NUREG-1508
BLM NM-010-93-02
BIA EIS-92-001

# Final Environmental Impact Statement

## to Construct and Operate the Crownpoint Uranium Solution Mining Project, Crownpoint, New Mexico

Docket No. 40-8968
Hydro Resources, Inc.

U.S. Nuclear Regulatory Commission

Office of Nuclear Material Safety and Safeguards

In Cooperation With

U.S. Bureau of Land Management
Albuquerque District

U.S. Bureau of Indian Affairs
Navajo Area Office

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# Environmental Impact Statement
## to Construct and Operate the Crownpoint Uranium Solution Mining Project, Crownpoint, New Mexico

Docket No. 40-8968
Hydro Resources, Inc.

Manuscript Completed: February 1997
Date Published: February 1997

**Division of Waste Management**
**Office of Nuclear Material Safety and Safeguards**
**U.S. Nuclear Regulatory Commission**
**Washington, DC 20555-0001**

**in Cooperation With**

**Albuquerque District**
**U.S. Bureau of Land Management**
**Albuquerque, New Mexico 87107**

**Navajo Area Office**
**U.S. Bureau of Indian Affairs**
**Gallup, New Mexico 83701**

# ABSTRACT

This Final Environmental Impact Statement (FEIS) addresses the proposed action of issuing a combined source and 11e(2) byproduct material license and minerals operating leases for Federal and Indian lands to Hydro Resources, Inc. (HRI). This action would authorize HRI to conduct in-situ leach uranium mining in McKinley County, New Mexico. Such mining would involve drilling wells to access the ore bodies, then recirculating groundwater with added oxygen to mobilize uranium found in the ore. Uranium would then be removed from the solution using ion exchange technology in processing plants located at three separate sites. As proposed by HRI, a central plant would provide drying and packaging equipment for the entire project.

The Draft Environmental Impact Statement (DEIS) for the proposed action was prepared by an interagency review group comprising staff from the Nuclear Regulatory Commission, the Bureau of Indian Affairs, and the Bureau of Land Management, and published in October 1994. After evaluating the environmental impacts of the proposed action in the DEIS, the reviewing agencies concluded that the appropriate action was to issue the requested license and proposed leases authorizing HRI to proceed with the project. This FEIS reevaluates the proposed licensing action on the basis of written and oral comments received on the DEIS and on additional information obtained in 1995 and 1996. The FEIS describes and evaluates (1) the purpose of and need for the proposed action, (2) alternatives to the proposed action, (3) the environmental resources that could be affected by the proposed action and alternatives, (4) the potential environmental consequences of the proposed action and alternatives, and (5) the economic costs and benefits associated with the proposed action. Based on this assessment, the FEIS makes recommendations concerning the requested license and proposed leases.

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# SUMMARY AND CONCLUSIONS

This Final Environmental Impact Statement (FEIS) addresses the proposed action of issuing Hydro Resources, Inc. (HRI) a combined source and 11e(2) by-product material license from the Nuclear Regulatory Commission (NRC) and minerals operating leases for Federal and Indian lands from the Bureau of Land Management (BLM) and the Bureau of Indian Affairs (BIA). The license and leases would allow HRI to conduct in-situ leach (ISL) uranium mining, also known as solution mining, in McKinley County, New Mexico. By issuing the license and leases, NRC, BLM, and BIA would retain programmatic and regulatory oversight in administrative matters and would impose operating restrictions and specify monitoring, recordkeeping, and reporting requirements as conditions of the license and leases.

As summarized below, this FEIS describes the evaluation conducted concerning (1) the purpose of and need for the proposed action, (2) alternatives to the proposed action, (3) the environmental resources that could be affected by the proposed action and alternatives, (4) the potential environmental consequences of the proposed action and alternatives, and (5) the economic costs and benefits associated with the proposed action. The evaluation is based on a comprehensive review of HRI's license application, environmental reports, related submittals, independent information sources, and written and oral comments on the draft EIS.

On April 25, 1988, HRI submitted an application to the NRC proposing to construct and operate ISL facilities at its Church Rock site in McKinley County, New Mexico. HRI subsequently amended its proposal to address additional lease areas known as the Unit 1 and Crownpoint sites near Crownpoint, New Mexico, and to propose that central processing be conducted in a plant located at the Crownpoint site. At the Church Rock site, HRI's mineral rights include 65 hectares (ha) (160 acres) of patented mining claims in Section 8, T16N R16W, and 80 ha (200 acres) of private minerals operating leases in Section 17, T16N R16W. The Unit 1 site involves 512 ha (1280 acres) of allotted lands requiring minerals operating leases issued and held in trust for the Navajo allotees by the BIA. The Unit 1 site is located in Sections 15, 16, 21, 22, and 23, T17N R13W. The Crownpoint site, which involves 365 ha (912 acres) of private leases and claims areas, is located in Sections 19, 24, and 25, T17N R13W, and Section 29, T17N R12W.

The proposed project would be designed to extract a total of 19 million kg (42 million lb) of uranium reserves, at a maximum rate of approximately 1.5 million kg/year (3 million lb/year). HRI anticipates that uranium recovery activities at the Church Rock, Unit 1, and Crownpoint sites would last approximately 8, 17, and 19 years, respectively.

HRI proposes to construct well fields in areas of its claims and minerals operating leases selected for their economic ore reserves. Existing and new surface facilities at each site would be used as processing plants for extracting uranium from aqueous mining solutions. Groundwater in the Westwater Canyon Member of the Morrison Formation would be fortified with dissolved oxygen and sodium bicarbonate, then continuously recirculated to oxidize and dissolve uranium minerals. In the Crownpoint/Unit 1 area, the top of the Westwater Canyon is found at an average depth of approximately 560 m (1840 ft). In the Church Rock area, the top of the Westwater Canyon is found at depths ranging from 140 to 230 m (460 to 760 ft). The proposed mining process would use a pattern of injection and production wells drilled into the ore zone. Each production well would be pumped at about 95 L/min (Lpm) [25 gal/min (gpm)], and enough patterns would operate in each well field area to provide a maximum processing plant flow rate of 15,000 Lpm (4000 gpm). Before mining could occur at either the Unit 1 or Crownpoint site, HRI would be required to conduct a groundwater restoration demonstration at the Church Rock site. The demonstration would be conducted at a large enough scale to determine the number of pore volumes that would be required to restore a production-scale well field.

Uranium would be recovered from the mining solution in each processing plant by circulating it through ion exchange columns. The ion exchange columns would be alternately taken off line and the uranium stripped, precipitated, and concentrated. All uranium slurry produced would be dried using a single dryer located in the central processing plant at Crownpoint. Uranium slurry would be transported by truck from the satellite Church Rock and Unit 1 facilities to Crownpoint for drying. The Crownpoint processing plant would use an existing building constructed for earlier uranium mining. New satellite processing plants would be constructed at Church Rock and Unit 1. Approximately 2.5 ha (6 acres) of land would be cleared to construct each satellite plant, including buildings, storage and parking areas, and retention ponds.

HRI proposes that groundwater restoration criteria be established on a parameter-by-parameter basis, and that the primary goal of restoration be to return all parameters to average pre-mining baseline conditions (HRI 1996e). In the event that water quality parameters cannot be returned to average pre-mining baseline levels, the secondary goal would be to return water quality to the maximum concentration limits as specified in United States Environmental Protection Agency (EPA) secondary and primary drinking water regulations (40 CFR § 141 and 143.3). For barium and fluoride, the secondary restoration goal would be set to the State of New Mexico primary drinking water standard. For uranium, 300 pCi/mL (0.44 mg/L) would be used. This concentration was obtained from 10 CFR Part 20 and is suitable for unrestricted release of natural uranium to water.

HRI proposes to employ a two-stage treatment system for all liquid effluents. Treated water that meets groundwater standards would be recirculated in the aquifer during restoration, and then either reinjected into the Westwater Canyon sandstone in a location isolated from mine units or applied to the land using ordinary irrigation equipment. Most solid wastes that would be generated by the mining process are defined as 11e(2) byproduct material in the Atomic Energy Act of 1954, as amended, and would require disposal at an off-site licensed disposal facility.

After HRI concluded the mining operation and demonstrated complete aquifer restoration, the wells would be plugged and abandoned, processing facilities would be decontaminated or decommissioned, all contaminated materials would be removed to a licensed waste disposal site, and all disturbed areas would be surveyed, decontaminated to acceptable levels, recontoured, revegetated, and released for unrestricted use.

This FEIS evaluates four alternatives. Under Alternative 1 (the proposed action), the NRC would issue HRI a license for the construction and operation of facilities for ISL uranium mining and processing at the Church Rock, Unit 1, and Crownpoint sites as proposed by HRI in the license application and related submittals. Under Alternative 2 (modified action), the NRC would issue HRI a license for the construction and operation of facilities for ISL uranium mining and processing as proposed by HRI, but at alternative sites and/or using alternative liquid waste disposal methods. Under Alternative 3 (the NRC staff-recommended action), the NRC would issue HRI a license for the construction and operation of facilities for ISL uranium mining and processing as proposed by HRI, but with additional measures required and recommended by NRC staff to protect public health and safety and the environment. Under Alternative 4 (no action), the NRC would not issue HRI a license for the construction and operation of facilities for ISL uranium mining and processing at the Church Rock, Unit 1, or Crownpoint sites.

This FEIS evaluates the potential environmental impacts of the proposed action, modified action, NRC staff-recommended action, and no action. The evaluation is based on the requirements of the National Environmental Policy Act (NEPA) of 1969 as amended, NRC's "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions" (10 CFR Part 51), and BLM's "Surface Exploration, Mining, and Reclamation of Lands" (25 CFR Part 216) and "Solid Minerals Exploration and Mining Operations" (43 CFR Part 3590).

On the basis of its independent review, the NRC staff concludes that the potential significant impacts of the proposed project can be mitigated, and that HRI should be issued a combined source and 11e(2) by-product material license from NRC and minerals operating leases from BLM and BIA. However, the license and leases should be conditioned on the commitments made by HRI in its license application and related submittals (see Appendix B) and the various NRC staff mitigation requirements and recommendations discussed in Section 4 and Appendix B.

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AAI | American Ag International |
| AIRFA | American Indian Religious Freedom Act |
| ALARA | as low as reasonably achievable |
| ASTM | American Society for Testing and Materials |
| ASME | American Society of Metallurgical Engineers |
| BIA | Bureau of Indian Affairs |
| BLM | Bureau of Land Management |
| CEQ | Council on Environmental Quality |
| CFR | Code of Federal Regulations |
| dB | decibel |
| dB(a) | decibel (auditory) |
| DEIS | Draft Environmental Impact Statement |
| EIS | Environmental Impact Statement |
| ER | Environmental Report |
| EMS | emergency medical service |
| EPA | U.S. Environmental Protection Agency |
| HCI | hydrochloric acid |
| HDPE | high-density polyethylene |
| HRI | Hydro Resources, Inc. |
| FWS | U.S. Fish and Wildlife Service |
| IHS | Indian Health Service |
| ISL | in-situ leach |
| IX | ion exchange |
| MSHA | U.S. Mine Safety and Health Administration |
| NAAQS | National Ambient Air Quality Standards |
| NCRP | National Council of Radiation Protection |
| NEPA | National Environmental Policy Act |
| NMED | State of New Mexico Environmental Department |
| NMSS | NRC Office of Nuclear Material Safety and Safeguards |
| NNEPA | Navajo Nation Environmental Protection Agency |
| NPDES | National Pollution Discharge Elimination System |
| NRC | U.S. Nuclear Regulatory Commission |
| NRCS | National Resource Conservation Service |
| NTUA | Navajo Tribal Utility Authority |
| NWS | National Weather Service |
| PM-10 | particulates <10 microns in diameter |
| PSD | prevention of significant deterioration |
| PVC | polyvinyl chloride |
| QA | quality assurance |
| RCRA | Resource Conservation and Recovery Act |
| R#W | Range # West |
| SCS | U.S. Soil Conservation Service |
| SDWA | Safe Drinking Water Act |

| | |
|---|---|
| TDS | total dissolved solids |
| TEDE | total effective dose equivalent |
| TVA | Tennessee Valley Authority |
| T#N | Township # North |
| UCL | upper control limit |
| UIC | underground injection control |
| UNC | United Nuclear Corporation |
| USDW | underground source of drinking water |
| WQA | New Mexico Water Quality Act |

# UNITS OF MEASURE AND METRIC CONVERSIONS

| | |
|---|---|
| acre | 43,560 $ft^2$ |
| acre-foot | 43,560 $ft^3$; 325,829 gal; 1.2 million L |
| Bq/g | 2.7E-5 µCi/g; 27.027 pCi/g |
| centimeter | 0.39 in. |
| cubic foot | 7.48 gal; 28.3 L |
| cubic meter | 35.3 $ft^3$ |
| C/kg (coulomb) | 2.58E-4 roentgen<br>2.58E-10 µR |
| fg/$m^3$ | femtogram (E-15 g) per cubic meter |
| hectare (ha) | 10,000 $m^2$; 2.47 acres |
| kilogram | 2.20 lb |
| kilometer | 0.62 miles |
| liter | 0.26 gal |
| MBq | 2.7E-5 Ci<br>2.7E7 pCi |
| meter | 3.28 ft |
| millisievert | 100 mrem |
| pCi/l | E-9 µCi/ml |
| pCi/g | E-6 µCi/g |
| Sievert | 100 rem |
| tonne | 1,000 kg (2,200 lbs) |

# 1. PURPOSE OF AND NEED FOR THE PROPOSED ACTION

## 1.1 INTRODUCTION

Under the Atomic Energy Act of 1954 as amended, the Nuclear Regulatory Commission (NRC) has statutory responsibility for the protection of public health and safety and the environment related to source nuclear material (defined as uranium and/or thorium in any form, or ores containing 0.05 percent or more by weight of uranium and/or thorium). One portion of NRC's responsibility is to issue source material licenses to "receive title to, receive, possess, use, transfer, or deliver any source material after removal from its place of deposit in nature" (10 CFR § 40.1 and 40.3).

On April 25, 1988, Hydro Resources, Inc. (HRI), submitted an application to the NRC for a source material license to produce uranium commercially using in-situ leach (ISL) mining (also known as solution mining) at its Church Rock property in McKinley County, New Mexico (Figure 1.1). On May 8, 1989, HRI amended its application to include uranium recovery processing at an existing mine facility in Crownpoint, New Mexico (Figure 1.1). On April 23, 1992, HRI amended its application to include ISL mining on allotted lands known as Unit 1 west of the existing facility at Crownpoint (Figure 1.1). On July 31, 1992, HRI amended its application to include ISL mining on lands associated with the existing facility in Crownpoint (Figure 1.1). HRI's proposal to conduct ISL mining and processing at the Church Rock, Unit 1, and Crownpoint sites is referred to collectively as the Crownpoint Uranium Solution Mining Project.

Pursuant to 10 CFR Part 51, NRC's regulations for implementing the National Environmental Policy Act of 1969 (Public Law 91-190) (NEPA), the NRC published the *Draft Environmental Impact Statement to Construct and Operate the Crownpoint Uranium Solution Mining Project, Crownpoint, New Mexico* (NUREG-1508) in October 1994. The draft environmental impact statement (DEIS) was prepared by an interagency review group consisting of the NRC and two Federal cooperating agencies, the Bureau of Land Management (BLM) and the Bureau of Indian Affairs (BIA).

## 1.2 DESCRIPTION OF THE PROPOSED ACTION

The proposed action by the NRC is to issue HRI a source material license for the construction and operation of facilities for ISL uranium mining and processing at the Church Rock, Unit 1, and Crownpoint sites. The proposed action by the BLM and BIA is to grant HRI minerals operating rights and leases on the Federal and Indian lands on which the proposed project would be located. Section 2.1 of this FEIS contains a description of HRI's proposed facilities and operations at each site.

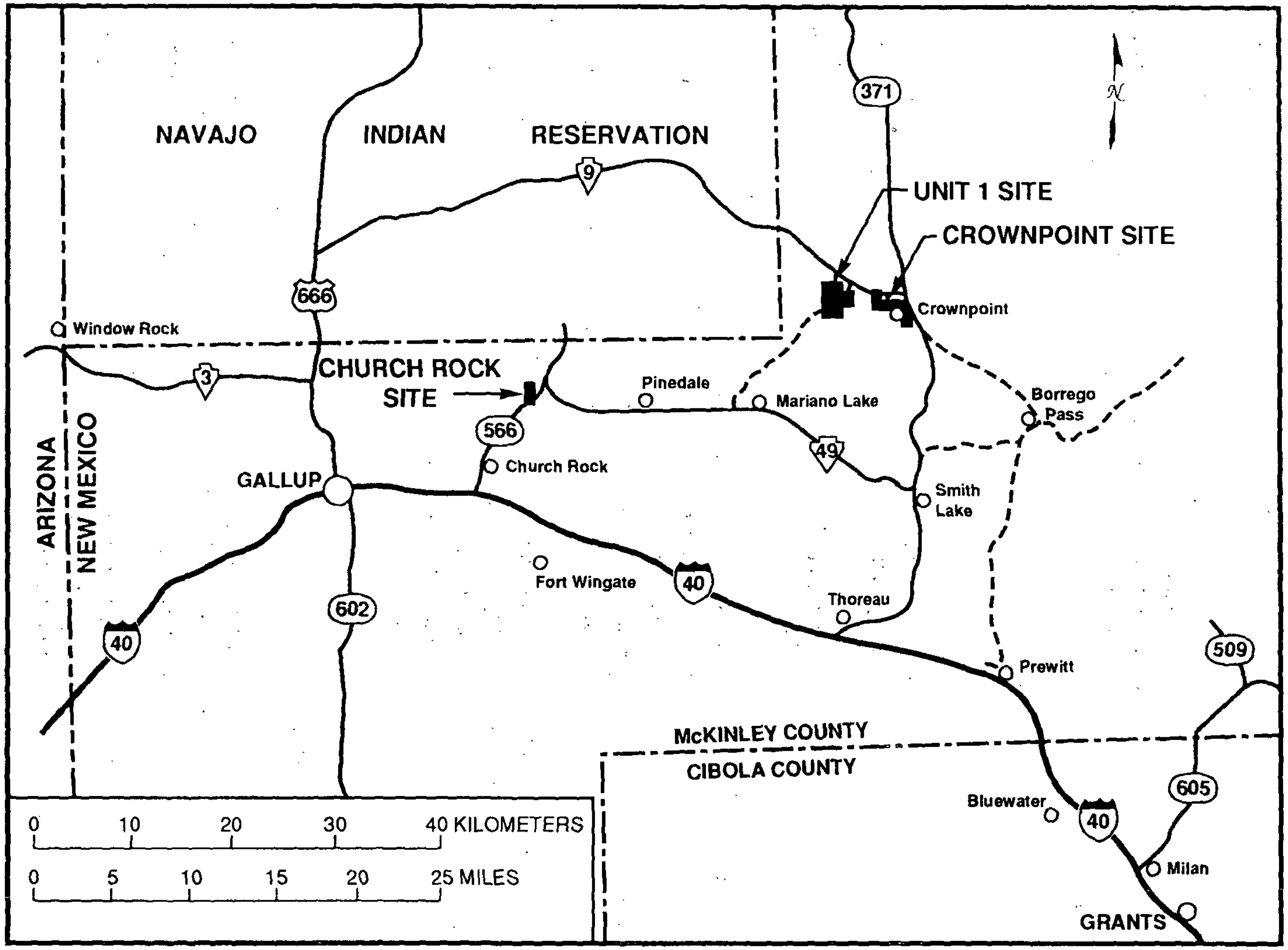


Figure 1.1. Regional index map of west-central New Mexico and the project site locations.

## 1.3 PURPOSE OF AND NEED FOR THE PROPOSED ACTION

The purpose of the proposed action is to license and regulate HRI's proposal to construct and operate facilities for ISL uranium mining and processing. The NRC's need for action is to fulfill its statutory responsibility to protect public health and safety and the environment in matters related to source nuclear material (Atomic Energy Act of 1954 as amended). The BLM and BIA's need for action is to fulfill their statutory responsibilities to regulate mining activities on Federal and Indian lands (Mining Law of 1872, Allotted Lands Mineral Leasing Act of 1909, Mineral Leasing Act of 1920, National Historic Preservation Act of 1966, Endangered Species Act of 1973, Federal Land Policy and Management Act of 1976).

## 1.4 SCOPE OF THE EIS

Under NEPA, Federal agencies must consider the effects of their actions on the environment. Section 102(1) of NEPA requires that the policies, regulations, and public laws of the United States be interpreted and administered in accordance with the policies set forth in the Act. It is the intent of NEPA to have Federal agencies incorporate consideration of environmental issues and allow public input into their decision-making processes.

NRC's regulations for implementing NEPA are contained in 10 CFR Part 51. To fulfill its responsibilities under NEPA, NRC published the *Draft Environmental Impact Statement to Construct and Operate the Crownpoint Uranium Solution Mining Project, Crownpoint, New Mexico* (NUREG-1508) and conducted public comment meetings on the DEIS. This FEIS analyzes the environmental impacts and economic costs of the proposed action and of alternatives to the proposed action and incorporates revisions in response to public and agency comments on the DEIS. Appendix A of this FEIS contains responses to the public and agency comments. The FEIS addresses potential impacts to the following resources: air quality, geology and soils, hydrology (including groundwater and surface water), ecology, land use, socioeconomics, aesthetics, cultural resources, and environmental justice. The FEIS also evaluates transportation risk, health physics and radiological impacts, and includes a cost/benefit analysis for the proposed action.

## 1.5 SCOPING PROCESS

The NRC, BLM, and BIA initiated a scoping process to identify significant issues to be addressed in the DEIS in 1992. A Notice of Intent to prepare the DEIS was published in the *Federal Register* (57 FR 39326) on August 28, 1992. Two public scoping meetings were held on September 24, 1992, in Window Rock, Arizona, and Crownpoint, New Mexico. At these meetings, NRC, BLM, and BIA described their review procedures and responsibilities, and HRI representatives described the proposed project. State, local, and tribal government agency representatives and concerned local citizens also made statements and asked questions at the meetings.

The NRC received one letter commenting on the scope of the DEIS. The NRC, BLM, and BIA considered the oral and written comments in determining the scope of the DEIS.

The NRC conducted three public comment meetings to solicit oral and written comments on the DEIS. Two public comment meetings were held in Crownpoint, New Mexico, on February 22, 1995, and one was held in Church Rock, New Mexico, on February 23, 1995. A total of 76 participants provided oral comments at the meetings, and the NRC received 52 sets of written comments. Responses to written comments are provided in Appendix A of this FEIS, and revisions in response to both oral and written comments have been incorporated in the FEIS text as appropriate.

The NRC staff met Federal requirements for providing information and making the DEIS available, and in some cases exceeded the requirements by providing additional copies of the DEIS and translators at all meetings and extending the comment period to accommodate members of the public. The NRC acknowledges that the technical information contained in the DEIS is difficult to understand, especially for native speakers of languages other than English, and that language barriers may have prevented some people from becoming informed about the proposed action and from commenting on the DEIS. Nevertheless, many people did comment and those comments are addressed in Appendix A and reflected in revisions made throughout this FEIS. In the context of environmental justice, addressed in a U.S. Presidential executive order and NRC guidelines, and because so many people have shown their interest in the EIS process, additional reasonable efforts to facilitate communication between the public and the NRC are being made. These efforts include wider distribution of this FEIS, and, to provide information to more local people, translating a summary of the FEIS into Navajo on video.

