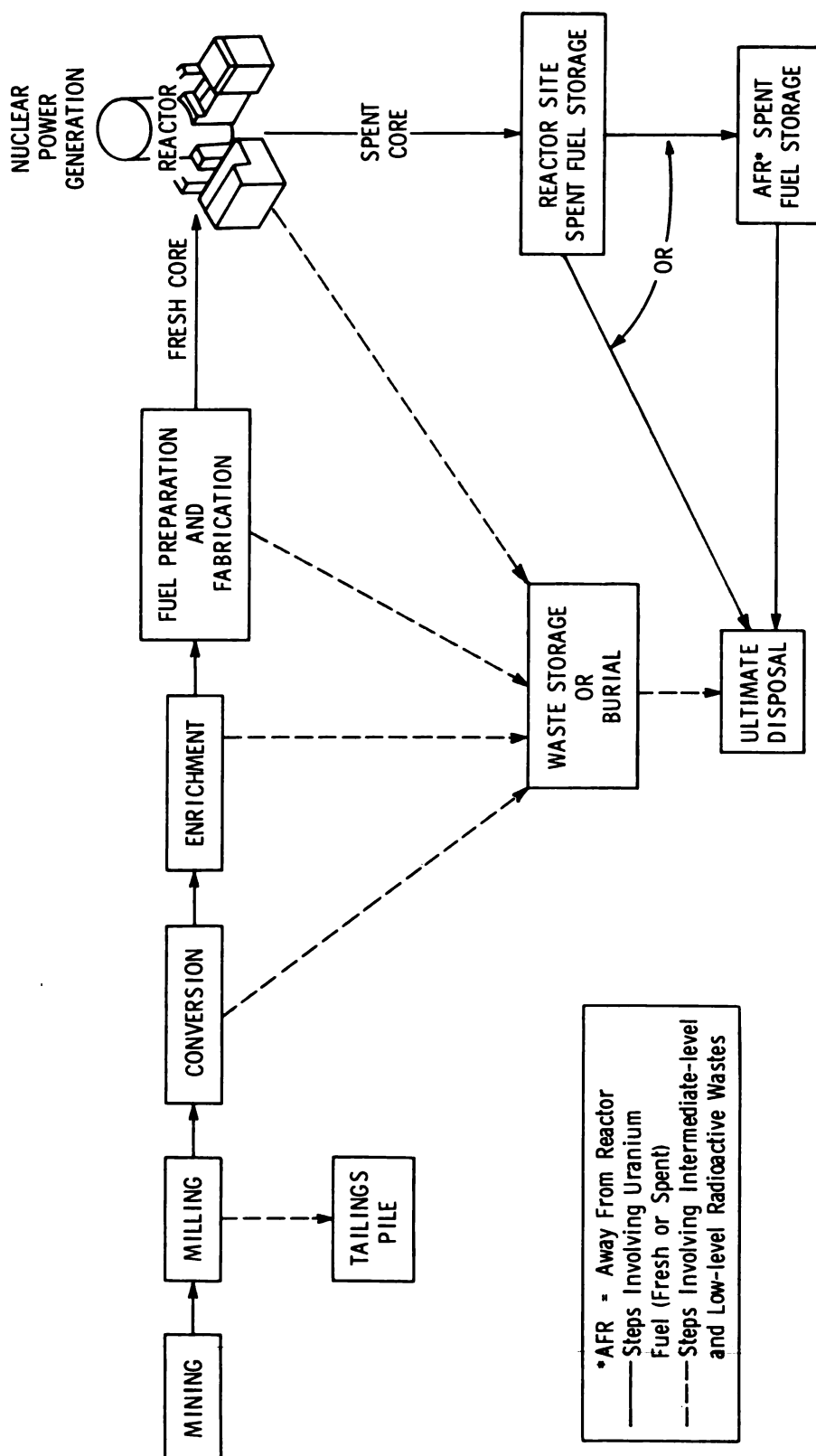


Fig. G.1. The LWR Fuel Cycle.