## 1.6 COOPERATING AGENCIES

The BLM and BIA are serving as cooperating agencies in the NEPA assessment and licensing/leasing process for the proposed project. These agencies are involved because they have jurisdiction over the minerals operating rights and leases on Federal and Indian lands that HRI would need for the proposed project. As discussed in Section 1.3, the BLM and BIA's need for action is to fulfill their statutory responsibilities to regulate mining activities on Federal and Indian lands.

The authority of the BLM and BIA is described in 43 CFR Part 3590 and 25 CFR Part 216, which address approving proposed minerals operating leases involving Indian trust and allotted lands. Additionally, the proposed project would involve land for which the surface is held in trust for the Navajo Nation, but the mineral rights are held by others. Under NEPA and as a Trustee of Indian Lands, BIA must adequately analyze and disclose the environmental impacts of the proposed project to determine whether mining leases should be approved. BLM's authority is limited to the Federal and Indian lands involved in this project.

## 1.7 OTHER STATE AND FEDERAL AGENCIES

The State of New Mexico Environmental Department (NMED) has authority under the Safe Water Drinking Act (SWDA) that stems from a grant of primacy from EPA for administering underground injection control (UIC) programs in New Mexico, excluding Indian country (40 CFR Part 147, Subpart GG). The State's authority under the SWDA does not extend to any parts of the proposed project that would be in Indian country, such as allotments, land held in trust for the Navajo Nation, and land within a dependent Indian community, where EPA retains authority over UIC permitting. EPA Region IX administers the Federal UIC program for all Navajo Indian country. Currently, there are disputes over the jurisdictional status of some of the project area, and similar conflicts may arise regarding other project areas.

For ISL uranium mining operations in Indian country (including Navajo Indian country) in New Mexico, HRI would have to obtain a Class III injection well permit and an aquifer exemption from EPA requiring aquifer clean-up and monitoring that protects surrounding underground sources of drinking water (USDW), as specified by EPA. In addition, HRI would be required to implement mechanical integrity test procedures for all wells, to obtain surety bonds for groundwater restoration and closure of the mines, and to plug and abandon wells used in the project in accordance with an approved plan.

For ISL uranium mining operations outside Indian country in New Mexico, HRI would have to obtain a Class III injection well permit and a temporary aquifer designation from the State (which must be approved by EPA) requiring that groundwater quality be restored to background conditions after mining is completed.

# 2. ALTERNATIVES INCLUDING THE PROPOSED ACTION

This FEIS evaluates four alternatives:

- Alternative 1 (the proposed action): issue HRI a license for the construction and operation of facilities for ISL uranium mining and processing at the Church Rock, Unit 1, and Crownpoint sites as proposed in the license application and related submittals;
- Alternative 2 (modified action): issue HRI a license for the construction and operation of facilities for ISL uranium mining and processing as proposed by HRI, but at alternative sites and/or using alternative liquid waste disposal methods;
- Alternative 3 (the NRC staff-recommended action): issue HRI a license for the construction and operation of facilities for ISL uranium mining and processing as proposed by HRI, but with additional measures required and recommended by the NRC staff to protect public health and safety and the environment; and
- Alternative 4 (no action): do not issue HRI a license for the construction and operation of facilities for ISL uranium mining and processing at the Church Rock, Unit 1, or Crownpoint sites.

These alternatives are described in detail in Sections 2.1, 2.2, 2.3, and 2.4. The assessments described in this FEIS were performed to evaluate a limited number of developmental and operational alternatives proposed by HRI for the purpose of evaluating potential environmental impacts. Other acceptable developments or operational alternatives are not precluded, but have not been fully assessed in connection with this licensing action. Requests for changes or additions beyond the alternatives evaluated in this FEIS would require additional assessment to determine their acceptability.

This FEIS does not evaluate alternative uranium mining methods. The DEIS determined that surface and open pit mining are not reasonable alternatives because the ore bodies at the proposed sites are too deep to be extracted economically. Further, underground mining would have more significant environmental impacts than ISL mining, and the ore from underground mining would require processing at a conventional uranium mill to produce the final product. Significant quantities of tailings (residual rock materials after uranium removal) would be produced by conventional milling, which are normally disposed of on-site at the conclusion of the mill's operating life. NUREG-0706, *Final Generic Environmental Impact Statement on Uranium Milling* (NRC 1980a), provides a detailed evaluation of impacts associated with tailings disposal from conventional uranium milling. The environmental impacts of underground mining and conventional milling would be more severe than those of ISL mining. Consequently, underground mining and conventional milling are not evaluated in this FEIS.

## 2.1 ALTERNATIVE 1 (THE PROPOSED ACTION)

The proposed action for the NRC is to issue HRI a license to construct and operate facilities for ISL uranium mining and processing at the Church Rock, Unit 1, and Crownpoint sites (Figure 1.1). Under HRI's proposal, the Church Rock and Unit 1 facilities would operate as satellite processing facilities, producing precipitated uranium slurry (also known as yellowcake slurry) for shipment by truck to the

Crownpoint site. The Crownpoint facility would operate as the central processing facility for the project, producing yellowcake slurry as well as drying and packaging the slurry from all three sites for final shipment. This section provides a summary of HRI's proposed project, including descriptions of the ISL process and facilities that would be used and the sites that would be developed.

### 2.1.1 Description of the Proposed ISL Process and Facilities

The ISL uranium recovery process proposed by HRI involves two primary operations. The first occurs in the well fields, where barren mining solution (a mixture of groundwater, oxygen, and bicarbonate known as lixiviant) would be injected through wells into an ore zone, and pregnant lixiviant (lixiviant that contains uranium) would be withdrawn from production wells. The second operation occurs at the processing plants, where uranium would be extracted from the pregnant lixiviant.

#### 2.1.1.1 Well Field Procedures and Equipment

Injection and production wells used for ISL mining would be drilled and constructed using standard mud-rotary drilling techniques for deep-water wells. In each well field, injection wells would be arranged near production wells as couplets or geometric patterns designed for optimal uranium recovery. Typical well fields exhibit a repeating five- or seven-spot pattern, where each production well is surrounded by four or six injection wells (Figure 2.1). HRI would consider the geometry of the ore body and surface topography to determine the appropriate well field patterns.

Designing, constructing, testing, and operating injection wells would be subjected to regulation primarily through the UIC program conducted by EPA and the State of New Mexico. The proposed program would require authorization from EPA and the State to use Class III injection wells. HRI's proposed methods and materials to construct injection, production, and monitoring wells are in general accordance with EPA requirements for Class III injection wells found in 40 CFR Part 146. The design and configuration of all wells would be consistent to ensure that each complies with requirements for injection.

At the Unit 1 and Crownpoint sites, injection and production well casings would be constructed using fiberglass or steel casing (HRI 1996a; HRI 1996c). Plastic polyvinyl chloride (PVC) casing would only be used at the Church Rock site (HRI 1996a). HRI's proposed casing specifications are discussed in Section 4.3.1 of this EIS.

Casings in injection, production, and monitoring wells would use centering stabilizers to maintain the casing in the center of the hole. Each well would be sealed against the rock formations by backfilling the annular space using an NRC-approved cement grout with a bentonite gel additive. Cement would be forced into the annulus from the bottom, and then forced to the surface to ensure a complete seal. HRI proposes to open each well by installing interval screens with casing, by under-reaming the casing and installing a telescoped screen, or by using perforated fiberglass casing (Figure 2.2).

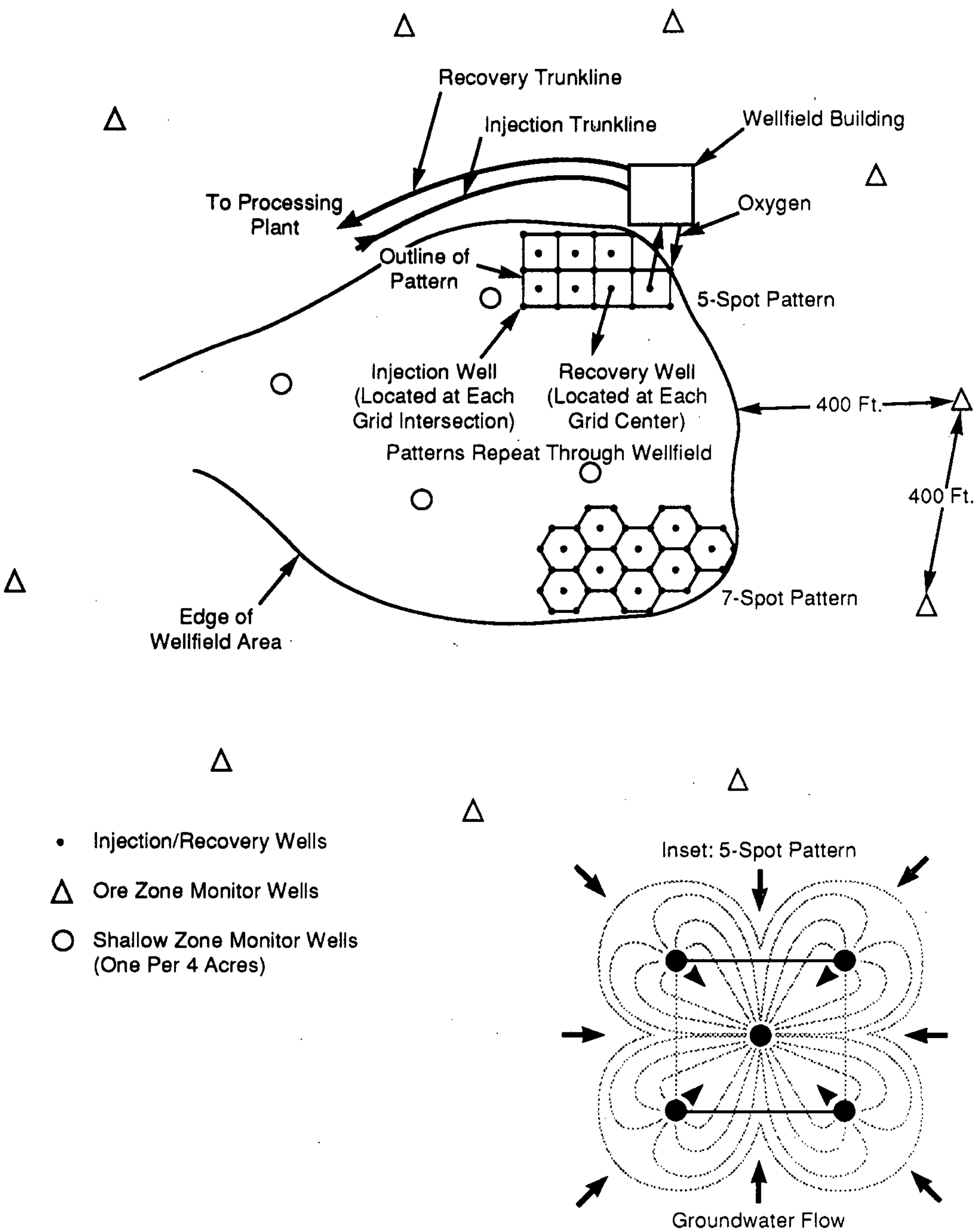


**Figure 2.1. Schematic diagram of a well field showing injection/production well patterns, monitor wells, manifold building, and pipelines.**

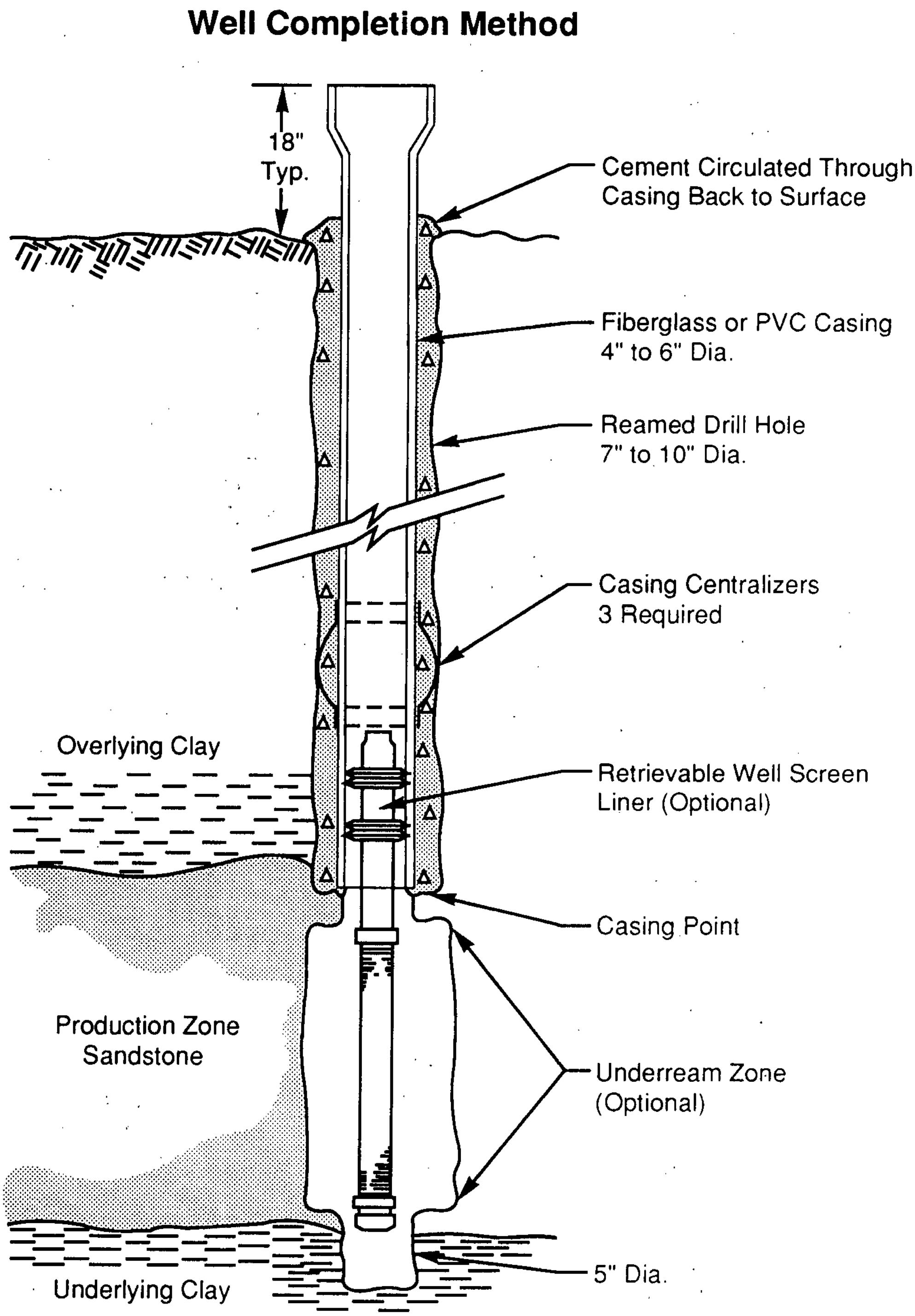


**Figure 2.2. Cross-section of a typical injection, production, or monitor well completed using the underreamed method.**

Each well would be tested for mechanical integrity before use. The purpose of the test is ensure that the well does not allow hydraulic communication between one aquifer and another. The test is designed to detect imperfections in the casing sections and inadvertent damage from underreaming, and to ensure that there are connections between sections and cement grout sealing the casing in place. HRI's proposed test consists of pressurizing the casing and monitoring it for pressure loss. HRI's proposed testing program would be required by NRC license condition.

Wells that do not pass integrity tests would be reworked and tested again. Wells repeatedly failing the integrity test would not be considered operational. In order to ensure the public health and safety, HRI would be required by license condition to plug and abandon all such holes in accordance with New Mexico State Engineer requirements.

HRI proposes to use high-density polyethylene (HDPE) for its well field distribution pipelines, which would lie mainly on the surface. This construction technique would expedite routine inspections, early leak detection, and repairs. At road crossings or other high-traffic areas, pipelines would be encased in steel culverts and buried. The proposed pipe material exhibits high chemical resistance and is suitable for operating pressure up to 265 psi and operating temperature from below freezing to approximately 80°C (180°F). Solution mining typically involves injection pressure of less than 100 psi and operating temperatures between 13 and 38°C (55 and 100°F). The operating temperature and processing flow rate would prevent freezing in the surface pipelines during winter.

All well field piping would be housed in containment buildings or buried at least 0.5 m (20 in.) below the surface. Typically, each well would be connected to the respective injection or production manifold using polyethylene or PVC pipe and fittings. Manifolds, located in small containment buildings, would direct solution between individual wells and pipelines to the recovery plant. Meters and control valves in individual well lines would monitor and control flow rates and pressures for each well. Additionally, the entire injection and production system would be metered on the trunk lines for continuous monitoring in the processing plant. This system would be pressure-tested for mechanical integrity in a fashion similar to the wells.

### 2.1.1.2 Lixiviant Chemistry

Uranium, present in the aquifer in a reduced insoluble form, would be oxidized and dissolved by the lixiviant solution injected into the ore zone. Once uranium is oxidized, it easily complexes with bicarbonate anions in the groundwater and becomes mobile. Table 2.1 shows the anticipated concentrations of the principal chemical species in HRI's pregnant lixiviant from the well fields for processing.

HRI proposes to use a lixiviant solution composed of bicarbonate ion complexing agents and added dissolved oxygen. Uranium compounds contained in mineralized grain coatings would first become oxidized (Table 2.2, reaction 1). The oxidized uranium would react with the lixiviant to form either a soluble uranyl tricarbonate complex, shown in reaction 2a, or a bicarbonate complex, shown in reaction 2b.

**Table 2.1. Anticipated concentrations of principal chemical species in HRI's pregnant lixiviant from the well fields for processing**
[Data are from HRI 1993a, test data, and operational licensing experience.]

| Chemical species | Concentration (mg/L) |
|---|---|
| Calcium | 100–350 |
| Magnesium | 10–50 |
| Sodium | 500–1600 |
| Potassium | 25–250 |
| Carbonate | 0–500 |
| Bicarbonate | 800–1500 |
| Sulfate | 100–1200 |
| Chloride | 250–1800 |
| Nitrate | <0.01–0.2 |
| Fluoride | 0.05–1 |
| Silica | 25–50 |
| Total dissolved solids | 1500–5500 |
| Uranium | 50–250 |
| Radium-226 (pCi/L) | 1000 |
| **Other parameters** | |
| Conductivity ($\mu$mhos/cm) | 2500–7500 |
| pH (standard units) | 7.0–9.0 |

**Table 2.2. Principal chemical reactions taking place in the ore body during uranium oxidation**

(1) $2UO_2 + O_2 \longrightarrow 2UO_3$
(2a) $UO_3 + Na_2CO_3 + 2NaHCO_3 \longrightarrow UO_2(CO_3)_3^{4-} + 4Na^+ H_2O$
(2b) $UO_3 + 2NaHCO_3 \longrightarrow UO_2(CO_3)_2^{2-} + 2Na^+ + H_2O$

HRI would pump uranium-enriched pregnant solution from production wells to the processing plants for uranium extraction by ion exchange. The resulting barren lixiviant would then be chemically refortified and reinjected into the well field to repeat the leaching cycle.

HRI anticipates using production flow rates of 9500 to 11,500 Lpm (2500 to 3000 gpm) at each ion exchange plant. Potential emissions at each plant were conservatively modeled assuming a maximum flow rate of 15,000 Lpm (4000 gpm), and HRI would be restricted from exceeding this rate by license condition. Maximum injection pressures to be used in each of the mine areas would be determined when the operating wells are completed. The approximate values of allowable surface (well head) pressures for each area are 2075 kPa (301 psi) at the Crownpoint and Unit 1 sites and 807 kPa (117 psi) at the Church Rock site (HRI 1996a). During normal operations, production rates would be controlled to approximately 1 percent of the production fluid stream. The production bleed would reduce the hydraulic pressure within the mine-unit aquifer and prevent mining solutions from migrating outward.

#### 2.1.1.3 Processing Plant Facilities

At each of the three sites, HRI proposes both to build new facilities and/or to convert existing surface facilities from former underground mines into ISL processing plants. Uranium recovery would require columns containing ion exchange resin, vessels to store various solutions, piping, and pumps. The proposed process flow involves pumping lixiviant through the ion exchange columns and then returning it to the injection circuit. The ion exchange system would be operated in a closed system under low pressure. When uranium is removed from the resins, the concentrated uranium solution would be stored in precipitation tanks. The yellowcake slurry that would be produced in the precipitation tanks (and trucked from the Church Rock and Unit 1 facilities to the Crownpoint facility) would then enter a drying and packaging process at the Crownpoint facility. In the drying and packaging process, the yellowcake slurry would be dewatered, washed, dried, and packaged for storage and final shipment.

HRI's processing facilities would include the following major structures:

- a processing plant, in which uranium extraction and precipitation equipment would be located;
- at the Crownpoint facility, a dryer building that would house the yellowcake dryer and drum packing unit;
- waste retention ponds;
- wastewater treatment facilities; and
- administrative offices, laboratories, and workshops.

The satellite processing facilities at Church Rock and Unit 1 would produce only yellowcake slurry, but the Crownpoint plant would also include drying and packaging equipment (Figure 2.3). Under an NRC license condition, all yellowcake would be stored inside the restricted area. Liquid oxygen tanks would be located in the well fields. Other chemical storage tanks would be located on the concrete pad near a waste retention pond.

The main (Crownpoint) and satellite (Church Rock and Unit 1) processing plants would contain various vessels to hold and process liquid solutions. The principal vessels would include ion exchange columns, elution columns, and yellowcake precipitation tanks. Other surge tanks would hold barren lixiviant before its injection in the well fields, barren eluant, and yellowcake slurry. HRI's proposal includes general specifications for all vessels and piping. The specifications cite applicable American Society for Testing and Materials (ASTM) standards for plastic and fiberglass components, and American Society of Metallurgical Engineers (ASME) guides for all steel vessels that would be operated under pressure.

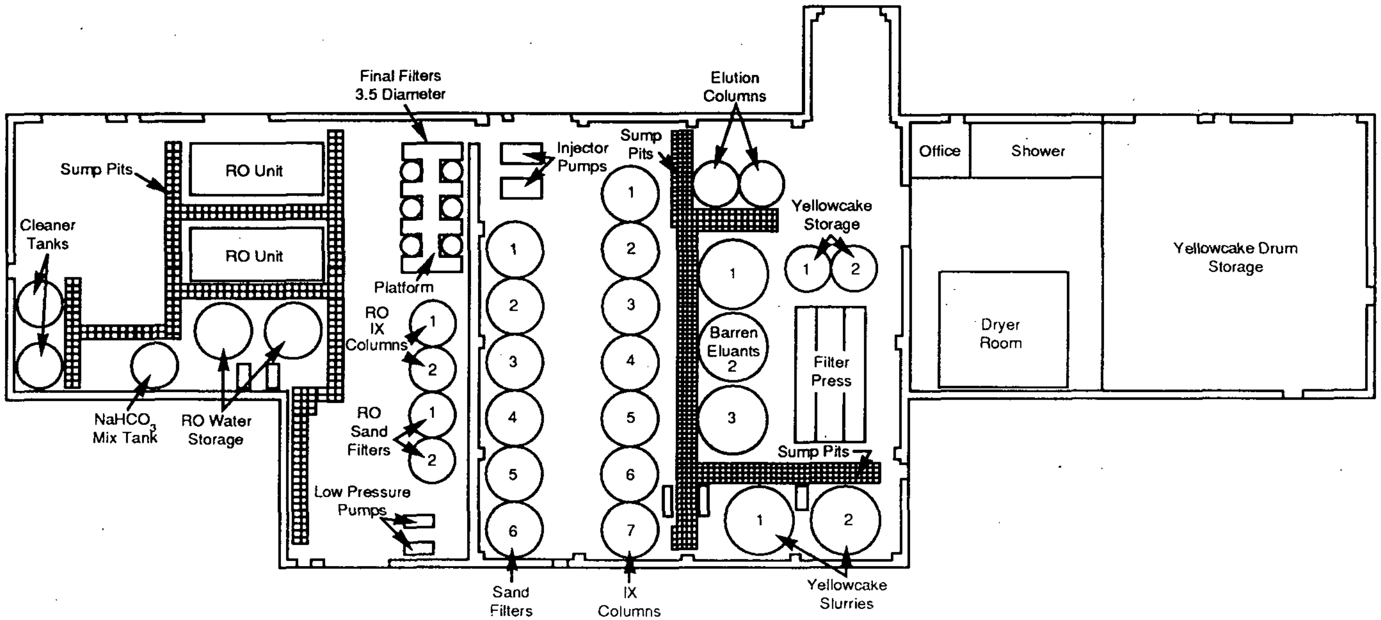


**Figure 2.3. Layout of the main processing plant. Satellite ion exchange plants would be identical, but without the dryer and yellowcake storage area.**

The processing plants would be constructed on concrete pads 20 cm (8 in.) thick with curbs 15 cm (6 in.) high. HRI designed the foundation to retain the fluid contents of the largest vessel on the pad. According to that design, the foundation would be constructed with sumps and drains to catch and retain potential spills inside the plant. Thicker footings would be provided where heavy processing equipment and vessels would be located. The curb would be designed to confine and hold potential spills in the plant, so they could be pumped into storage tanks or retention ponds.

### 2.1.1.4 Uranium Recovery Process

During the solution mining process, HRI would add oxygen to groundwater. Combined with naturally occurring and added bicarbonate ions in the groundwater, this solution, known as lixiviant, would be pumped down injection wells into the mineralized zones where it would dissolve uranium from the sandstone formation (Figure 2.4). The uranium-bearing solution would migrate through the pore spaces found in the sandstone, and would be recovered from production wells. The uranium would then be extracted in the processing plant, and the leaching solution would be recharged and reused.

Uranium solution would be transferred from mining units to ion exchange equipment in the processing plants. The process, schematically illustrated in Figure 2.5, would involve an ion exchange circuit, an elution circuit, and precipitation and drying.

During mining, the well field water would be enriched with uranium and other minerals associated with the ore. Earlier licensing experience indicates that concentrations of trace metals such as arsenic, selenium, vanadium, iron, manganese, and radium may become elevated during the leaching process. Uranium concentration in the pregnant lixiviant from individual production wells could exceed 100 mg/L. The nominal concentration in lixiviant would be 60 mg/L. Once the solution reaches the plant, it would be processed through the three circuits discussed above.

In the ion exchange circuit, the solution would be stored in a surge tank or pumped directly into a series of ion exchange columns. The uranium would be absorbed by ion exchange onto resin beads. The resulting barren solution exiting the ion exchange columns would be recharged with sodium bicarbonate if needed, distributed back to the well fields, and injected with oxygen for further uranium recovery.

As resins in an ion exchange column become saturated with uranium, the column would be taken off-stream for the elution circuit. In the processing plants, resin could either be eluted in its ion exchange column or transferred to an elution tank. During elution, the uranium would be stripped by flushing the resin beads with concentrated brine solution. The resin beads, then virtually free of uranium, would be replaced in an ion exchange column for reuse. The resulting pregnant eluant, which would contain the uranium stripped from the resin beads, would be discharged into a holding tank. The concentration of uranium in the pregnant eluant would be approximately 20,000 mg/L. When a sufficient volume of pregnant eluant is held in storage, the final precipitation and drying circuit would begin.

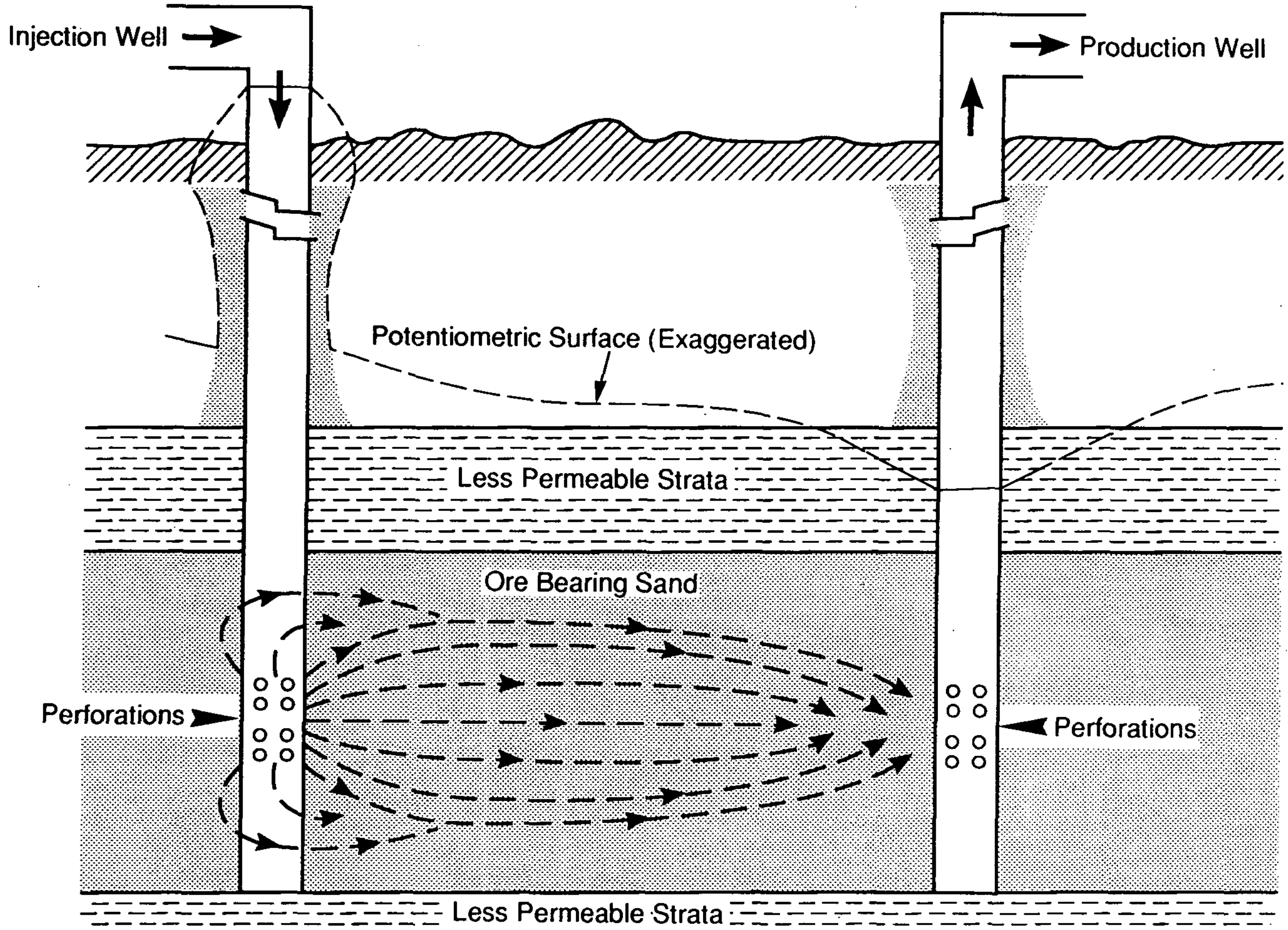


**Figure 2.4. Schematic cross-section illustrating ore-zone geology and lixiviant migration from an injection well to a production well.**

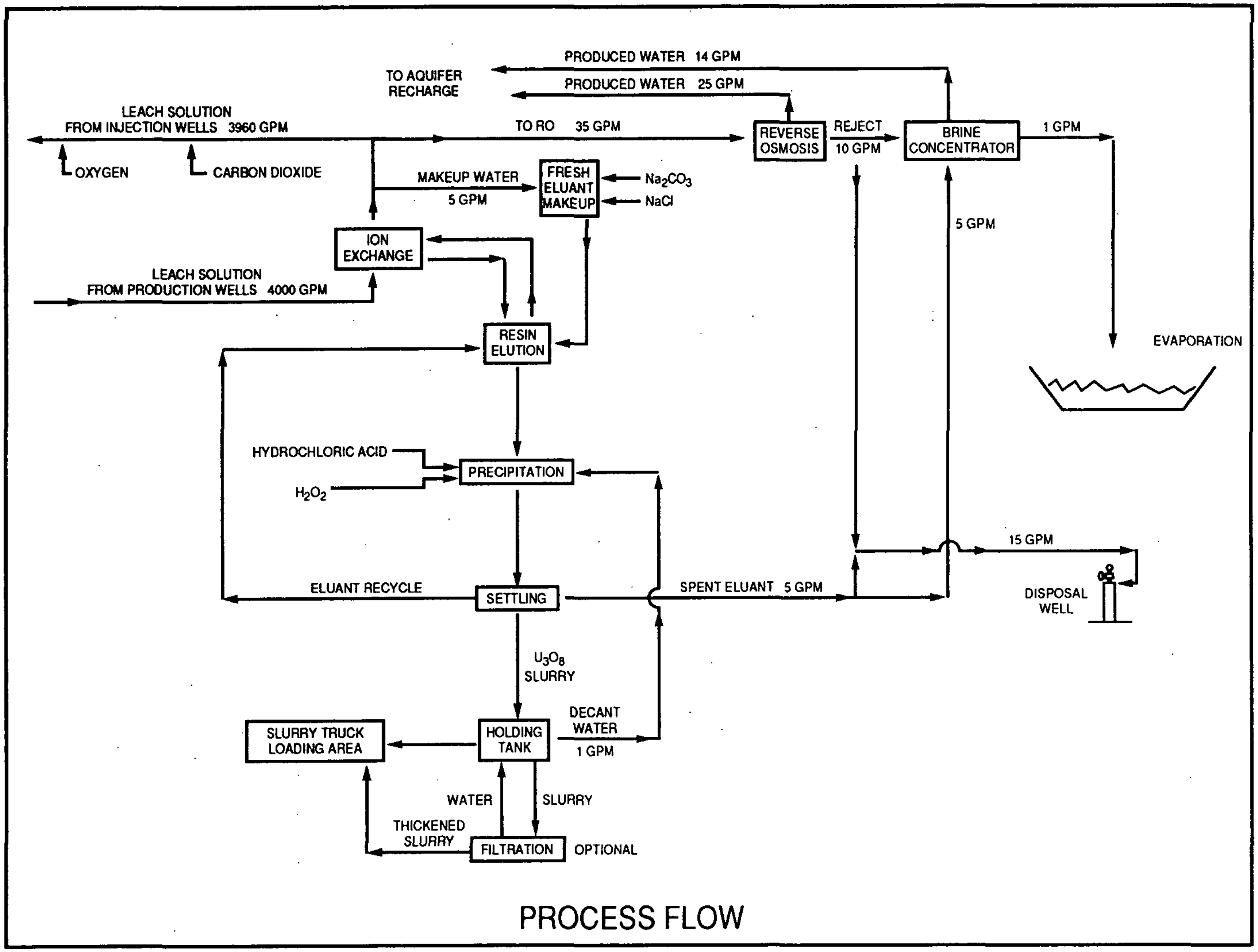


**Figure 2.5. Schematic flow diagram of the ISL uranium recovery process.**

Pregnant eluant would be acidified using hydrochloric acid (HCl) to destroy the uranyl carbonate complex. Hydrogen peroxide would then be added to the solution to precipitate the uranium. The precipitated uranyl peroxide ($UO_4$ or yellowcake) slurry might require pH adjustment, and then would be allowed to settle. The now-barren eluant would be recycled, and the yellowcake slurry would be transported by truck to the Crownpoint facility. At the Crownpoint facility, yellowcake would be further dewatered and washed using a filter press and then dried. Water left over from dewatering and drying would either be reused in the elution circuit or directed to a wastewater retention pond. HRI's proposed operations would result in a maximum yearly production rate of 3 million lb of yellowcake.

At the satellite ion exchange plants, the resins would be eluted and the uranium precipitated and filtered. The resulting yellowcake slurry would be transported by truck to the main Crownpoint facility for drying (Figure 2.6). HRI's proposal indicates yellowcake would be transported to the Crownpoint processing plant in sole-use semitrailer tankers designed and placarded for this purpose, in accordance with U.S. Department of Transportation requirements.

### 2.1.1.5 Waste Retention Ponds

The purpose of retention ponds is to store wastewater until treatment, promote evaporative loss of water which cannot be discharged to the environment, and maintain control of source and 11e(2) by-product material found in the liquid effluents from solution mining. HRI proposes to use three waste retention ponds at each processing site. These ponds, which would occupy approximately 2.5 ha (6 acres) each, would be constructed below ground level to maintain all processing solutions below grade. HRI commits to designing and constructing its pond embankments to meet specifications in NRC Regulatory Guide 3.11, *Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills* (NRC 1977a), in the event that pond operating levels above grade are required. HRI would be required by license condition to perform and document inspections of the pond embankments, fences, and liners, as well as measurements of pond freeboard and checks of the leak detection system.

The ponds would have double synthetic liners and an intervening layer up to 18 cm (6 in.) thick containing sand and perforated piping forming an underdrain leak detection system. An acceptable design alternative would eliminate the intervening sand blanket, replacing it with synthetic grid material.

If increased waste storage and evaporation pond capacity becomes necessary, HRI would be required either to provide additional pond area, or to construct the ponds with above-grade embankments and storage levels. Therefore, HRI would be required by license condition to maintain fluid levels below grade, or to construct its ponds in accordance with NRC Regulatory Guide 3.11, *Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills* (NRC 1977a), or other acceptable design criteria.

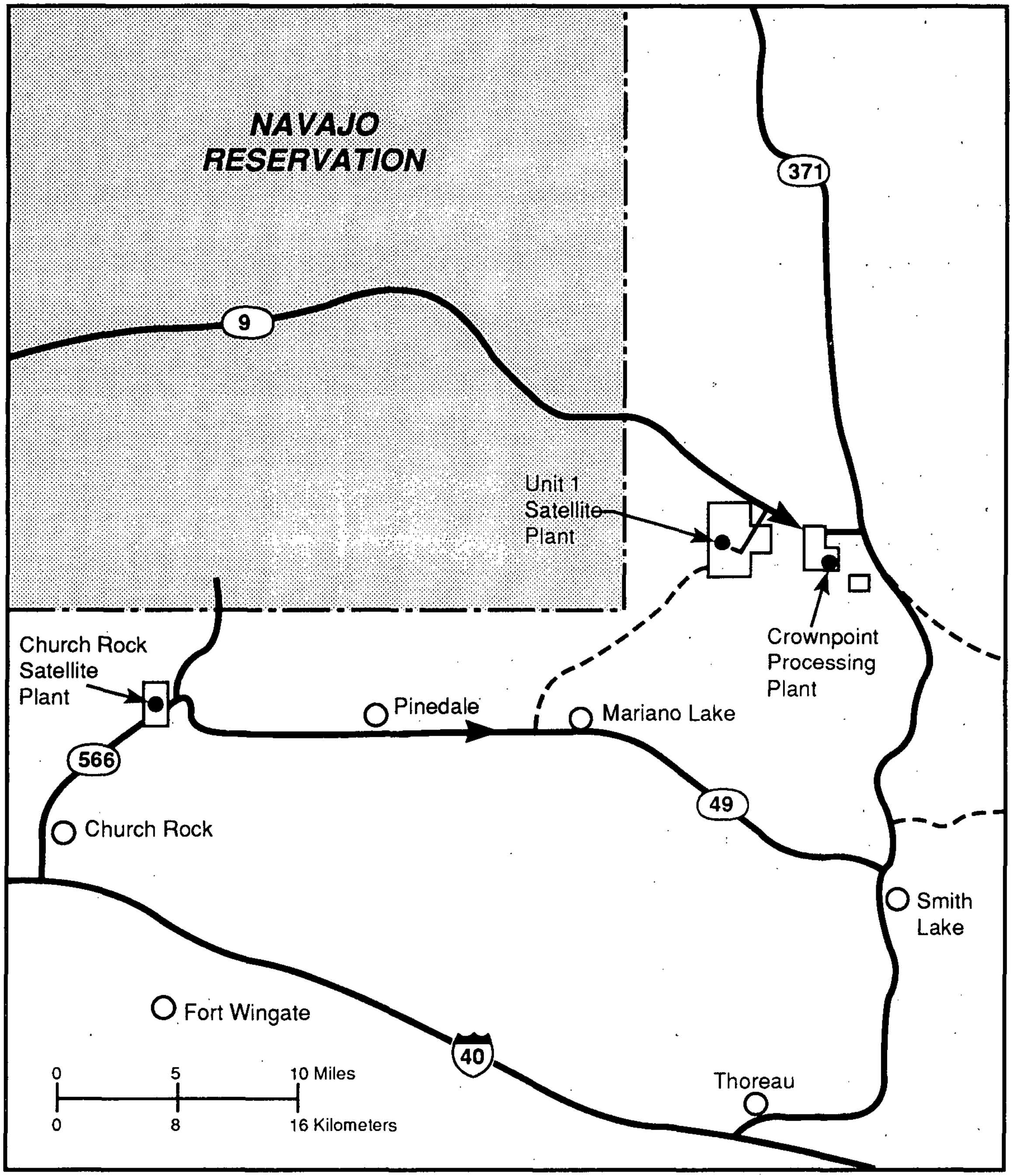


**Figure 2.6. Haul routes for yellowcake slurry from satellite plants to the Crownpoint plant.**

#### 2.1.1.6 Instrumentation

HRI would monitor its production system in both the well fields and the processing plants. The metering system would permit continuous pressure monitoring on both the injection and production pipeline systems, and would provide audible alarms for plant operators in the event of leaks or ruptures. Formal visual inspections would be conducted and documented twice during each 12-hr shift. Additionally, mining company personnel who would conduct routine construction and maintenance in the well field areas would provide well field surveillance. HRI would provide its plants with sumps and pump equipment to prevent any potential spills from escaping the processing pad.

In the yellowcake drying area at the Crownpoint facility, HRI would periodically inspect the entire dryer system and check the integrity and efficiency of the vacuum system, fabric bag filter unit, and heating system. An NRC license condition would require that HRI suspend yellowcake drying operations if emission control equipment is not operating within specifications for design performance. Additionally, HRI would be required to maintain manufacturer-recommended pressure in the drying chamber by (1) performing and documenting checks of air pressure differential during operation, or (2) installing instrumentation that would provide an alarm if the air pressure differential falls below the manufacturer's recommended levels.

Routine environmental monitoring would be conducted independently of operational monitoring. HRI's proposed environmental monitoring systems are based on an outline provided in NRC's Regulatory Guide 4.14, *Radiological Effluent and Environmental Monitoring at Uranium Mills* (NRC 1980b).

HRI's proposed environmental and plant monitoring and documentation system (including associated routine and nonroutine reporting procedures) would be required by NRC license conditions. In-plant radiation monitoring and occupational safety programs would be reviewed and approved by the NRC.

### 2.1.2 Description of the Proposed Waste Management and Effluent Control System

Solution mining produces two principal types of effluents that could be released to the environment: (1) the gaseous emissions and airborne particulates resulting from lixiviant circulation and yellowcake drying, and (2) wastewater from well field processing and aquifer restoration. Other contaminated materials, produced largely during site decommissioning, would also require appropriate disposal. HRI did not request approval to dispose of 11e(2) by-product material or other wastes at any of the proposed project sites. On-site disposal of 11e(2) by-product material by HRI would not be authorized as a licensed activity. Other NRC-licensed ISL extraction facilities are required to have an agreement for the disposal of 11e(2) by-product material with a facility licensed to accept such material. Currently, 11e(2) by-product material disposal capacity includes four NRC-licensed uranium mill tailings sites, two mill tailings sites licensed by NRC Agreement States, and one NRC-licensed commercial disposal facility. In the event the agreement expires or is terminated, the licensee must attain a new agreement within a specified time period or stop further lixiviant injection. This is a standard requirement at all NRC-licensed ISL extraction facilities.

### 2.1.2.1 Gaseous Effluents and Airborne Particulates

Uranium recovery operations may release radon gas at various stages of the processing system, and uranium and other particulates from the yellowcake dryer. These substances are naturally occurring in the ore body, and are circulated to the surface in the groundwater during the mining process.

HRI would minimize radon releases by employing a closed pressurized well field and ion exchange system. Radon gas dissolved in circulating lixiviant would be kept in solution by maintaining pressure on the system. Excess vapor pressure, mainly from dissolution of carbon dioxide or oxygen in the circulating lixiviant, along with some radon, would then be vented by relief valves. These relief valves would be installed at numerous outdoor locations on the trunk pipelines to disperse radon emissions and prevent accumulation in any one area. The ion exchange vessels would provide a closed system, and vents would not be installed.

Radon release from the plants would occur when individual ion exchange columns are opened for resin transfer or elution. At this stage of the process the contents of one ion exchange column would be transferred to open eluant or precipitation vessels. Radon releases here would be limited to the quantity of radon dissolved in the water contained in one ion exchange column. Radon escaping from the solution would be vented from the vessels through the ventilation system of processing buildings. All effluent releases would be subject to release limits specified in 10 CFR Part 20, as well as occupational and environmental programs.

The largest potential source of radon emissions from the proposed facilities is wastewater. Combined with turbulence caused by the pond discharge outlet, radon gas in wastewater would come out of solution and escape to the atmosphere. HRI proposes to minimize this radon source by removing radon in intermediate holding tanks using a vacuum pump, compressing the gas, and dissolving it in the lixiviant injection system. Radon would then be recirculated in the mining solution. In the process, carbon dioxide removed with the radon would be put to use by augmenting the carbonate content of the lixiviant.

HRI proposes to use vacuum dryer technology in its yellowcake drying and packaging system at the Crownpoint facility. In a vacuum dryer, the heating source is contained in a separate, isolated system so that no radioactive materials are entrained in the heating system or the exhaust it generates. The drying chamber containing yellowcake slurry would be subjected to strong vacuum pressure. Moisture in the yellowcake would be the only source of vapor remaining in the system. Any potential leak would result in outside air flowing into the drying chamber.

Emissions from the drying chamber would be treated in two phases. First, all water vapor would be drawn through a bag filter to remove yellowcake particulates with an efficiency exceeding 99 percent. Captured particulates would be returned to the drying chamber. Second, using a condenser all water vapor from the drying chamber would be cooled and condensed. The vapor would be drawn through a water jacket and condensate, thereby capturing virtually all particulates escaping the bag filter. The condensate would then be returned to the uranium precipitation circuit in the plant. This technology would result in zero emissions, and require no ventilation from the drying chamber to the atmosphere.