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 G.1. A 1000-MWe reactor will require ~ 22 MT of uranium fuel per year at a plant factor of 0.6 and ~ 30 MT 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 MT 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 G.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.<sup>2</sup>

Table G.1. Projected U.S. Requirements for  $U_3O_8$ , 1976-2000<sup>a,b</sup>

| Year | Generating Capacity, GWe | Annual $U_3O_8$ Requirements, MT | Cumulative $U_3O_8$ Requirements, $\times 10^3$ MT |
|------|--------------------------|----------------------------------|----------------------------------------------------|
| 1976 | 43                       | 9,500                            | 9.35                                               |
| 1977 | 49                       | 10,000                           | 19.1                                               |
| 1978 | 53                       | 10,000                           | 29.1                                               |
| 1979 | 57                       | 11,000                           | 40.2                                               |
| 1980 | 61                       | 11,000                           | 52.0                                               |
| 1981 | 74                       | 17,500                           | 69.4                                               |
| 1982 | 87                       | 18,000                           | 87.6                                               |
| 1983 | 100                      | 20,500                           | 108                                                |
| 1984 | 112                      | 22,500                           | 130                                                |
| 1985 | 127                      | 26,500                           | 157                                                |
| 1986 | 141                      | 28,000                           | 185                                                |
| 1987 | 154                      | 30,000                           | 215                                                |
| 1988 | 167                      | 32,500                           | 248                                                |
| 1989 | 181                      | 35,500                           | 283                                                |
| 1990 | 195                      | 38,000                           | 321                                                |
| 1991 | 210                      | 41,000                           | 362                                                |
| 1992 | 225                      | 43,500                           | 406                                                |
| 1993 | 240                      | 46,500                           | 452                                                |
| 1994 | 260                      | 51,500                           | 504                                                |
| 1995 | 280                      | 54,500                           | 558                                                |
| 1996 | 300                      | 58,000                           | 616                                                |
| 1997 | 320                      | 61,500                           | 678                                                |
| 1998 | 340                      | 65,500                           | 743                                                |
| 1999 | 360                      | 68,500                           | 811                                                |
| 2000 | 380                      | 71,500                           | 883                                                |

<sup>a</sup>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.

<sup>b</sup>To convert to short tons, multiply by 1.1.

Table G.2. Comparison of Total and Nuclear Generating Capacity, Operating in Years 1977-2000

| Year | Total Generating Capacity, GWe <sup>a</sup> |         | 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                           |

<sup>a</sup>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.

Cumulative requirements through the year 2000 would be 883,000 MT of uranium as  $U_3O_8$  (Table G.1). Table G.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;<sup>3</sup> i.e., the sum of reserves and probable resources is approximately equal to the lifetime requirements of the 380 GWe installed by 2000.

Table G.3. Comparison of U. S. Reactor Requirements and Domestic Resource Availability (in MT  $U_3O_8$ <sup>a</sup> as of January 1978)<sup>b</sup>

| Time Period                            | Reactor Demand | Resource Availability  |                        |
|----------------------------------------|----------------|------------------------|------------------------|
|                                        |                | @ \$30/lb <sup>c</sup> | @ \$50/lb <sup>c</sup> |
| Through year 2000                      | 883,000        |                        |                        |
| For 30-year lifetime of 380 GWe        | 2,051,000      |                        |                        |
| Reserves <sup>d</sup>                  |                | 626,000                | 808,000                |
| Probable resources                     |                | 921,000                | 1,180,000              |
| Sum of reserves and probable resources |                | 1,550,000              | 2,000,000              |

<sup>a</sup>To convert to short tons multiply by 1.1.

<sup>b</sup>Based on information presented by U. S. Energy Research and Development Administration (now U. S. Dept. 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.

<sup>c</sup>Costs include all those incurred in property exploitation and production except costs of money and taxes.

<sup>d</sup>Does not include 126,000 MT of  $U_3O_8$  which could be produced as a by-product of phosphate fertilizer and copper production.

In 1977, 23 mills produced about 12,000 MT (14,000 tons) of  $U_3O_8$  while handling 32,000 MT (35,000 tons) of ore per day. These mills operated at 80 to 85% of capacity. The  $U_3O_8$  content of the ore was less than 3 lb/ton (< 0.15%).<sup>4</sup>

As can also be seen from Table G.1, the annual requirement for  $U_3O_8$  in 1981 (17,500 MT) exceeds the output of existing uranium mills (12,000 MT). At licensed capacity, the total production of  $U_3O_8$  through 20 years of operation at Morton Ranch, beginning in 1980, would be about 2.5% of the national requirements. The Morton Ranch project will contribute to meeting the demand forecasted for the nuclear power industry.

#### References for Appendix G

1. National Energy Plan, Office of the President, April 1977.
2. Brown and Williamson, "Domestic Uranium Requirements, Policy and Evaluation," U. S. Department of Energy, paper presented at the Uranium Seminar, Grand Junction, Colorado, 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, Colorado, October 1977.