### 2.1.2.2 Liquid Effluents

**Operations.** Both the satellite and the main processing facilities would generate liquid and solid wastes. The largest total waste stream at each plant would occur as production bleed during uranium recovery. HRI estimates that its production bleed rate at each plant would amount to 1 percent of the flow rate. Operating at full licensed capacity, each lease area would produce wastewater at a rate of 40 gpm.

HRI proposes to treat production bleed to remove radium (Section 2.1.2.1), and then conduct additional treatment to purify the bulk of the wastewater while concentrating other contaminants in a small volume of wastewater. Purified water would be used in the plant to supply process water, and the remainder would be discharged using an NRC-approved disposal method.

Intermittent liquid waste streams from production would include periodic flushing of depleted eluant to reduce accumulated impurities. Another waste stream would result from uranium precipitation and filter washing; the stream would likely be contaminated with dilute HCL. These wastes would be collected, retained, and treated in a brine concentrator (Figure 2.5).

**Aquifer Restoration.** During aquifer restoration, HRI proposes to produce degraded groundwater at rates between 570 and 950 Lpm (150 to 250 gpm). Restoration would be accomplished by combining groundwater sweep and permeate injection.

Groundwater sweep is accomplished by pumping the depleted well field without injecting fluids. Barren process water treated by reverse osmosis would be injected at a later phase to enhance groundwater restoration. All water drawn from the aquifer during groundwater sweep would be processed to remove uranium, then treated with barium chloride (BaCl) to remove radium. HRI proposes to then conduct additional treatment to purify the bulk of the wastewater, and concentrate remaining contaminants in a small volume. Purified water would then be used to continue aquifer flushing, or could be released according to an NRC-approved discharge plan.

### 2.1.2.3 Wastewater Treatment

**Radium Removal.** HRI would remove radium from wastewater by using barium chloride treatment. Barium and radium would form an insoluble salt with sulfate already found in the processing solution. Additional flocculent may be added to enhance precipitation and settling. This process would be performed in retention ponds or in holding vessels inside the processing plants. HRI has documented radium-removal tests conducted on sample mine water from the project area; these tests indicate that more than 99 percent of radium in solution would be removed using the tested techniques (Table 2.3). The treatment results in radium concentrations below 1 percent of Federal limits for releases to waterways. The effectiveness of this treatment would be monitored by daily water sampling.

Radium-contaminated sludge in ponds resulting from water treatment would require disposal as solid 11e(2) by-product material. These waste materials would be collected in barrels or as bulk slurry, and transported to a site licensed for disposal of 11e(2) by-product material. No permanent by-product radioactive waste disposal would be authorized at any of the three project sites.

**Reverse Osmosis.** Reverse osmosis is a water treatment technique that splits a wastewater stream, purifying one portion of the stream, and concentrating contaminants in the other. The process works by pumping wastewater under high pressure through low-permeability membranes. Water molecules can pass through the membrane, while most dissolved and suspended chemicals cannot. The treated water passing through the membrane is called permeate. Depending on how the process is performed, the permeate can become essentially deionized. The chemical constituents become concentrated in the portion of the water that does not pass through the membranes. The result is a volume of clean water, and a reduced volume of more concentrated briny water.

**Table 2.3. HRI's data on barium chloride treatment for removing radium from wastewater (HRI 1988)**

| | BaCl concentration (mg/L) | Final radium concentration (pCi/L) |
|---|---|---|
| Test 1 | 0.0 (waste stream) | 74.0 |
| | 10.5 | 0.21 |
| | 14.0 | 0.24 |
| | 17.5 | 0.24 |
| Test 2 | 0.0 (waste stream) | 73.4 |
| | 10.5 | 0.66 |
| | 14.0 | 0.28 |
| | 17.5 | 0.40 |
| Test 3 | 0.0 (waste stream) | 73.4 |
| | 14.0 | 0.20 |
| | 17.5 | 0.64 |

Reverse osmosis typically concentrates contaminants in approximately one-third of a water stream, while purifying the remaining two-thirds. HRI proposes to retain the reverse osmosis brine for further treatment and concentration of contaminants, as described in the next section. The clean permeate would be released as described in Section 2.1.2.4.

**Brine Concentration.** Brine resulting from reverse osmosis water treatment would be processed again through a brine concentrator. The brine concentrator works by heating and evaporating the water in the brine, then condensing the water vapor as pure water. The highly concentrated brine would largely consist of precipitated solids in the form of common salts.

Together, reverse osmosis water treatment and brine concentration would produce approximately 1 part of briny slurry and salt solids from each 300 parts of wastewater. The brine sludge would be held in a lined retention pond and kept moist enough that solids would not become suspended in the air.

The remaining larger volume of purified wastewater can then be released according to an approved discharge plan.

### 2.1.2.4 Liquid Waste Disposal Options

The solution mining industry has used various disposal methods for liquid waste streams, including evaporation ponds, deep-well injection, land application, and surface discharge under a National Pollution Discharge Elimination System (NPDES) permit. Each of these disposal methods is used to varying degrees in the industry for defined waste streams.

**HRI's Proposal.** HRI proposes to treat all wastewater resulting from both well field production and aquifer restoration. Uranium would be removed using ion exchange. Radium would be removed in settling ponds or closed vessels using BaCl treatment (Table 2.3). Other chemical constituents found dissolved in the wastewater would become concentrated in a relatively small quantity of briny sludge, using a combination of reverse osmosis treatment and brine concentration. Using this combination, 4 L (1 gal) of brine sludge would remain for every 1200 L (300 gal) or so of treated wastewater. HRI would retain the radium wastes as 11e(2) by-product material, requiring disposal at an NRC-licensed facility.

The proposed project would use evaporation ponds. If other wastewater disposal methods were used in the future, they would have to be proposed by HRI under a license amendment and would be subject to additional environmental review. HRI would be required to demonstrate that any disposal method selected meets NRC's release limits for radionuclides (10 CFR Part 20) as well as standards from any other required permits. Authorization to use surface discharge or deep-well disposal would require separate permits, and is not requested in HRI's proposal.

Evaporation from ponds, the most commonly used wastewater disposal technique at solution mines, is typically used for all waste streams. HRI estimates that 40 ha (100 acres) of evaporation ponds would be required at each project site. All of this land would be significantly disturbed by construction, and could require decontamination during decommissioning. This disposal technique requires lined ponds equipped with leak detection systems and concentrates and maintains all 11e(2) by-product materials in a sludge that is then disposed of in a licensed disposal site.

During groundwater restoration, the capacity of the evaporation ponds may be exceeded by the quantity of wastewater produced. In this situation, HRI could dispose of excess wastewater by deep-well injection, land application, or surface discharge subject to prior NRC approval.

Deep-well injection is a popular disposal method among mining companies. This method uses specially drilled wells to dispose of liquid wastes. These wells typically extend deeper than 1525 m (5000 ft), are well below any usable aquifer, and are commonly completed in a horizon where groundwater is not suitable for drinking. An acceptable stratigraphic unit for deep-well disposal would contain a deep, confined aquifer with water quality degraded by more than 10,000 mg/L total dissolved solids. HRI considers that the Abo or Yeso Formations, underlying the sites approximately 1570 to 1645 m (5150 to 5400 ft) deep, most likely meet these criteria. At other solution mines, reverse osmosis brine is often injected into these wells. Disposal by deep-well injection would require an injection well permit granted by the EPA or other appropriate agencies. Use of a deep injection well would require an NRC license amendment after the injection well permit was granted.

Land application is a disposal technique that uses agricultural irrigation equipment to broadcast wastewater on a relatively large area of land. Land application is currently authorized at several solution mines. Water released in this fashion would require uranium and radium removal as described above. At each site, irrigation would be restricted to the lease areas held by HRI, and would be regulated by irrigation standards or water use standards adopted by the appropriate regulatory authority (State of New Mexico Environmental Department or U.S. EPA), generally using a zero-release NPDES permit. NRC would require HRI to decontaminate areas if radionuclide accumulation exceeds decommissioning standards. HRI's application specifies that on-site land application could occur on 22 ha (54 acres) in the southeastern portion of the Church Rock lease area, and on two tracts of land totaling 35 ha (85 acres) in its Unit 1 and Crownpoint lease areas. Off-site land application for the Church Rock site could occur on 256 ha (640 acres) in Section 16, T16N R16W east of the Church Rock site. Off-site land application for the Crownpoint and Unit 1 sites could occur on 256 ha (640 acres) in Section 12, T17N R13W north of the Crownpoint and Unit 1 sites.

Another disposal method utilized by the solution mining industry is surface discharge, requiring authorization by the EPA or other appropriate agencies. This disposal method has been used only for discharging treated water, but has been considered by licensees for other waste streams. Generally, radionuclides in wastewater authorized for this method of disposal are subject to release limits found in NRC regulations. Surface discharge is most likely to be used as a disposal method at the Church Rock site (HRI 1996a). Should surface discharge be implemented, HRI would have to obtain the appropriate State and Federal permits.

### 2.1.3 Restoration, Reclamation, and Decommissioning

Following uranium recovery in each mine unit, HRI would be required by NRC license to restore groundwater quality. At the conclusion of the project, all contaminated materials, soil, and structures would be removed from the sites. The facilities would then be decommissioned, and the well field and processing plant sites would be reclaimed. The following sections provide details regarding standards which would be met, and the procedures used to meet them.

Detailed restoration, reclamation, and decommissioning plans, related cost estimates, and an appropriate surety would be required by the NRC before HRI could begin uranium recovery operations. NRC regulations require that the licensee maintain an adequate financial surety in the form of surety bonds, cash, certificates of deposit, deposits of government securities, or irrevocable letters of credit to cover the costs for decommissioning, reclamation of the disturbed areas, waste disposal, and groundwater restoration. The amount of the surety is based on cost estimates for completing the approved reclamation plan by a third party in the event the licensee defaults. The surety is reviewed annually by NRC and adjusted to reflect expansions in operations, changes in engineering design, and inflation.

### 2.1.3.1 Aquifer Restoration

Consistent with current ISL restoration practices, HRI proposes (HRI 1996e) that restoration criteria be established on a parameter-by-parameter basis, and that the primary goal of restoration be to return all parameters to average pre-mining baseline conditions. In the event water quality parameters cannot be returned to average pre-mining baseline levels through reasonable restoration efforts, the secondary goal would be to return water quality to the maximum concentration limits specified in EPA regulations in 40 CFR Part 141 and § 143.3, secondary and primary drinking water regulations. For barium and fluoride, the secondary restoration goal would be set to the State of New Mexico primary drinking water standards. For uranium, 300 pCi/mL (0.44 mg/L) would be used. This concentration was obtained from 10 CFR Part 20 and is suitable for unrestricted release of natural uranium to water.

Table 2.4 presents the list of constituents for which HRI proposes to monitor restoration success. Before mining, HRI proposes to establish baseline groundwater quality in selected wells in the production zone, perimeter monitor wells, and monitor wells in overlying aquifers. Approved procedures for baseline determination would be specified in an NRC license condition. All baseline groundwater data will be subject to review by an HRI Safety Evaluation Review Panel. In addition, HRI would be required to use baseline conditions as the primary restoration target for all constituents. The HRI groundwater baseline conditions and well field restoration would be subject to NRC inspection.

HRI proposes to restore the aquifers using techniques called groundwater sweep and permeate injection (Figure 2.7). Groundwater sweep involves flushing the aquifer with naturally occurring groundwater and decontaminated water to remove any remaining lixiviant and degraded groundwater. Affected water in each mine unit being restored would be withdrawn at flow rates of 570 to 950 Lpm (150 to 250 gpm), processed through ion exchange to remove uranium, then treated to remove radium and total dissolved solids. This treated water, known as permeate, would then be reinjected to further flush the aquifer. Groundwater sweep and permeate injection would be balanced so that a cone of depression would be maintained, causing groundwater to flow into the mining unit. Thus, natural groundwater would be drawn into the mining unit's center.

### 2.1.3.2 Land Reclamation

When the project is fully operational, only certain portions of the proposed mine area would be in production. Therefore, reclamation would occur in interim steps to minimize environmental impacts during and after mining takes place, and would restore disturbed land to its pre-mining use. A license condition would require HRI to submit a final decommissioning plan for NRC review and approval at least 12 months prior to license termination.

**Table 2.4. HRI's proposed list of chemical constituents to be analyzed in each monitoring well for restoration purposes**

| | |
|---|---|
| **A. Common constituents** | |
| Ammonia | Magnesium |
| Bicarbonate | Potassium |
| Calcium | Sodium |
| Carbonate | Sulfate |
| Chloride | Nitrate |
| Fluoride | |
| **B. Trace and minor elements** | |
| Arsenic | Manganese |
| Barium | Mercury |
| Boron | Molybdenum |
| Cadmium | Nickel |
| Chromium | Selenium |
| Copper | Silver |
| Iron | Uranium |
| Lead | Vanadium |
| Radium-226 | Zinc |
| **C. Physical parameters** | |
| Total dissolved solids | |
| Alkalinity | |
| Specific conductivity | |
| pH | |

**Topsoil Handling**. Topsoil from existing mine facilities is already stockpiled. Topsoil from pond areas and other areas requiring significant grading or surface disturbance would be removed, stockpiled and stabilized. Well fields as a whole would not be cleared of vegetation or topsoil. Where concentrated disturbance occurs, such as drilling sites, topsoil would be bladed to one side and then respread over the area as soon as construction was completed.

**Well Fields**. After restoring groundwater in the mined aquifers, HRI would decommission each well field, and remove all well field lines and pipelines. In addition, HRI would plug and abandon injection, production, and monitor wells according to applicable regulatory requirements, Navajo Water Code, and BLM requirements for wells permitted on Navajo lands in addition to New Mexico State Engineer requirements for wells permitted under State authority. After removing pumps and tubing, HRI would

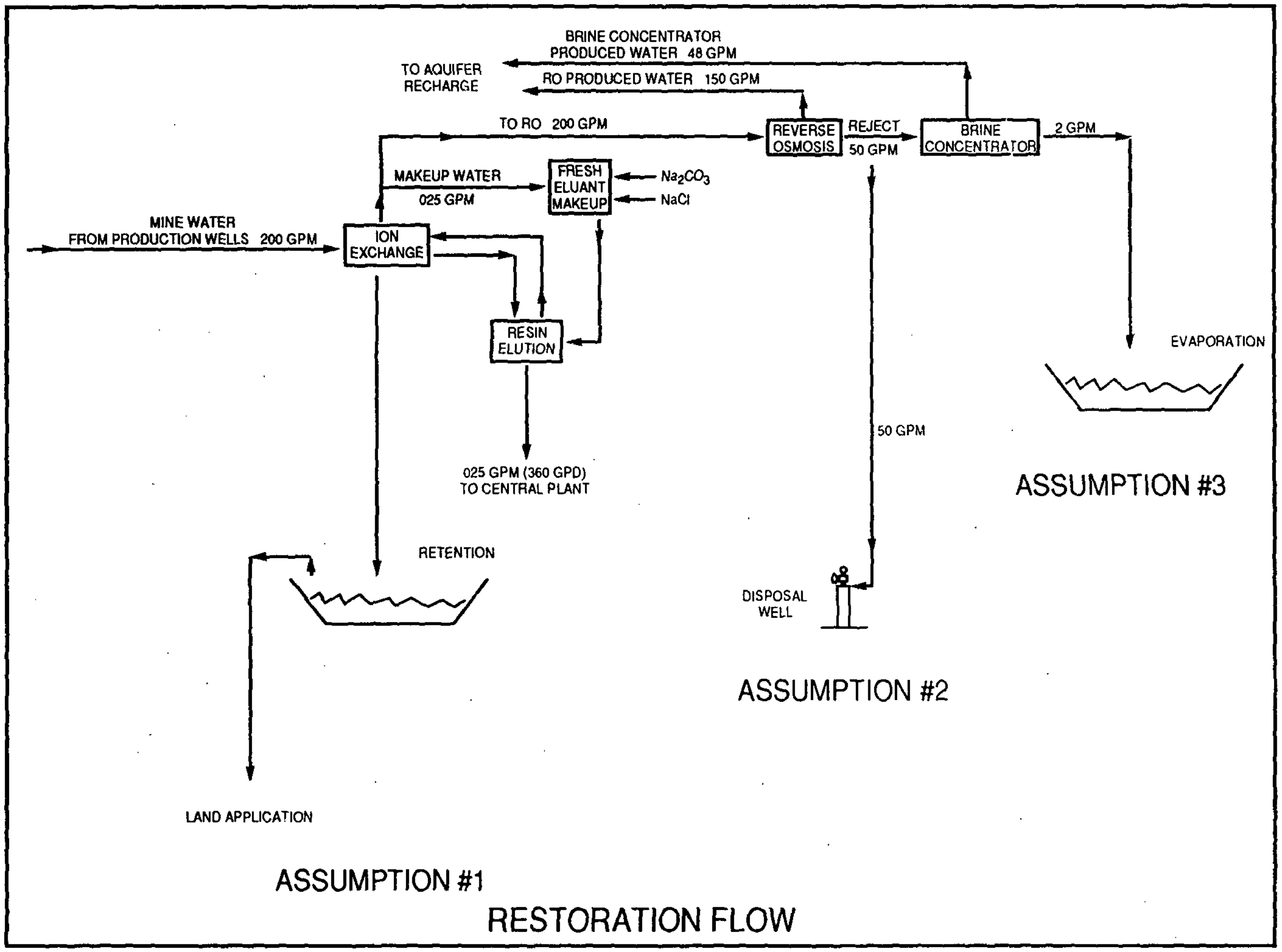


**Figure 2.7. Schematic flow diagram and approximate flow rates of restoration wastewater treatment systems.**

backfill each well with an approved cement slurry, and cut the casing 1 m (3 ft) below the surface. HRI would then backfill the wellhead area and would reclaim the surface according to the approved plan.

**Pad Reclamation.** The plant and pond areas would be reclaimed in a manner similar to that used for well field areas, and the reclamation would be subject to approval by land owners and/or lessors. First, HRI would remove all contaminated material and pond liners, and return excess soil in pond embankments to the ponds as fill. Next, HRI would reestablish land surface contours and replace topsoil on disturbed areas. A period of several years would be required to establish a viable vegetative cover.

**Radiation Surveys.** Any equipment or buildings that could be decontaminated to levels acceptable for unrestricted use might be sold and left to be used for other purposes. All other equipment, buildings, foundations, piping, and associated support facilities would be removed, and appropriate radiation surveys would be conducted over the associated areas. In the well fields, where gamma surveys correlate well with actual radiation concentrations in soil, gamma surveys would be conducted as each mining unit is decommissioned. Gamma survey results would be compared with background values,
and soil samples would be obtained from locations that exhibit elevated gamma readings. Areas exhibiting elevated uranium and radium-226 levels would be decontaminated in accordance with release limits specified in NRC's regulations. Contaminated soil would be disposed of in the same manner as other radioactively contaminated material. All survey results would be subject to verification by the NRC.

**Recontouring.** After completing decommissioning and decontamination, HRI would recontour the land surface and provide a terrain consistent with the post-mining land use. In addition, HRI would replace topsoil stockpiles over areas from which they were removed.

**Revegetation.** HRI proposes to reseed all disturbed areas using plant mixtures selected from eight native plant species, depending on the soil type encountered in various areas. The species include the native grasses and shrubs listed in Table 2.5. Mulch would be used in any area where water retention, soil temperature, or soil crusting prevent suitable seed germination and growth.

### 2.1.3.3 Plant Decontamination and Decommissioning

Solid wastes generated at the site during operations would consist of spent resin, empty chemical containers, miscellaneous pipes and fittings, contaminated sludge in ponds, and domestic trash. These wastes would be classified as contaminated or noncontaminated waste, according to their radiological survey results. Noncontaminated waste could be disposed of as ordinary trash.

Any contaminated material accumulating at the site during operations or reclamation may be disposed of as 11e(2) by-product material. Alternatively, contaminated equipment could be sold or transferred to another source material licensee. This method would involve minimal decontamination, and all shipments would be subject to U.S. Department of Transportation requirements. No permanent by-product radioactive waste disposal would be authorized at any of the three project sites.

**Table 2.5. HRI's proposed seed application rates for reclaimed areas**
All values given in kilograms per hectare (pounds per acre)

| | Clay soil | Loamy soil | Sandy soil |
|---|---|---|---|
| Arriba western wheatgrass | 7.2 (6.4) | 5.4 (4.8) | 7.2 (6.4) |
| Alkali sacaton | 0.9 (0.8) | 0.8 (0.7) | 0.6 (0.5) |
| Vaughn sideoats grama | | 2.3 (2.0) | 1.8 (1.6) |
| Paloma Indian ricegrass | | | 2.7 (2.4) |
| Bandera Rocky Mountain penstemon | | | 0.3 (0.3) |
| Pastura little bluestem | | | 0.3 (0.3) |
| Loveington blue grama | 0.3 (0.3) | 0.7 (0.6) | |
| Fourwing saltbush | 1.4 (1.2) | | |
| Total | 9.8 (8.7) | 9.2 (8.1) | 12.9 (11.5) |

Contaminated material having no salvage value would be stored in a restricted area until it could be shipped to a licensed waste disposal facility. The project would not generate any "hazardous waste," as defined by the Federal Resources Conservation and Recovery Act (RCRA).

After the project was completed, equipment from the processing plants would be handled in one of three ways:

- Contaminated equipment might be dismantled and sold or transferred to another licensed facility. Alternatively, equipment decontaminated in accordance with NRC guidance might be sold for reuse, salvage or scrap.
- Decontaminated materials having no resale value, such as building foundations, might be removed for disposal elsewhere or buried on-site.
- Waste materials that could not be decontaminated would be disposed of in an NRC-licensed facility.

After all liquid in ponds was eliminated as approved in the license, residues and the pond liners would be removed and disposed of in a licensed facility. Pond liners typically cannot be economically cleaned for unrestricted use. Pond areas would then be reclaimed along with other disturbed areas.

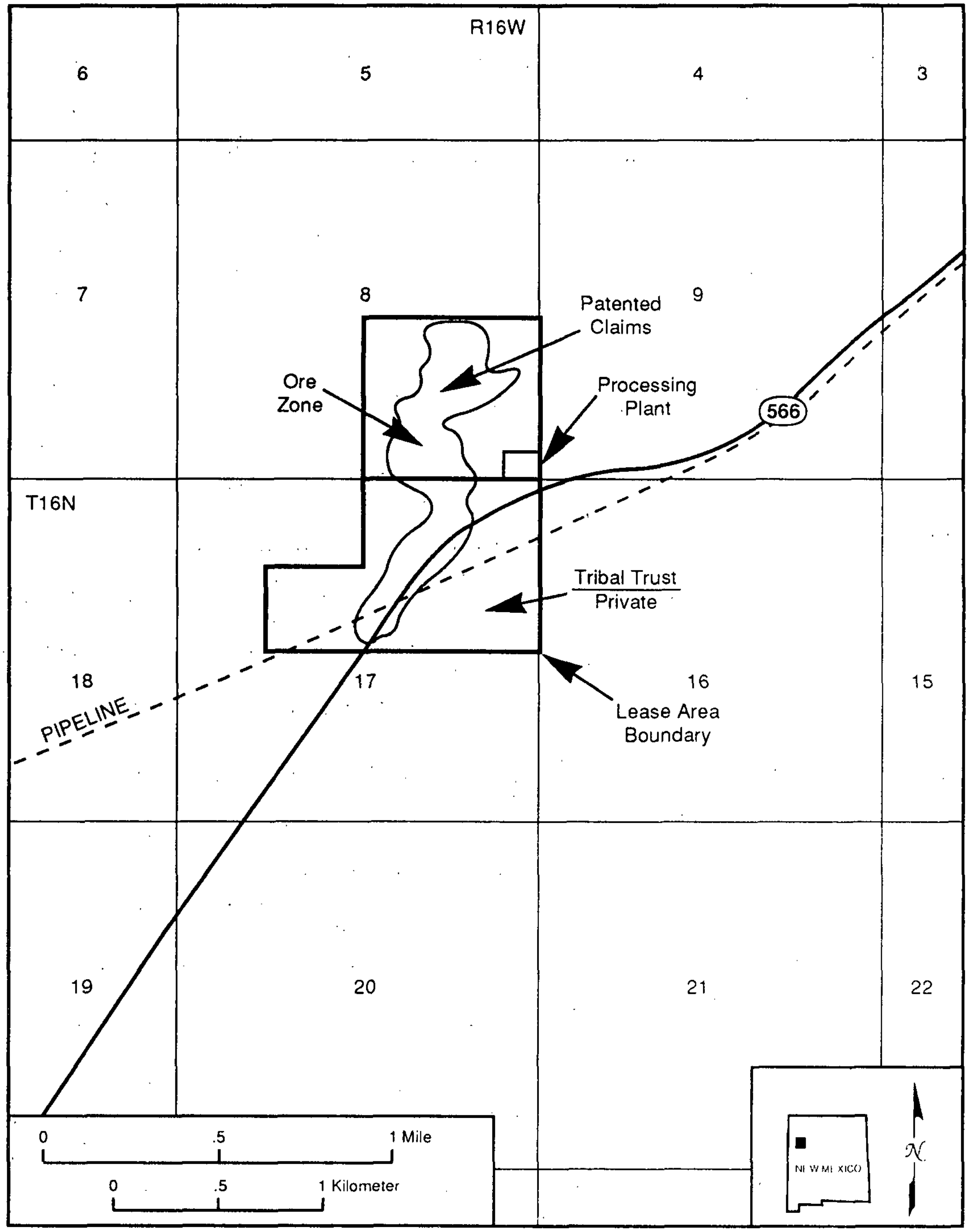


**Figure 2.8. Church Rock lease areas showing surface ownership above minerals ownership, if different.**

## 2.1.4 Description of the Proposed Sites

### 2.1.4.1 The Church Rock Site

The Church Rock mining units and satellite processing facility would be located in Sections 8 and 17, T16N R16W (Figure 2.8), approximately 10 km (6 miles) north of the town of Church Rock. The satellite processing facility would be located in Section 8. HRI's mineral rights include 65 ha (160 acres) of patented mining claims in Section 8, and 80 ha (200 acres) of leases in Section 17. HRI anticipates that uranium recovery activities at the Church Rock site would occur over approximately 8 years.

The Church Rock site covers 145 ha (360 acres), of which approximately 90 percent [130 ha (324 acres)] would be disturbed during project construction and operation. The estimate of 130 ha (324 acres) includes areas that have been previously disturbed as well as those that would be newly disturbed. The satellite processing facility's buildings, plant areas, parking lots, and settling ponds would occupy approximately 2.5 ha (6 acres). Well fields would occupy approximately 32 ha (80 acres). Additional acreage would be required for access roads, on-site wastewater land application areas, and evaporation ponds. If HRI disposes of wastewater using off-site land application (i.e., in Section 16, T16N R16W), an additional area of up to 256 ha (640 acres) could be disturbed. Thus, the total land area that would be disturbed at the Church Rock site ranges from 130 ha (324 acres) (on-site land application) to 386 ha (964 acres) (off-site land application in Section 16).

### 2.1.4.2 The Unit 1 Site

The Unit 1 mining units and satellite processing facility would be located in Sections 15, 16, 21, 22, and 23, T17N R13W (Figure 2.9), approximately 3.2 km (2 miles) west of the town of Crownpoint. The satellite processing plant, retention ponds, and support facilities would be located in Section 21. The mine plan would initially affect reserves in Sections 21 and 22. HRI anticipates that uranium recovery activities at the Unit 1 site would occur over approximately 17 years.

The Unit 1 site covers 512 ha (1280 acres), of which approximately 70 percent [358 ha (896 acres)] would be disturbed during project construction and operation. The estimate of 358 ha (896 acres) includes areas that have been previously disturbed as well as those that would be newly disturbed. The satellite processing facility's buildings, plant areas, parking lots, and settling ponds would occupy approximately 2.5 ha (6 acres). Well fields would occupy approximately 280 ha (700 acres). Additional acreage would be required for access roads, on-site wastewater land application areas, and evaporation ponds. If HRI disposed of wastewater using off-site land application (i.e., in Section 12, T17N R13W), an additional area of up to 256 ha (640 acres) could be disturbed. Thus, the total land area that would be disturbed at the Unit 1 site ranges from 358 ha (896 acres) (on-site land application) to 614 ha (1536 acres) (off-site land application in Section 12).

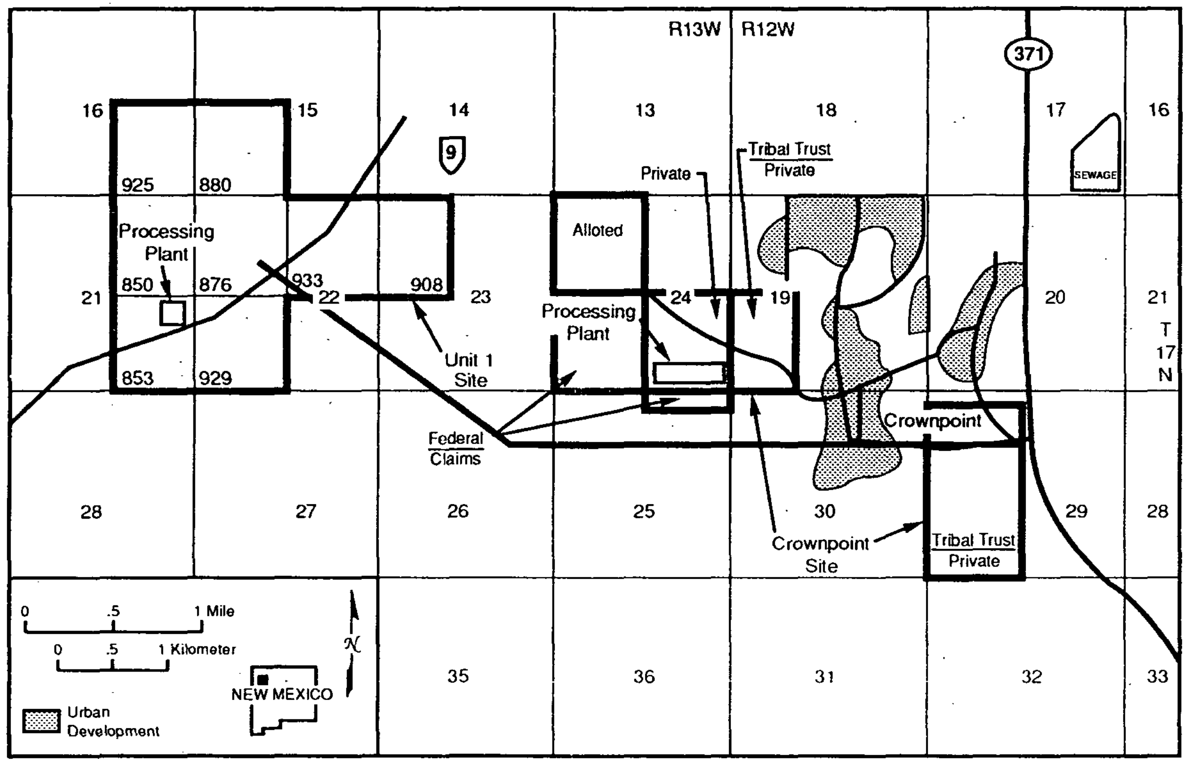


Figure 2.9. Land and minerals status: in Unit 1 showing allotment numbers; in the Crownpoint leases showing surface ownership above minerals ownership, if different.

### 2.1.4.3 The Crownpoint Site

The Crownpoint mining units and central processing facility would be located in Sections 19, 24, and 25, T17N R13W, and Section 29, T17N R12W (Figure 2.9). The Crownpoint portion of the project would use existing facilities for the central processing plant, located on the west edge of the town of Crownpoint in Section 24. HRI anticipates that uranium recovery activities at the Crownpoint site would occur over approximately 19 years.

The Crownpoint site covers 365 ha (912 acres), of which approximately 70 percent [255 ha (638 acres)] would be disturbed during project construction and operation. The estimate of 255 ha (638 acres) includes areas that have been previously disturbed as well as those that would be newly disturbed. Existing processing facilities and settling ponds, which occupy approximately 5.5 ha (14 acres) in the southeastern quarter of Section 24, would be used. Well fields would occupy approximately 205 ha (510 acres). Additional acreage would be required for access roads, on-site wastewater land application areas, and evaporation ponds. If HRI disposed of wastewater using off-site land application, it would occur in Section 12, T17N R13W. Because Section 12 would also be used for land application for the Unit 1 site under this scenario, its 256 ha (640 acres) are included above in the land disturbance calculations for Unit 1. Thus, the total land area that would be disturbed at the Crownpoint site would be approximately 255 ha (638 acres).

### 2.1.4.4 Site Development

Initially, HRI proposes to operate well fields only at the Church Rock site (Figure 2.10), and to transport yellowcake slurry by truck to the Crownpoint facility for drying and packaging. Mining would begin at the Unit 1 and Crownpoint sites in the late 1990s (Figure 2.11).

During initial production, HRI proposes to conduct demonstration projects at each site, producing uranium from an initial well field and then immediately restoring the well field. These demonstrations would be intended to confirm reclamation cost data for bonding purposes. Before mining could occur at either the Unit 1 or the Crownpoint site, HRI would have to conduct a groundwater restoration demonstration at the Church Rock site. The demonstration would be conducted at a large enough scale that production-scale groundwater restoration was demonstrated. If restoration to preestablished groundwater quality standards could not be achieved, mining at the Church Rock site would cease and no mining would be allowed at either the Unit 1 or the Crownpoint site.

## 2.2 ALTERNATIVE 2 (MODIFIED ACTION)

Under Alternative 2, the NRC would issue HRI a license for the construction and operation of a modified version of the proposed project. The modified project could consist of alternatives to the proposed project in three primary areas: sites for ISL mining, sites for yellowcake drying and packaging, and liquid waste disposal methods.

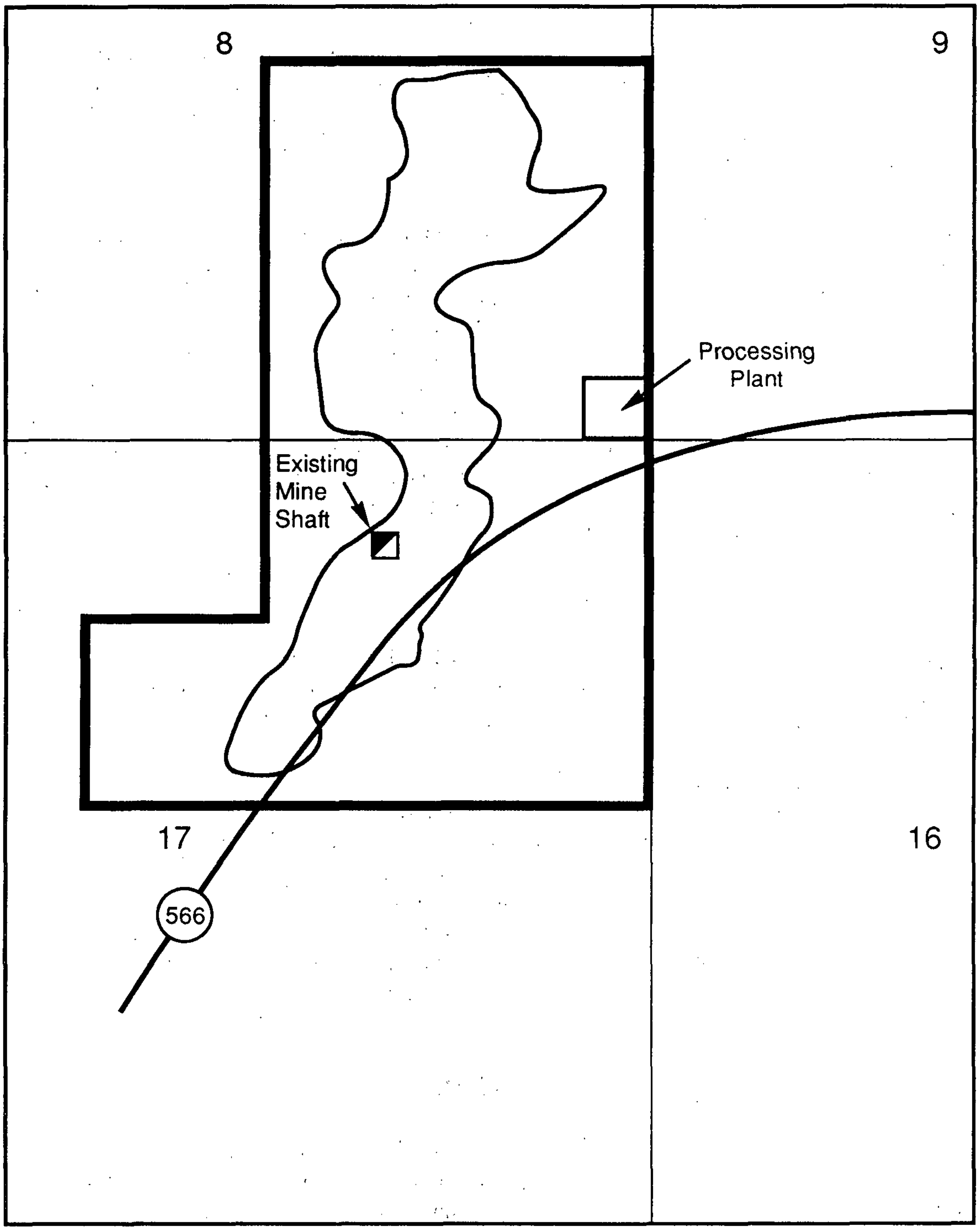


**Figure 2.10. Church Rock lease area, showing mine-unit and facility locations.**

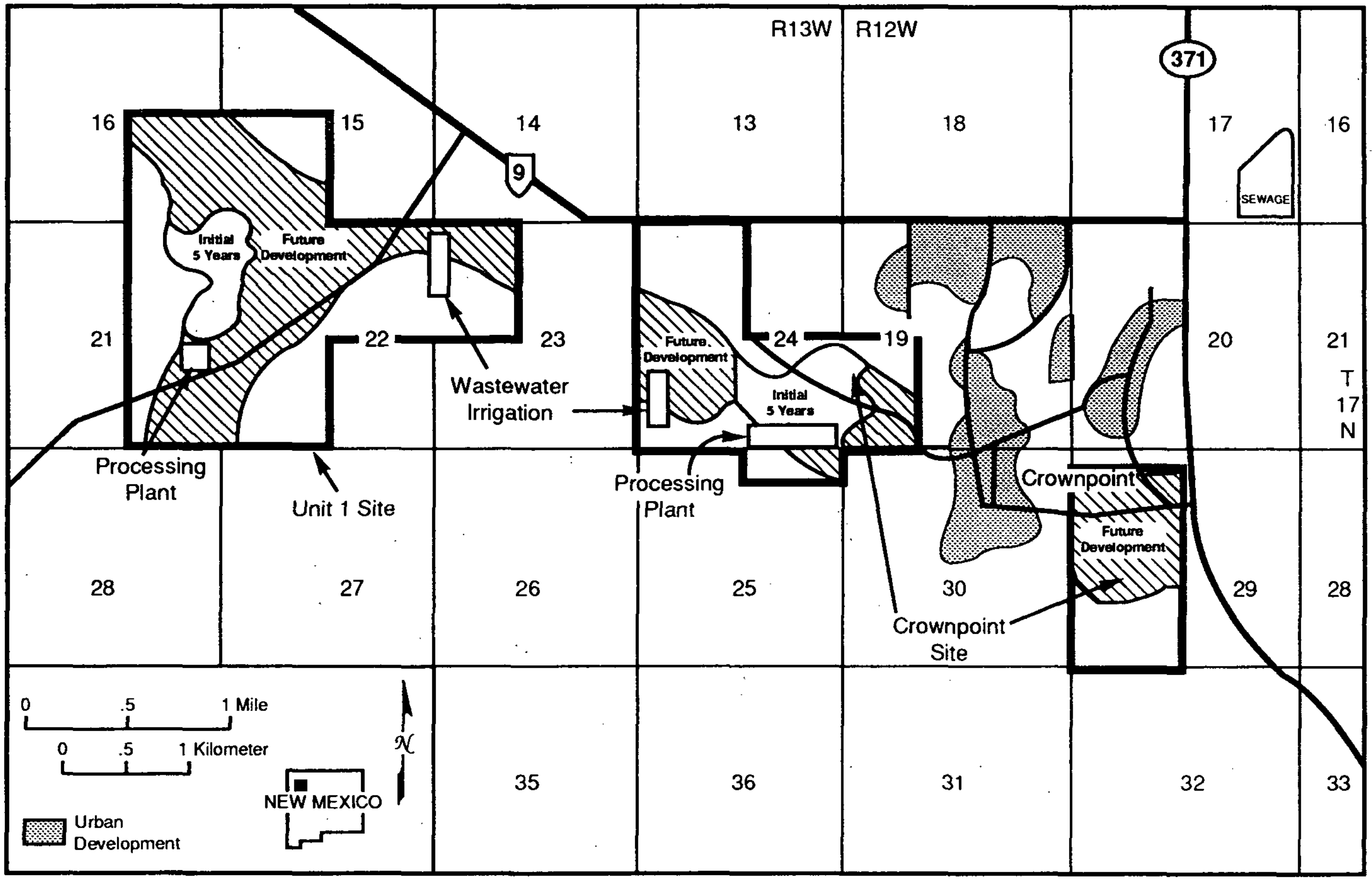


**Figure 2.11. Unit 1 and Crownpoint lease areas, showing the ore zones, initial 5-year mine plan, and facility locations.**

### 2.2.1 Alternative Sites for ISL Mining

HRI proposes to conduct ISL mining at the Church Rock, Unit 1, and Crownpoint sites. However, potential impacts to public health and safety or the environment might indicate that ISL mining should not be conducted at all three sites. Alternative sites for ISL mining include

- the Church Rock site only,
- the Unit 1 site only,
- the Crownpoint site only,
- the Church Rock and Unit 1 sites only,
- the Church Rock and Crownpoint sites only, or
- the Unit 1 and Crownpoint sites only.

The primary difference between these alternatives and the proposed project is that ISL mining would occur at only one or two of the proposed sites. Thus, the potential environmental impacts of mining at the sites listed above will be addressed as subunits of the proposed project in the FEIS.

### 2.2.2 Alternative Sites for Yellowcake Drying and Packaging

HRI proposes to dry and package all yellowcake produced by the project at the central processing facility at Crownpoint. Alternative sites that could be selected for yellowcake drying and packaging include

- the proposed Church Rock processing facility,
- the proposed Unit 1 processing facility,
- HRI's existing ISL facility at Kingsville, Texas, and
- the Ambrosia Lake uranium mill, located north of Milan, New Mexico (Figure 1.1).

The primary difference between these alternatives and the proposed project is that yellowcake slurry would be transported by truck to a location other than the Crownpoint processing facility. The FEIS examines the potential environmental impacts of these alternatives for drying and packaging.

### 2.2.3 Alternative Liquid Waste Disposal Methods

HRI's proposal for disposing of liquid wastes generated by the project is described in Section 2.1.2.4. Generally, HRI proposes to dispose of liquid wastes through a combination of evaporation ponds, aquifer reinjection, land application, and reinjection into the Westwater Canyon sandstone outside the mining area. The FEIS examines the impacts of HRI's proposal and alternative liquid waste disposal methods, including various combinations of evaporation ponds, deep-well injection, land application, and surface discharge.

## 2.3 ALTERNATIVE 3 (THE NRC STAFF-RECOMMENDED ACTION)

Under Alternative 3, the NRC would issue HRI a license for the construction and operation of the proposed project, but with additional measures required and recommended by NRC staff to protect public health and safety and the environment. These additional measures are discussed for each resource area in Sections 4.1 through 4.12 and listed for the entire project in Appendix B.

## 2.4 ALTERNATIVE 4 (NO ACTION)

No action means that "the proposed activity would not take place, and the resulting environmental effects from taking no action would be compared with the effects of permitting the proposed activity or an alternative activity to go forward" (*Federal Register* 46, 18026). Thus, the no-action alternative for NRC is not to issue HRI a license for the construction and operation of facilities for ISL uranium mining and processing at the Church Rock, Unit 1, or Crownpoint sites. The no-action alternative for the BLM and BIA is not to approve HRI's application for minerals operating rights and leases on the Federal and Indian lands involved in the proposed project.

# 3. AFFECTED ENVIRONMENT

## 3.1 METEOROLOGY, AIR QUALITY, AND NOISE

This section describes meteorology, air quality, and noise in the region in which the three project sites are located. The description is not site-specific because the available data are collected on a regional basis and because the project sites have similar characteristics.

### 3.1.1 Meteorology

The project sites are located on the Northwestern Plateau climatological subdivision of New Mexico. Due to the relatively weak synoptic scale, meteorological influence in the project area is largely influenced by local topography. The region is semiarid continental, with the mean annual precipitation averaging 26 cm (10.2 in.) (TVA 1979). Precipitation typically is concentrated during summer and early fall, occurring as thundershowers of short duration. Approximately 50 percent of the precipitation falls in July through October. The mean monthly rainfall during the remainder of the year totals only 1.4 cm (0.5 in.).

Temperatures in the region are represented by data from the nearby Crownpoint station, measured over a 42-year period. Table 3.1 presents mean monthly and annual normal temperatures for Crownpoint. Because of the relatively high elevation of the project area, temperatures greater than 32°C (90°F) occur infrequently, only 12 times per year on average. The extreme maximum temperature recorded at Crownpoint is 36°C (97°F). Because of the high elevation and relatively infrequent cloud cover in the project area, radiant cooling is substantial and results in an average of 143 days of the year with temperatures below freezing. Extremely low temperatures are rare, with the lowest on record being -27°C (-17°F).

The mean annual temperature is 10.6°C (51°F). The coldest monthly mean of -1°C (30°F) occurs in January, and the highest monthly mean of 22.2°C (72°F) occurs in July. The frost-free growing season lasts 140 days, extending from early May to early October. The mean freeze-free period lasts about 22 days longer than the growing season. However, large variations in the freeze dates occur from year to year.

Maximum precipitation occurs during the summer thunderstorm season. Table 3.2 presents normal monthly and annual precipitation for Crownpoint. The data indicate that approximately one-half of the annual precipitation total falls during July, August, and September. Most of the winter precipitation occurs as snow. Based on mean snowfall estimates for nearby locations, including Crownpoint, and on actual 1975 snowfall amounts for Gallup and Chaco Canyon National Monument, the estimated yearly average snowfall for the project area is 66 cm (26 in.).