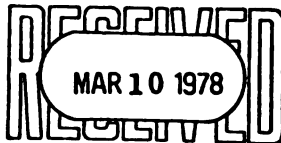
**APPENDIX H. LETTER OF HISTORIC PRESERVATION OFFICER**

THE STATE



OF WYOMING

UNITED NUCLEAR CORP.



MINING &amp; MILLING DIV.

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March 9, 1978

JAN L. WILSON  
Acting Director  
777-7885Mr. C. E. Wolff, Plant Superintendent  
Wyoming Operations, United Nuclear Corp.  
P. O. Box 2996  
Casper, Wyoming 82602

Dear Mr. Wolff:

Thank you for the letter of March 3 regarding cultural site clearance for UNC's Morton Ranch Uranium Project within Sections 10, 11, 14 and 15, T35N, R72W, of 6th P.M.

The State Archeologist has already made a reconnaissance survey of this area and recommends archeologic clearance, stipulating that should your development activities result in discovery of any archeologic values his office should be immediately notified. The State Historic Preservation Officer (SHPO) concurs with this evaluation.

As far as historic values are concerned, there are no properties enrolled in the National Register of Historic Places that would be affected by UNC's proposal. This is also true of any properties listed in the Wyoming Inventory of Historic Sites (which might qualify for later enrollment in that "Register"). In short the proposal has complete historic resource clearance from this office.

Sincerely,

Jan L. Wilson, Acting Director  
and Wyoming State  
Historic Preservation Officer  
By:

Ned Frost, Chief  
Historical Division

JLW/NMF/mlr

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |                                                                              |                                         |                                                              |                         |
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| <b>NRC FORM 335</b><br>(7-77)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  | <b>U.S. NUCLEAR REGULATORY COMMISSION</b><br><b>BIBLIOGRAPHIC DATA SHEET</b> |                                         | <b>1. REPORT NUMBER (Assigned by DDC)</b><br><br>NUREG-0532  |                         |
| <b>4. TITLE AND SUBTITLE (Add Volume No., if appropriate)</b><br>Final Environmental Statement related to operation of<br>Morton Ranch Uranium Mill - United Nuclear Corporation<br>Docket No. 40-8602                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |                                                                              |                                         | <b>2. (Leave blank)</b>                                      |                         |
| <b>7. AUTHOR(S)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |                                                                              |                                         | <b>3. RECIPIENT'S ACCESSION NO.</b>                          |                         |
| <b>9. PERFORMING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code)</b><br>U.S. Nuclear Regulatory Commission<br>Office of Nuclear Material Safety and Safeguards<br>Washington, D. C. 20555                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |                                                                              |                                         | <b>5. DATE REPORT COMPLETED</b><br>MONTH   YEAR              |                         |
| <b>12. SPONSORING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code)</b><br><br>Same as above                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |                                                                              |                                         | <b>DATE REPORT ISSUED</b><br>MONTH   YEAR<br>February   1979 |                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |                                                                              |                                         | <b>6. (Leave blank)</b>                                      |                         |
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| <b>13. TYPE OF REPORT</b><br>Final Environmental Statement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |                                                                              |                                         | <b>PERIOD COVERED (Inclusive dates)</b>                      |                         |
| <b>15. SUPPLEMENTARY NOTES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |                                                                              |                                         | <b>10. PROJECT/TASK/WORK UNIT NO.</b>                        |                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |                                                                              |                                         | <b>11. CONTRACT NO.</b>                                      |                         |
| <b>16. ABSTRACT (200 words or less)</b><br>A Final Environmental Statement for United Nuclear Corporation related to application for license approval for the Morton Ranch Uranium Mill to be located in Converse County, Wyoming (Docket No. 40-8602), 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 Morton Ranch Uranium Mill against environmental and other costs and considering available alternatives, the action called for is issuance of a source material license subject to stipulated conditions. |  |                                                                              |                                         |                                                              |                         |
| <b>17. KEY WORDS AND DOCUMENT ANALYSIS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |                                                                              | <b>17a. DESCRIPTORS</b>                 |                                                              |                         |
| <b>17b. IDENTIFIERS/OPEN-ENDED TERMS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |  |                                                                              |                                         |                                                              |                         |
| <b>18. AVAILABILITY STATEMENT</b><br><br>Release unlimited                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |                                                                              | <b>19. SECURITY CLASS (This report)</b> |                                                              | <b>21. NO. OF PAGES</b> |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |                                                                              | <b>20. SECURITY CLASS (This page)</b>   |                                                              | <b>22. PRICE</b>        |

















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