Average annual relative humidity is estimated to range from a maximum of near 65 percent about sunrise to near 30 percent in mid-afternoon. Afternoon humidity in the warmer months, however, is

**Table 3.1. Mean temperature in degrees Centigrade (Fahrenheit) for Crownpoint, New Mexico, 1931-1960**

| Month | Mean | Mean maximum | Mean minimum |
|---|---|---|---|
| January | -1.1 (30) | 5.0 (41) | -7.8 (18) |
| February | 2.2 (36) | 8.3 (47) | -4.4 (24) |
| March | 5.0 (41) | 12.2 (54) | -2.2 (28) |
| April | 9.4 (49) | 17.2 (63) | 1.7 (35) |
| May | 14.4 (58) | 22.2 (72) | 6.7 (44) |
| June | 20.0 (68) | 27.8 (82) | 12.2 (54) |
| July | 22.2 (72) | 29.4 (85) | 15.0 (59) |
| August | 21.1 (70) | 28.3 (83) | 13.9 (57) |
| September | 17.8 (64) | 25.0 (77) | 10.0 (50) |
| October | 11.7 (53) | 18.9 (66) | 4.4 (40) |
| November | 4.4 (40 | 11.7 (53) | -2.2 (28) |
| December | 0.0 (32) | 6.7 (44) | -6.1 (21) |
| Annual | 10.6 (51) | 17.8 (64) | 3.3 (38) |

*Source*: TVA 1979.

**Table 3.2. Monthly and annual precipitation for Crownpoint, New Mexico, 1931-1960**

| Month | Millimeters | Inches |
|---|---|---|
| January | 14.7 | 0.58 |
| February | 14.5 | 0.57 |
| March | 11.9 | 0.47 |
| April | 12.7 | 0.50 |
| May | 16.8 | 0.66 |
| June | 17.3 | 0.68 |
| July | 43.7 | 1.72 |
| August | 53.6 | 2.11 |
| September | 27.9 | 1.10 |
| October | 20.8 | 0.82 |
| November | 12.2 | 0.48 |
| December | 13.5 | 0.53 |
| Annual | 259.6 | 10.22 |

*Source*: TVA 1979.

commonly below 20 percent. The mean annual relative humidity for Gallup is 50 percent. The gross annual lake evaporation in the project area is approximately 218 cm (86 in.).

Little comprehensive wind observation data are available for the immediate project area. The nearest National Weather Service (NWS) station with available wind data is Gallup (TVA 1979), located approximately 19 km (12 miles) and 56 km (35 miles) west-southwest of Church Rock and Crownpoint, respectively. Five-year wind data for Gallup (U.S. Department of Commerce 1981) indicate a prevailing wind with southwest and west-southwest components (Figure 3.1). A windy season occurs during the spring months, averaging 19 km/hr (12 mph), and summer wind averages 13 km/hr (8 mph). Winds are generally calm 10 percent of any 24-hr period and exceed 38 km/hr (24 mph) 5 percent of the time.

Based on the input parameters of solar altitude, cloud cover, ceiling height, and wind speed, atmospheric stability can be classified into several categories (TVA 1979). The closest weather stations with available long-term atmospheric records from which stability conditions can be estimated are Zuni, Farmington, and Albuquerque, New Mexico, about 90 km (57 miles) southwest, 115 km (72 miles) north, and 150 km (93 miles) southeast of the Crownpoint site, respectively. The frequencies of the various stability conditions for these three locations are presented in Table 3.3. The data indicate that stability conditions contributing to good dispersion conditions (Pasquill Classes A through D) occur more than 55 percent of the time at all three stations.

Thunderstorms are relatively frequent during the summer months in northwestern New Mexico and occur on about 50 days per year in the project area. Tornadoes are occasionally reported in New Mexico, most frequently during afternoon thunderstorms from May through August, and typically in the eastern part of the State. Only one tornado was reported in the one-degree square including Crownpoint during the period from 1955 to 1967. The resulting calculated probability of a tornado striking the site in any year is 0.00006, or once in each 16,700 years.

Maximum short-duration rainfalls in this area are generally caused by thunderstorms, while maximum precipitation of longer duration results from the infrequent invasion of a tropical cyclone from the Gulf of Mexico or the Gulf of California. Occasionally, brief, high-intensity showers may cause flash floods in the normally dry arroyos. Information regarding potential flooding is discussed in Section 3.3.2.

### 3.1.2 Air Quality

National Ambient Air Quality Standards (NAAQS) exist for sulfur dioxide ($SO_2$), nitrogen dioxide ($NO_2$), carbon monoxide (CO), ozone ($O_3$), lead (Pb), and particulate matter small enough to move easily into the lower respiratory tract (particles less than 10 $\mu$m in aerodynamic diameter, designated PM-10). The NAAQS are expressed as pollutant concentrations that are not to be exceeded in the ambient air, that is, in the outdoor air to which the general public has access [40 CFR § 50.1(e)]. Primary NAAQS are designated to protect human health; secondary NAAQS are designated to protect human welfare by safeguarding environmental resources (such as soils, water, plants, and animals) and manufactured materials. Primary and secondary NAAQS are presented in Table 3.4. New Mexico has adopted the NAAQS as the air quality standards for the State.

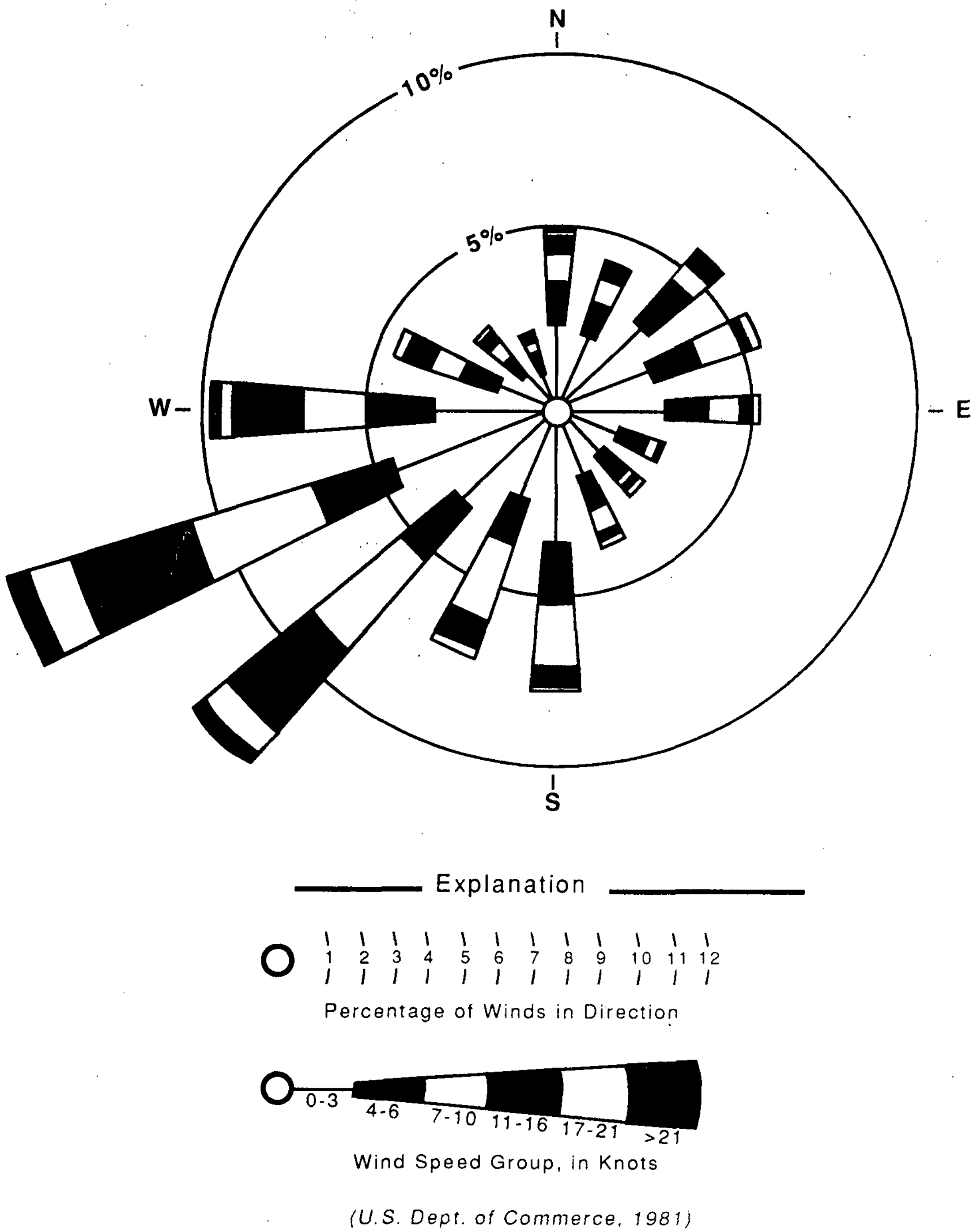


**Figure 3.1. Wind rose for Gallup, New Mexico—average annual conditions, 1976–1980.** *Source:* U.S. Department of Commerce 1981.

**Table 3.3. Percent frequency distributions of Pasquill Stability Classes for Zuni, Farmington, and Albuquerque**

| Stability class | Zuni (1967–1971) | Farmington (1960–1968) | Albuquerque (1960–1964) |
|---|---|---|---|
| A (extremely unstable) | 2.4 | 4.8 | 2.4 |
| B (unstable) | 7.0 | 10.6 | 13.5 |
| C (slightly unstable) | 14.2 | 12.4 | 12.8 |
| D (neutral) | 35.1 | 27.8 | 30.0 |
| E (slightly unstable) | 17.8 | 10.7 | 13.8 |
| F (stable) | 23.5 | 34.4 | 27.5 |

*Source*: TVA 1979.

**Table 3.4. National Ambient Air Quality Standards[a]**

| Pollutant | NAAQS (fg/m$^3$) Primary | Secondary | Measurement |
|---|---|---|---|
| Carbon monoxide (CO) | 10,000<br>40,000 | | 8-hr average[b]<br>1-hr average[b] |
| Nitrogen dioxide ($NO_2$) | 100 | 100 | Annual arithmetic mean |
| Ozone ($O_3$) | 235 | 235 | 1-hr average[c] |
| Lead (Pb) | 1.5 | 1.5 | Quarterly average[d] |
| Particulates <10 microns in diameter (PM-10) | 50<br>150 | 50<br>150 | Annual arithmetic mean<br>24-hr average[c] |
| Sulfur dioxide ($SO_2$) | 80<br>365 | 1300 | Annual arithmetic mean<br>24-hr average[b] |

[a]Where no value is listed, there is no corresponding standard.
[b]Not to be exceeded more than once per year.
[c]Not to be exceeded on more than 1 day/year on the average over 3 years.
[d]Calendar quarter.

*Source*: EPA 1996.

The air quality in the project region is good. The area is sparsely populated and is not heavily developed with industrial sources of air pollution. The area is designated as being in attainment of the all the individual NAAQS (EPA 1996).

In addition to ambient air quality standards, which represent an upper bound on allowable pollutant concentrations, there are national standards for the prevention of significant deterioration (PSD) of air quality (40 CFR § 51.166). The PSD standards differ from the NAAQS in that the NAAQS provide maximum allowable concentrations of pollutants, while PSD requirements provide maximum allowable increases in concentrations of pollutants for areas already in compliance with the NAAQS. PSD standards are therefore expressed as allowable increments in the atmospheric concentrations of specific pollutants. Allowable PSD increments currently exist for three pollutants: $NO_2$, $SO_2$, and PM-10. PSD increments are particularly relevant when a major proposed action (involving either a new source or a major modification to an existing source) may degrade air quality without exceeding the NAAQS, as would be the case, for example, in an area where the ambient air is very clean. One set of allowable increments exists for Class II areas, which cover most of the United States, and a much more stringent set of allowable increments exists for Class I areas, which are specifically designated areas where the degradation of ambient air quality is to be severely restricted. Class I areas include certain national parks and monuments, wilderness areas, and other areas as described in 40 CFR § 51.166(e) and 40 CFR Part 81:400–437. Maximum allowable PSD increments for Class I and Class II areas are given in Table 3.5. Class I areas in the Four Corners region include Mesa Verde National Park and Arches National Park. A list of Class I areas in Arizona, Colorado, New Mexico, and Utah is presented in Table 3.6.

### 3.1.3 Noise

Background noise around the three project sites is mostly from light automobile and truck traffic and would be comparable to noise levels in a quiet residential area. This is about 50 decibels in the normal (A-scale) auditory frequency band [dB(A)]. Residents (i.e., potentially sensitive receptors) are adjacent to or within close proximity of (less than 1 km) all three project sites.

## 3.2 GEOLOGY AND SOILS

### 3.2.1 Regional

Topographic relief in the vicinity of the project sites is approximately 600 m (2000 ft), from an elevation of 2000 m (6500 ft) to 2600 m (8500 ft). The region is characterized by mesas that dip gently to the north and by broad valleys with intermittent streams. Locally, arroyos have incised the mesas by headward erosion, forming steep-sided canyons.

The project sites are located northeast of the Zuni Uplift on the Chaco Slope structural subdivision of the San Juan Basin (Figure 3.2). The San Juan Basin is a structural depression occupying a major portion of the southeastern Colorado Plateau physiographic province (Hunt 1974). The plateau encompasses much of western Colorado, eastern Utah, northeastern Arizona, and northwestern New

**Table 3.5. Allowable increments for prevention of significant deterioration of air quality (allowable PSD increments)[a]**

| Pollutant | Allowable PSD increments (fg/$m^3$) Class I | Class II | Measurement |
|---|---|---|---|
| Carbon monoxide (CO) | | | |
| Nitrogen dioxide ($NO_2$) | 2.5 | 25 | Annual average |
| Ozone ($O_3$) | | | |
| Lead (Pb) | | | |
| PM-10[b] | 4 | 17 | Annual average |
| | 8 | 30 | 24-hr[c] |
| Sulfur dioxide ($SO_2$) | 2 | 20 | Annual average |
| | 5 | 91 | 24-hr[d] |
| | 25 | 512 | 3-hr[d] |

[a]Where no value is listed, there is no corresponding standard. Class I areas are specifically designated areas in which degradation of air quality is severely restricted (e.g., many national parks); Class II areas (all areas in the United States not designated as Class I) have a less stringent set of allowable PSD increments.

[b]Particulate matter less than 10 $\mu$m in diameter.

[c]Not to be exceeded on more than 1 day/year on the average over 3 years.

[d]Not to be exceeded more than once per year.

Mexico. The San Juan Basin is underlain by up to 3000 m (10,000 ft) of sedimentary strata, which generally dip gently from the margins toward the center of the basin. The margins of the basin are characterized by relatively small elongate domes, uplifts, and synclinal depressions.

The stratigraphic sequence in the San Juan Basin is composed of units ranging from Precambrian to the Holocene age. Stratigraphic descriptions presented here are limited to formations that would be involved in the proposed mining operation or formations that may have environmental significance, such as important aquifers found above and below the mine zone. A generalized stratigraphic column is shown in Figure 3.3.

The Morrison Formation is composed of the Recapture, Westwater Canyon, and Brushy Basin Members and is the host formation for major uranium deposits in the area. In addition, the Westwater Canyon is an important regional aquifer. The following regional descriptions are derived from reports by Green and Pierson (1977), Hilpert (1963, 1969), TVA (1979), Chenoweth and Learned (1980), and HRI (1993).

**Table 3.6. EPA Class I prevention of significant deterioration areas**

| Utah | Colorado |
|---|---|
| Arches National Park | Black Canyon of the Gunnison Wilderness |
| Bryce Canyon National Park | Eagles Nest Wilderness |
| Canyonlands National Park | Flat Tops Wilderness |
| Capitol Reef National Park | Great Sand Dunes Wilderness |
| Zion National Park | La Garita Wilderness |
| | Maroon Bells-Snowmass Wilderness |
| **Arizona** | Mesa Verde National Park |
| | Mount Zirkel Wilderness |
| Chiricahua National Monument Wilderness | Rawah Wilderness |
| Chiricahua Wilderness | Rocky Mountain National Park |
| Galiuro Wilderness | Weminuche Wilderness |
| Grand Canyon National Park | West Elk Wilderness |
| Mazatzal Wilderness | |
| Mount Baldy Wilderness | **New Mexico** |
| Petrified Forest National Park | |
| Pine Mountain Wilderness | Bandelier Wilderness |
| Saguaro Wilderness | Bosque del Apache Wilderness |
| Sierra Ancha Wilderness | Carlsbad Caverns National Park |
| Superstition Wilderness | Gila Wilderness |
| Sycamore Canyon Wilderness | Pecos Wilderness |
| | Salt Creek Wilderness |
| | San Pedro Parks Wilderness |
| | Wheeler Peak Wilderness |
| | White Mountain Wilderness |

*Source*: EPA 1994.

The Recapture Member is the bottommost member of the Morrison Formation. It is as thick as 150 m (500 ft) northwest of Gallup but thins considerably and, in outcrops near Gallup and eastward, is only 45 to 90 m (150 to 300 ft) thick. The Recapture is regarded as one of the most variable stratigraphic units in the area. It occurs in the Gallup mining district as a sequence of interbedded siltstone, mudstone, and sandstone strata. Individual strata range from centimeters to meters in thickness. Sandstone beds are generally less than 5 m (15 ft) thick (Hilpert 1969). The Recapture is widely believed to interfinger with the underlying Cow Springs Sandstone, and several authors have combined the two units as one. No significant uranium deposits occur in the Recapture Member.

The Westwater Canyon Member of the Morrison Formation consists of interbedded fluvial red, tan, and light gray arkosic sandstone, claystone, and mudstone. It is the major water-bearing member of the Morrison. The unit's thickness in outcrop from Gallup to the continental divide ranges between 53 and 85 m (175 and 275 ft) (Hilpert 1969) and is known to be considerably thicker locally. In most

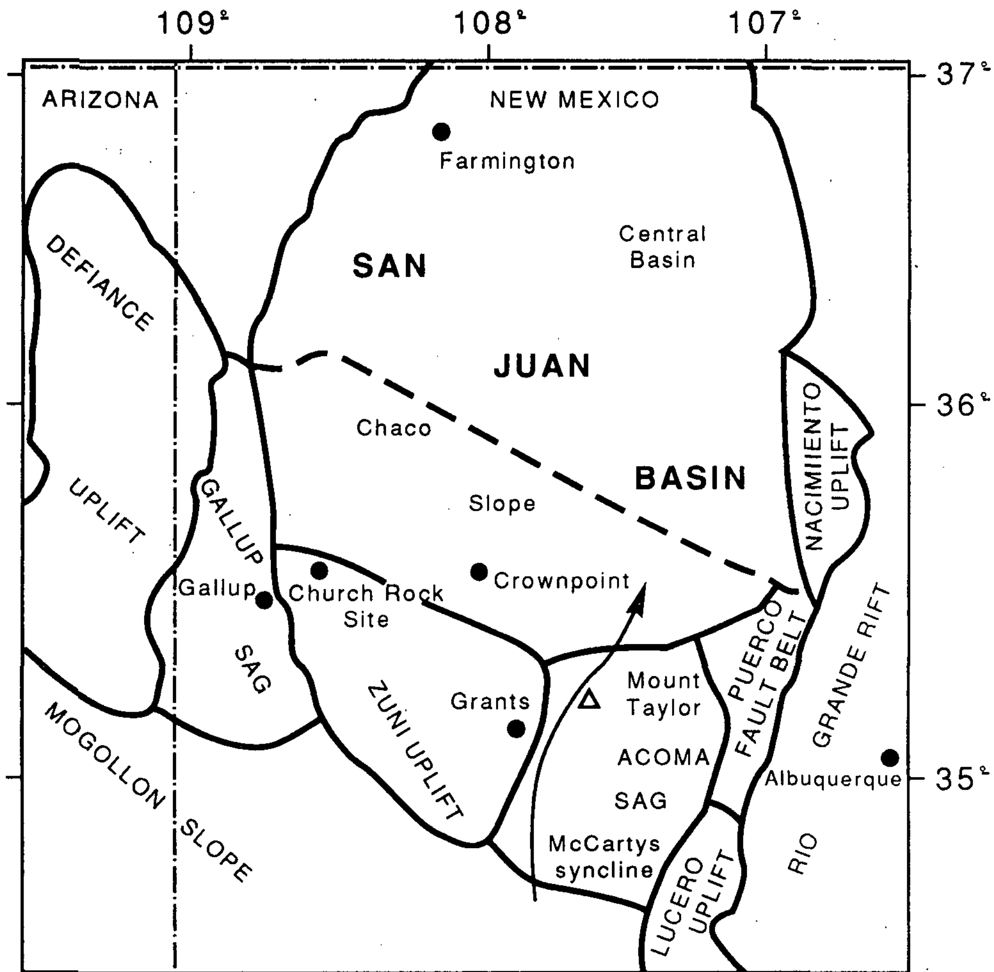


**Figure 3.2. Structural setting of the San Juan Basin.** *Source*: Kelley 1963; Kelley and Clinton 1960.

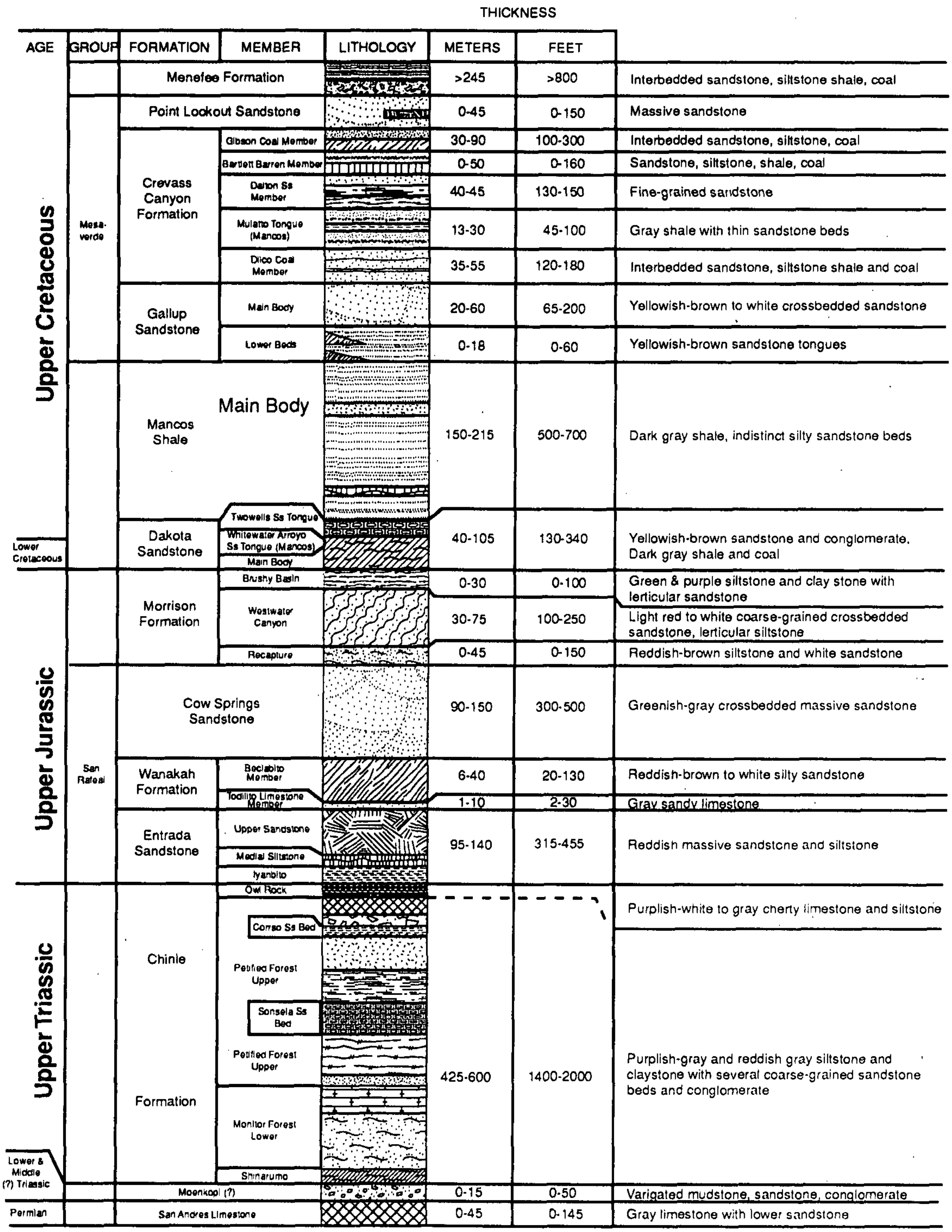


**Figure 3.3. Stratigraphic column of the Church Rock, New Mexico area.** *Source:* adapted from Chenoweth and Learned 1980; revised by staff.

places, the Westwater displays one or more mudstone units that range from thin partings to units up to 6 m (20 ft) thick. These mudstones have limited lateral continuity, and only the thicker ones are extensive. This member is host for the major uranium deposits in the region. The uranium occurs in coarse-grained, poorly sorted sandstone units and is closely associated with the carbonaceous material that coats the sand grains.

The Brushy Basin Member overlies the Westwater Canyon and ranges from 12 to 40 m (40 to 125 ft) thick in the Gallup region. It is mainly composed of light greenish gray and varicolored claystone, interbedded with sandstone lenses having similar lithology and appearance to sandstones found in the Westwater Canyon Member (Ristorcelli 1980). The mudstones are largely derived from volcanic ash falls (Peterson 1980) and contain considerable amounts of bentonite. Its contact with the Westwater Canyon is gradational and interfingering.

The Dakota Sandstone is the basal formation of the Cretaceous System and unconformably overlies the Morrison Formation. The Dakota is a gray-brown quartz sandstone with some interbedded conglomerate, shale, carbonaceous shale, and coal. It is a marine sandstone and is considered to represent the earliest transgression of late Cretaceous seas. The Dakota crops out around the margins of the San Juan Basin and thickens towards the center of the basin to about 60 m (200 ft) regionally.

The Mancos Shale overlies the Dakota Sandstone and is a thick, mostly uniform gray marine shale containing thin lenses of fine-grained sandstone. It varies in thickness up to 600 m (2000 ft) regionally. The Mancos has two upper sandy tongues, the Mulatto and Satan, that intertongue with the Mesaverde Group and merge with the main body of the Mancos to the east. The unit's lower shale tongues interfinger with the underlying Dakota. The Mancos forms the foundation bedrock at the Church Rock site.

The Mesaverde Group overlies the Mancos Shale and is composed of several formations that are described as follows in ascending order:

1. The Gallup Sandstone forms the basal unit of the Mesaverde Group. It is a gray-white or pink-to-tan, medium- to fine-grained, moderately well-sorted, calcareous, cross-bedded sandstone. Unlike the main body of the Gallup Sandstone, the Torrivio Sandstone Member, which intertongues with the Crevasse Canyon Formation, is very coarse- to medium-grained, poorly sorted, cross-bedded fluvial sandstone. The thickness of the Gallup varies regionally from 0 to more than 70 m (230 ft) and is about 25 m (80 ft) thick near Crownpoint.
2. The Crevasse Canyon Formation overlies the Gallup Sandstone and varies in thickness from 150 to more than 230 m (490 to 750 ft). It consists of an upper and lower member composed of interbedded lenticular sandstones, claystones, and thin discontinuous coal beds separated by a sheetlike body of fine-grained, well-sorted calcareous marine sandstone. In ascending order, the Dilco Coal Member, the Dalton Sandstone Member, and the Gibson Coal Member make up the Crevasse Canyon Formation.
3. The Point Lookout Sandstone overlies the Crevasse Canyon Formation and is split into two parts, the lower Hosta Tongue and the upper main body, by the Satan Tongue of the Mancos Shale. The

Point Lookout is a fine- to medium-grained, grayish brown to white sandstone. The Satan Tongue of the Mancos Shale consists of interbedded shale, mudstone, and thin calcarious sandstone beds.

Thick colluvium deposits are commonly found forming a mantle on steep slopes surrounding sandstone mesas and cuestas. By contrast, Quaternary alluvium is found on the valley floors of the region. These deposits consist of fine sand, silt, and clay derived from the weathering of sandstone, siltstone, and mudstone exposed at the surface. Alluvial deposits generally are thin but are known to exceed a thickness of 10 m (30 ft) in larger valleys.

The Grants Uranium Belt is one of the largest producers of uranium in the world. From 1950 through 1978, ore containing 123,000 metric tons of uranium oxide were extracted (Chenoweth and Holen 1980). This represented 40 percent of the U.S. production. Most uranium mineralization in the region occurs as pore fillings or coatings in sandstone of the Morrison Formation and, less importantly, in the Dakota Sandstone and Todilto Limestone (Hilpert 1963). The ore bodies occur as elongated masses or roll-front deposits. Generally, the deposits are a few feet thick and several hundred to a thousand feet long and may be stacked, usually parallel to the strike of the host rock. The major mineral is coffinite, with minor amounts of uraninite, andersonite, bayleyite, uranophane, tyuyamunite, and carnotite present.

Uranium first migrated into sandstone relatively soon after its deposition in tuffaceous sediment and other rocks of volcanic origin. The uranium was dissolved and transported by migrating groundwater until it was precipitated as coatings on sandstone grains. Ore deposits are associated with well-developed channel sandstones in the upper three-fourths of the Westwater Canyon Member. Ore zones are irregular in configuration and are elongated parallel to depositional features (N35°W). Varying rates of groundwater flow controlled by sedimentary facies in each stratigraphic zone in the Westwater Canyon produced stacked ore deposits near one another but not necessarily above and below one another (Peterson 1980). The deposits are found as irregular pods or as the classic c-shape roll fronts (Figure 3.4).

Site-specific information for this FEIS was derived by interpreting geophysical log information submitted by HRI, and to the extent practical, by verifying the information with independently published accounts.

### 3.2.2 Crownpoint

Figure 3.5 contains a stratigraphic column for the Unit 1 and Crownpoint sites. HRI's submittals show that the Recapture mudstone unit underlying the Crownpoint site is generally about 75 m (250 ft) thick. Wentworth and others (1980) verify that the Recapture Member underlying the east side of Crownpoint is about 80 m (260 ft) thick below the Section 29 uranium deposits. In the Crownpoint area, the top of the Westwater Canyon is found at an average approximate elevation of 1525 m (5000 ft) or a depth of 560 m (1840 ft). HRI's log data indicate that the Westwater Canyon Member thickens from about 72 m (236 ft) in the western part of Unit 1, to 90 m (295 ft) in Section 24, to over 105 m (345 ft) in

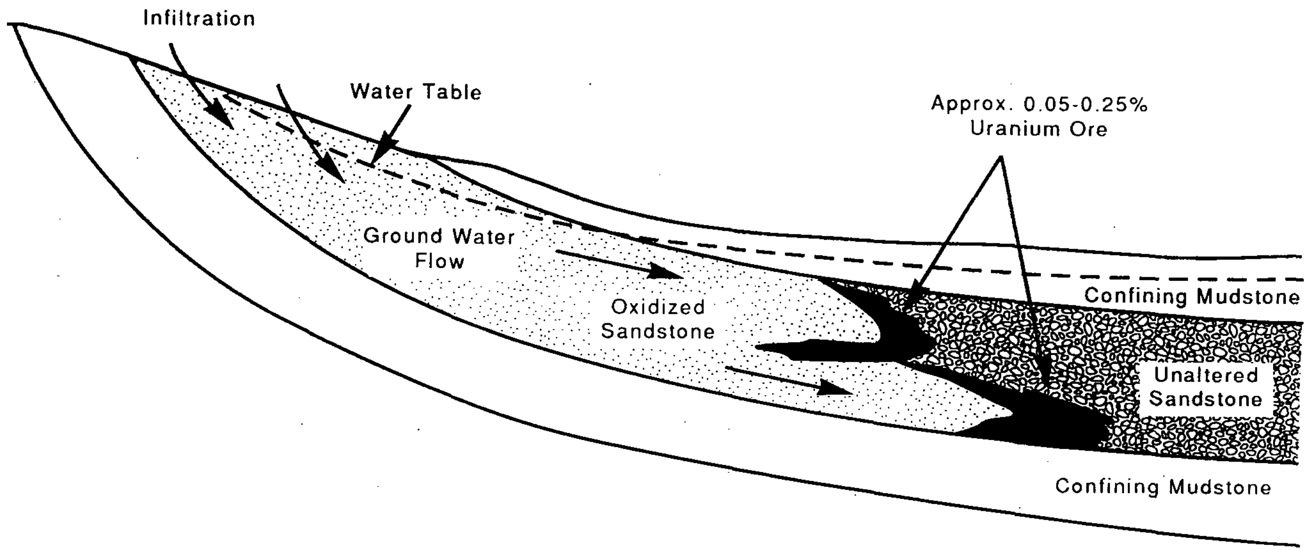


**Figure 3.4. Simplified cross-section of roll-front uranium deposits formed by regional groundwater migration.**

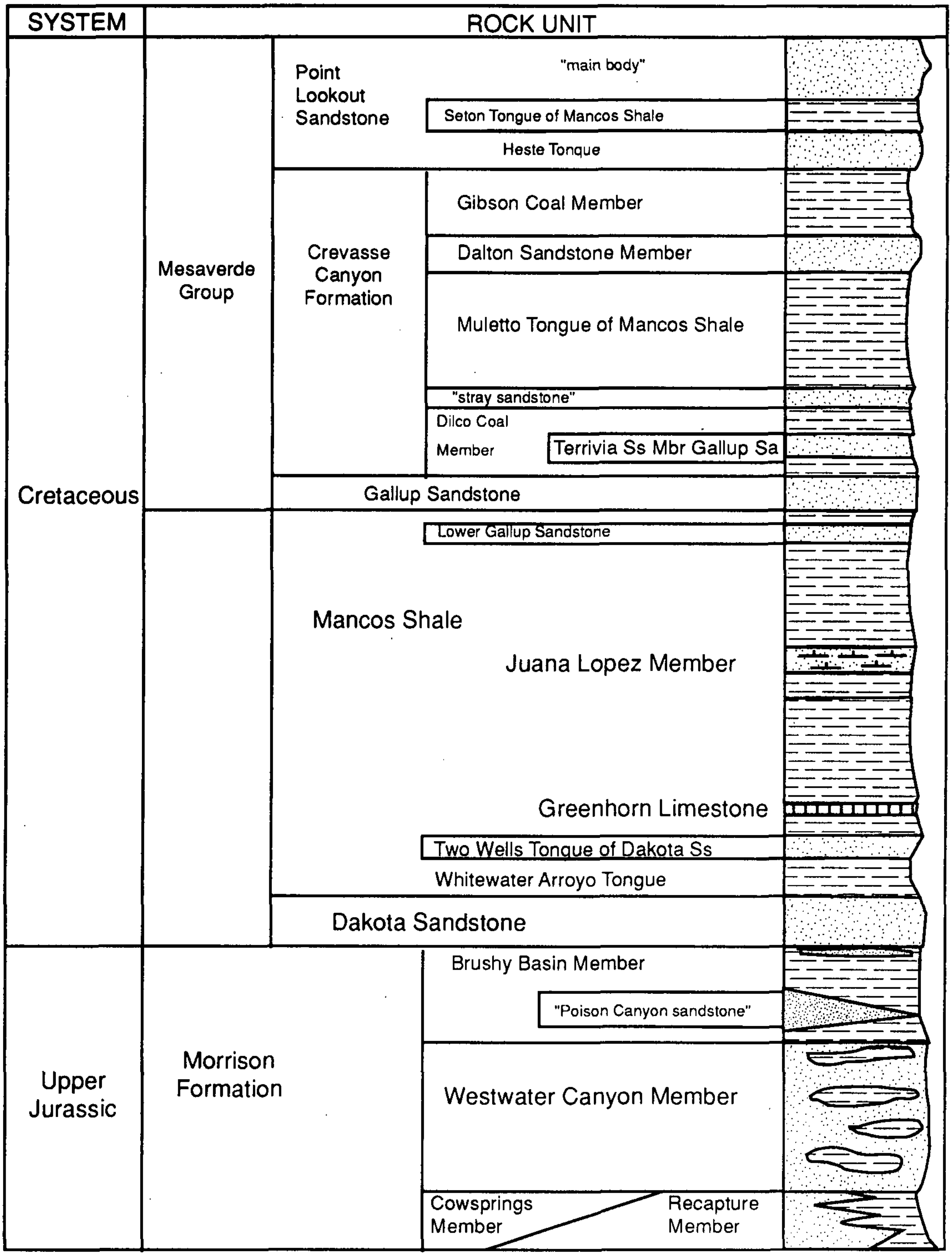


**Figure 3.5. Stratigraphic column of the Unit 1 and Crownpoint sites.**

Section 19 north of Crownpoint. Wentworth and others (1980) report a similar variation in thickness east of Crownpoint in Section 29, ranging from 76 to 107 m (250 to 350 ft). The Westwater Canyon consists of a series of gray to light red, fine- to medium-grained arkosic sandstones with a number of well-defined mudstone layers. The mudstone units are pale green or varicolored and range from a few centimeters to 9 m (30 ft) thick.

HRI's data indicate that the Brushy Basin Member averages 20 to 35 m (67 to 112 ft) thick near Crownpoint. These values agree with data from the Section 29 ore deposits (Wentworth and others 1980). The Brushy Basin Member contains shale with a few thin and discontinuous sandy lenses.

Rocks in the Crownpoint area dip approximately 1 to 2 degrees north-northeast. Wentworth and others (1980) report that northeast-trending faults are known in the Crownpoint area but have limited displacement. Robertson (1986) maps two east-trending faults crossing the town (Figure 3.6). Field observation indicates that one of the faults is well exposed on the mesa slopes in the southwest quarter of Section 19. The fault is observed in outcrops where sandstone and coal strata in the northern block are offset relatively downward by approximately 7 m (23 ft). Robertson's (1986) interpretation reveals that the fault steepens in the subsurface, passing through the ore zone. Associated cross-sections indicate that the offset of this fault is minor compared to strata thickness and that differing sandstone units are not juxtaposed.

Uranium deposits at the Crownpoint site average nearly 4 m (11 ft) thick in each zone (USGS 1982). The stacked ore zones have a combined thickness of about 37 m (120 ft). The combined dimensions of the Unit 1 and Crownpoint ore bodies exceed 8 km (5 miles) long, and their width varies from 290 to 760 m (950 to 2500 ft).

Major soil associations in the Crownpoint area are the Lohmiller–San Mateo, Hagerman-Travessilla, and Rock Land–Travessilla (TVA 1979). The Lohmiller–San Mateo association occupies the lowest topographic position in the area (Table 3.7). It occurs on flood plains, terraces, and gently sloping plains along ephemeral streams. Because the association is formed on alluvium derived from sandstone and shale, the soils are 15 to 25 cm (6 to 10 in) thick, light brownish-gray to pale brown, calcareous clay loam to loam. They form a surface layer overlying 152 cm (60 in.) or more of stratified, fine-textured alluvium.

**Table 3.7. Selected characteristics of the Lohmiller–San Mateo soil association in the Crownpoint area**

| Property | Description |
|---|---|
| Topographic position | Flood plains and low terraces |
| Texture | Loam or clay loam |
| Slope | 0 to 3 percent |
| Shrink-swell potential | Moderate to high |
| Permeability | 0.2–0.6 in./hr |

*Source:* TVA 1979.

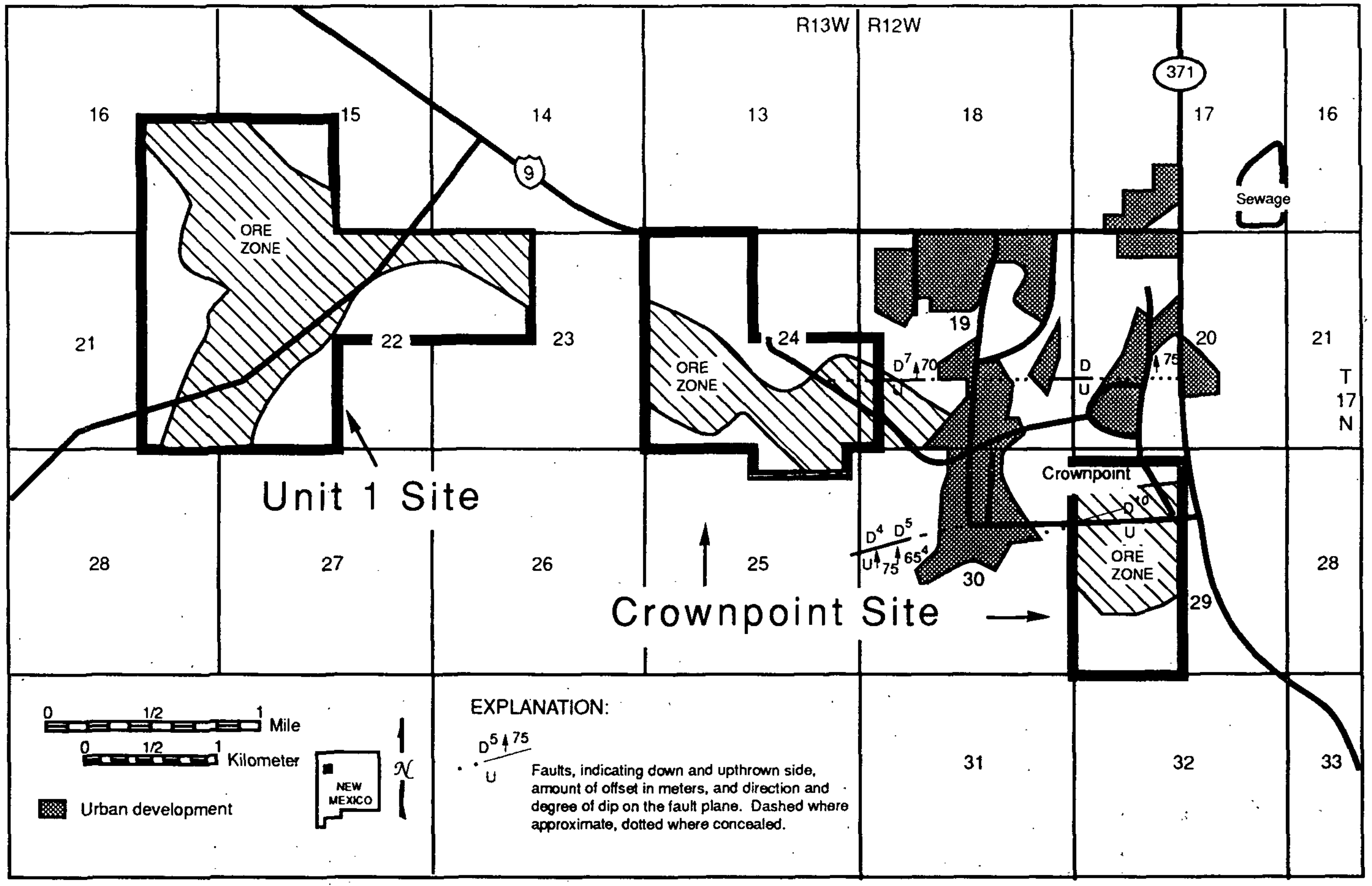


Figure 3.6. Surface locations of faults and ore zones in the Crownpoint area.

The dominant Hagerman and Travessilla soils of the Hagerman-Travessilla association are not as closely related as the two major soil types of the Lohmiller–San Mateo association. Hagerman soil (Table 3.8), a noncalcareous, fine sandy loam to loam, is confined to the mesa and ridge tops, whereas the thinner Travessilla soil (Table 3.9) occurs on steeper slopes of the mesas, ridges, and breaks. The surface layer has a fine sandy loam texture and is slightly calcareous. Small angular sandstone fragments are characteristic of the surface layer and increase in number with depth. Both soils are generally light brown in color.

**Table 3.8. Selected characteristics of the Hagerman soils in the Crownpoint area**

| Property | Description |
|---|---|
| Topographic position | Mesa and ridge tops |
| Texture | Fine sandy loam to loam |
| Slope | 1 to 5 percent |
| Shrink-swell potential | Low to moderate |
| Permeability | 0.6–2.0 in./hr |

*Source:* TVA 1979.

**Table 3.9. Selected characteristics of the Travessilla soils in the Crownpoint area**

| Property | Description |
|---|---|
| Topographic position | Steep slopes |
| Texture | Fine sandy loam with rock fragments |
| Slope | 3 to 25 percent |
| Shrink-swell potential | Low |
| Permeability | 2–6 in./hr |

*Source:* TVA 1979.

The Rock Land–Travessilla soil association occurs in rough, broken topography with considerable variation in local relief. Outcrops of sandstone and shale are common on the steep canyon walls and escarpments, with thin deposits of gravelly alluvium occurring on the breaks adjacent to larger drainages. This association dominantly consists of a complex of shallow soils and outcrops of sandstone and other sedimentary rocks. However, small isolated pockets of moderately deep soils do occur where topography permits.

## 3.2.3 Unit 1

HRI's submittals show that the Unit 1 site's geologic units and soils are very similar to the Crownpoint site's, with the exception that the Recapture mudstone unit underlying the Unit 1 and Crownpoint sites is generally about 75 m (250 ft) thick and the Brushy Basin Member averages 47 m (153 ft) thick. This similarity between the two sites is to be expected since their site boundaries are about 0.5 mile from each other.

## 3.2.4 Church Rock

Figure 3.7 contains a stratigraphic column of the Church Rock site. HRI indicates that the Recapture Member is at least 45 m (150 ft) thick in the mine area and overlies the Cow Springs Sandstone. This generally agrees with regional isopach data of Morrison strata (Saucier 1967), indicating that the Recapture is 60 m (200 ft) thick in this area. Hilpert (1969) provides cross-sections through the old Church Rock mine, based on Phillips Petroleum Company drilling logs, which indicate that a tongue of Cow Springs Sandstone closely underlies the Westwater Canyon. This sandstone, however, coincides with a sandstone interpreted by HRI in the lowermost part of the Westwater and appears to be underlain by Recapture Member Shale. In Section 13, west of HRI's Church Rock site, Peterson (1980) indicates that the Recapture Member does not occur and that the Westwater Canyon Member lies directly on the Cow Springs Sandstone.

The top of the Westwater Canyon is found at depths ranging from 140 to 230 m (460 to 760 ft), dipping north-northeastward beneath the Church Rock site (HRI 1988). HRI's drilling logs from Church Rock indicate that the Westwater Canyon Member averages 80 m (263 ft) thick in Section 17 and that the Westwater is not fully penetrated by wells in Section 8. Peterson (1980) reports that Westwater thickness ranges from 67 to 82 m (220 to 270 ft) 3.5 km (2 miles) west of the Church Rock site. HRI's logs from exploration drill holes and water wells indicate a relatively uniform thickness across the proposed mining area.

HRI's data indicate that the Brushy Basin Member (above the Westwater) is composed of two separate mudstone beds with an intervening sandstone layer. Data in the Environmental Report (HRI 1988) from wells along the ore body indicate that the total thickness of the unit averages 19 m (63 ft). The thickness of the lower mudstone (B clay) is 5 to 10 m (16 to 32 ft), while the sandstone (B sand) is 4 to 9 m (13 to 28 ft), and the upper mudstone (B clay) is 5 to 10 m (16 to 33 ft). Mine-zone cross-sections figured by Hilpert (1969) agree with these interpretations.

Strata in the Church Rock area display a northward dip of approximately 3 degrees. Some of the sandstone units in the area are known to exhibit jointing and fracturing in the subsurface. An account by Read and Werts (1967) indicates that the old Church Rock mine experienced excessive water seepage owing to fracture zones in the Westwater Canyon Sandstone. Northeast of the mine site, Pipeline Canyon is thought to coincide with a fault. The location of the fault is approximated by Chapman, Wood, and Griswold (1974) (Figure 3.8), trending southwestward into Section 17 (HRI's proposed permit area) and within 100 m (325 ft) of HRI's monitor well ring. The amount of potential fault displacement is not estimated.

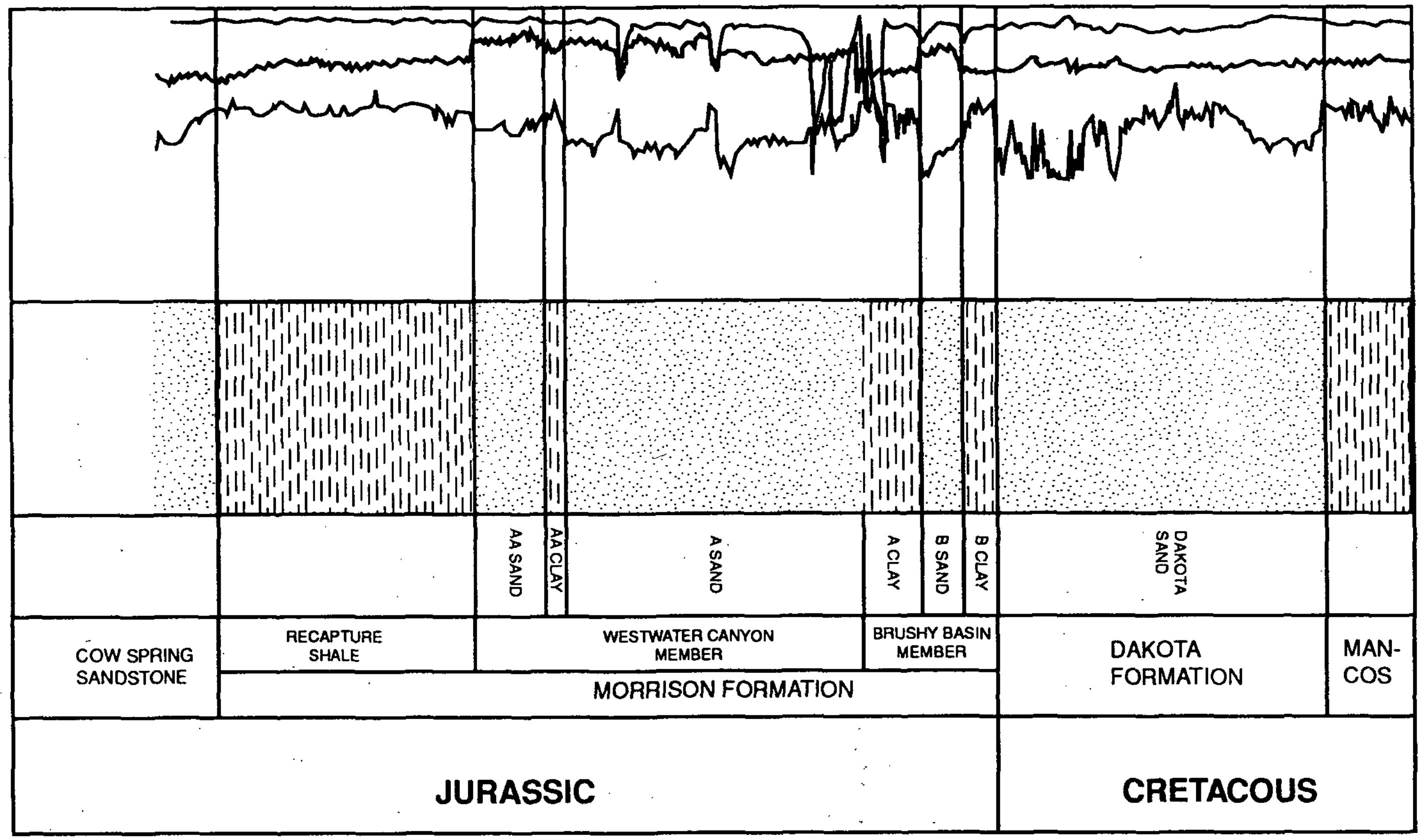


**Figure 3.7. Stratigraphic column of the Church Rock site.**

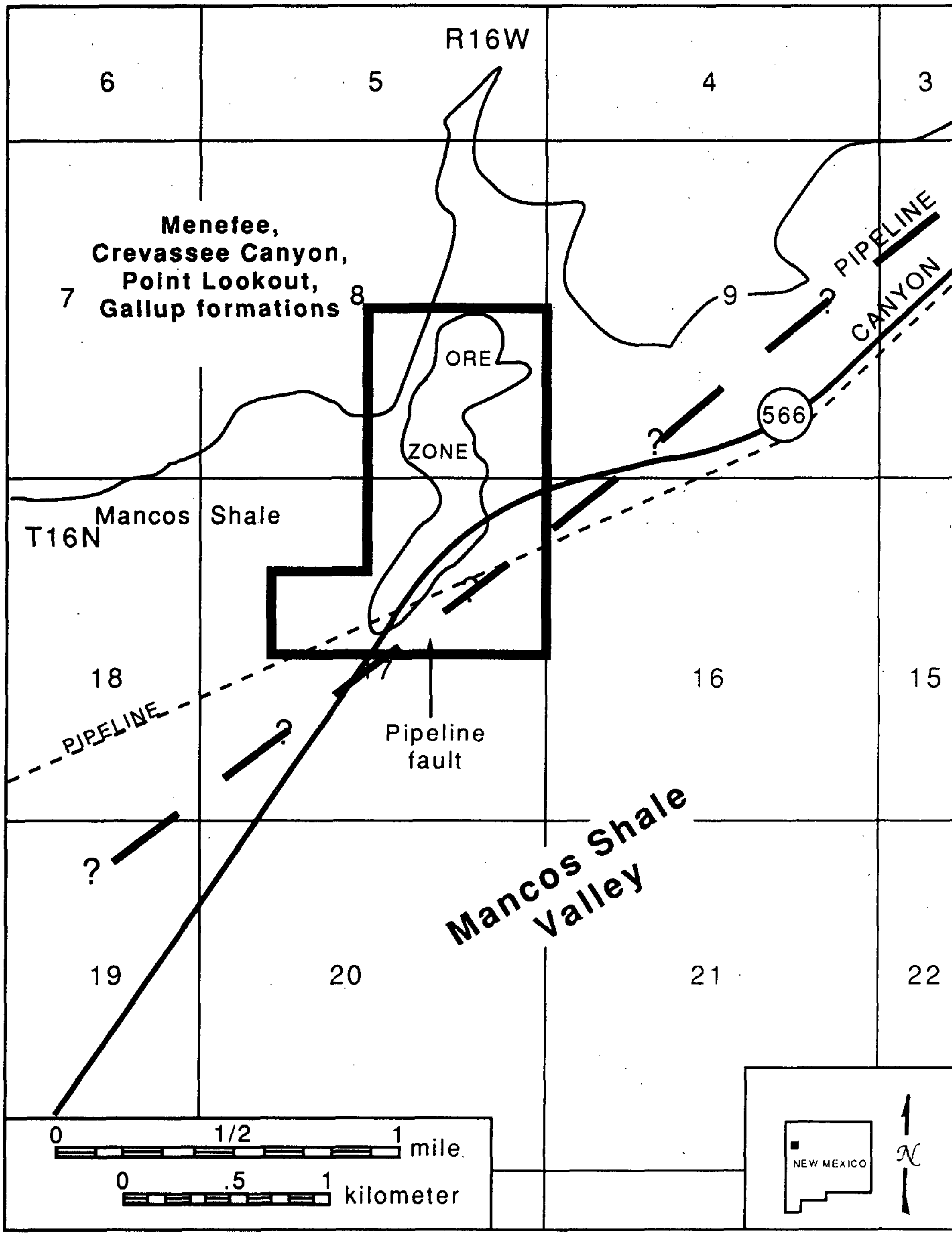


**Figure 3.8. Generalized geologic map of the Church Rock site area and the hypothetical Pipeline fault.** *Sources*: Kirk and Zech 1987; Chapman, Wood, and Griswold 1974.

According to Peterson (1980), the Pipeline fault extends southwestward and occurs approximately 1.5 km (1 mile) southeast of the Section 17 mining property area. This interpretation places the fault outside HRI's proposed permit area. A more recent detailed geologic map (Kirk and Zech 1987) indicates that the fault does not occur at all. This geologic map indicates no offset structural contours in the area. This interpretation is repeated by several regional geological studies including Sears and others (1936), O'Sullivan and Beaumont (1957), and Cooley and others (1969). No evidence for the fault is found in any of the site drilling data, and HRI indicates that if it exists, it is probably found some distance to the east.

The Church Rock site contains mineralization in the Cretaceous Dakota Sandstone and the Westwater Canyon Member of the Jurassic Morrison Formation (USGS 1975). The proposed operations would occur in sandstone in the upper Westwater. HRI has designated the production zone within the Westwater Canyon as the "A" sand.

Mineral resources present at the Church Rock site are contained in roll fronts and elongated tabular deposits (USGS 1975). Mineralization varies in thickness but averages 3 m (9 ft) thick in each zone. Because the ore bodies are stacked, it has a combined thickness of about 24 m (80 ft). Overall dimensions of the ore body are 1600 m (5300 ft) long and up to 300 m (1000 ft) wide.

The Church Rock lease area exhibits a complex mixture of soil associations. The well field and potential irrigation areas are underlain by two soil series, the El Rancho and Mikam (Table 3.10).

**Table 3.10. Selected characteristics of the El Rancho and Mikam Soil Series found in the Church Rock lease area**

| Property | Mikam | El Rancho |
|---|---|---|
| Topographic position | Alluvial fans and toe slopes | Terraces and valley bottoms |
| Texture | Fine loam | Clay loam to sandy clay loam |
| Slope | 0 to 15 percent | 0 to 15 percent |
| Shrink-swell potential | Low to moderate | Low to moderate |
| Permeability | Moderate, well drained | Moderate, well drained |

*Source*: HRI 1988.

## 3.3 HYDROLOGY

### 3.3.1 Groundwater

#### 3.3.1.1 Regional

Regional aquifers in northwestern New Mexico are grouped into multiple aquifer systems based on hydrologic relationships. At Church Rock, only the Dakota Sandstone and Morrison Formation present hydrologic concerns. At Crownpoint, additional shallower aquifers are found in the Mesaverde Group. The Dakota Sandstone is mostly unused as a water supply in McKinley County because of its generally poorer water quality.

The Westwater Canyon provides two valuable resources: uranium ore and high-quality groundwater. The Westwater Canyon is a classic example of an artesian aquifer. It is recharged from surface water infiltrating the rock in and around the Zuni and Defiance uplifts and moves in a down-dip direction toward the deeper parts of the San Juan Basin (Kelly 1977). The topographically higher recharge areas create a hydraulic head, causing groundwater to rise in wells in the basin, some of which flow at the surface.

#### 3.3.1.2 Crownpoint

With the exception of HRI-owned wells, there are no wells within the Crownpoint site boundary. Operating private wells in the area are widely dispersed. The nearest operating private well is located just outside the southwest boundary of the western half of the site. This is a private well drilled into the Gallup Sandstone of the Mesaverde Group. The next nearest operating private well is more than 0.5 miles distant from the site boundary. The nearest public water supply wells are located in the town of Crownpoint, with wells located within 0.4 km (0.25 miles) of both the eastern and western site boundaries.

The town of Crownpoint derives its water supply from six wells completed in the Westwater Canyon Sandstone of the Morrison Formation. The water-supply network is owned and operated by the BIA and the NTUA. Five of the wells (BIA-5, BIA-3, BIA-6, NTUA-1, and NTUA-2) are found near the HRI's Crownpoint site, as shown in Figure 3.9. Each water-supply well has up to 150 m (500 ft) of screened interval within the Westwater Canyon Member (Table 3.11), thus exposing a relatively thick zone of saturated rock. Three of the town of Crownpoint's water wells (BIA-5, BIA-3, and BIA-6) are completed in the Dakota Sandstone as well as the Westwater Canyon Member. In addition, well BIA-5 is also completed into the Cow Springs aquifer. HRI monitored water levels and pumping rates in these wells over several months (HRI 1992a) and found that each well is used sporadically and provides flow rates of 190 to 450 Lpm (50 to 120 gpm).

The town of Crownpoint water supply fits the definition of a "public water system," and the West Water Canyon Member and the Dakota Sandstone fit the definition of "underground sources of

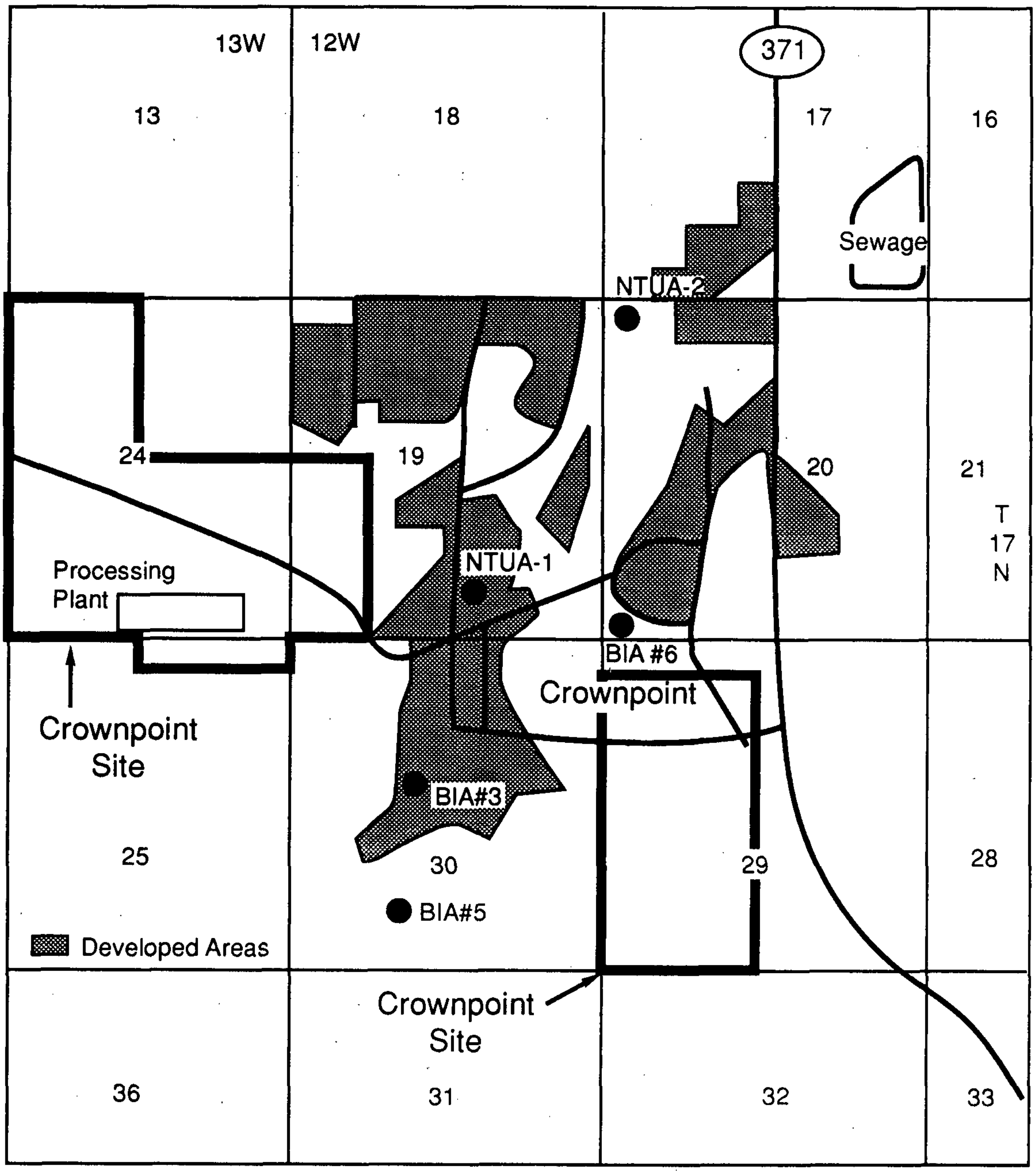


**Figure 3.9. Municipal water-supply wells completed in the Westwater Canyon Sandstone in the Crownpoint area.**

**Table 3.11. Municipal water-supply wells in the Crownpoint area**

| Name | Total depth (m) | Producing interval (m) |
|---|---|---|
| NTUA-1 | 715 | 590–695 |
| BIA-3 | 761 | 463–725 |
| BIA-5 | 775 | 488–775 |
| BIA-6 | 762 | 562–720 |
| NTUA-2 | 725 | 654–715 |

*Source*: HRI 1992a.

drinking water" in the EPA's National Primary Drinking Water Regulations. A public water system is a system for provision to the public of piped water for human consumption, if such has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year (40 CFR § 141.2). Drinking water storage is provided both below and above ground with a total capacity of 2.5 million L (675,000 gal). The BIA well capacities total 196,820 L/day (52,000 gpd), and NTUA well capacities total 870,187 L/day (229,904 gpd) (NRC 1994; Dalton 1995). Census figures indicate that the population of Crownpoint was 2108 persons occupying 673 total housing units in 1990 (NRC 1994). The Crownpoint water system also supplies water to the Crownpoint Boarding School, which has 568 students, and the Crownpoint Elementary and High schools, which have 646 and 638 students, respectively (NRC 1994). Water is also supplied to the Crownpoint Indian Hospital, with 56 beds and a hospital staff of 74, and the Community Health Service, which has a staff of 30 (NRC 1994).

Groundwater from the Westwater Member near the town of Crownpoint has a total dissolved solids concentration that ranges from 281 to 3180 ppm and averages 773 ppm (HRI 1992b). Groundwater as measured in Dakota Sandstone well CP10 has a total dissolved concentration that averages 683 ppm (HRI 1992b). Even though the town's water-supply wells are completed in sands that contain uranium deposits, radionuclide concentrations in the Crownpoint public water supply are low; uranium values range from 4.7 to 7.4 pCi/L, radium-226 from 0.18 to 0.29 pCi/L, and thorium-230 from 0.4 to 2.2 pCi/L (HRI 1995b). Water from the town of Crownpoint water-supply wells is of better quality than State of New Mexico drinking water quality standards.

An underground source of drinking water is an aquifer or its portion that (1) supplies any public water system or (2) contains a sufficient quantity of groundwater to supply a public water system and (a) currently supplies drinking water for human consumption, (b) contains fewer than 10,000 mg/L total dissolved solids, and (c) is not an exempted aquifer (40 CFR § 144.3). Water near the town of Crownpoint in the Westwater Canyon Member and the Dakota Sandstone currently meets all of these criteria.

The first aquifer beneath the mine zone aquifer (Westwater Canyon) is the Cow Springs aquifer. Little information is available on this aquifer. The limited water quality data available are incomplete but suggest that the Cow Springs aquifer contains good quality water (HRI 1996c). Reported transmissivity values are low, in the 35 $m^2$/day (374 gal/day/ft) range, for most of the San Juan Basin (HRI 1996c). Head data indicate that the Cow Springs aquifer has higher hydraulic heads than the Morrison, which implies upward vertical flow in the Cow Springs aquifer. Well BIA-5 is completed into the Dakota Sandstone aquifer, the Westwater Canyon aquifer, and the Cow Springs aquifer (HRI 1992b). In addition, a local well (Mobil Monument Windmill) located 0.5 miles east of the Crownpoint site in Section 28 appears to be completed into the Cow Springs aquifer as well as into the Westwater Canyon and deeper units (HRI 1992b).

The Recapture Shale, which lies on top of the Cow Springs Formation and is considered to be an aquitard, is about 79 m (260 ft) thick at the Crownpoint site. A large number of drill holes have been drilled into the Recapture Shale at each of the three project sites. Near the Crownpoint site, three drill holes have been identified that penetrate the total thickness of the Recapture Shale (HRI 1996a). These are drill holes 24–156c (located at the Crownpoint site), 238–132 [located 1.6 km (1 mile) east of Crownpoint], and 16–224 [located 3.2 km (2 miles) west of Crownpoint]. Most of the drill holes in the area only penetrated the upper 1.5 to 12.2 m (5 to 40 ft) of Recapture Shale. From an inspection of the materials submitted by HRI, NRC staff have not found any instances where the Recapture Shale is absent beneath the Crownpoint or Unit 1 sites.

Above the Recapture Shale is the Westwater Canyon aquifer, which is an artesian aquifer. Water quality in the Westwater Canyon is good and usually meets New Mexico drinking water quality standards (Tables 3.12 and 3.13). The five town water wells and the windmill located in Section 28 are completed in the Westwater Canyon aquifer. In the Crownpoint area, the top of the Westwater Canyon is found at an elevation of approximately 1525 m (5000 ft), but water levels rise naturally in wells approximately 445 m (1460 ft) from the top of the Westwater aquifer to 75 m (240 ft) below the surface (HRI 1992a). The natural potentiometric surface slopes north-northeastward but has been altered by pumping from drinking water supply wells in Crownpoint.

A potentiometric surface map of the Westwater aquifer for the Unit 1 and Crownpoint sites was prepared using a calibrated flow model to match monitor well level data collected in the summer of 1992 (Figure 3.10) (HRI 1996a). Summer water-level gradients were modeled because they tend to be steeper than winter gradients due to increased pumping from the town of Crownpoint water wells. This model was then used to calculate groundwater gradients for those areas in and around the town of Crownpoint that do not have monitor wells. The potentiometric map shows that in all directions, local groundwater flow is toward the town of Crownpoint water wells. Calculated groundwater flow velocities based on the piezometric surface map for the Crownpoint site ranged from 3.9 m/year (12.9 ft/year) in the east to 2.4 m/year (8 ft/year) at the west side of the site (HRI 1996a).

The Brushy Basin Shale overlies the mineralized zone and is considered an aquitard in the area (HRI 1992b). At the Crownpoint site, the Brushy Basin Member does not contain any aquifers and consists entirely of shale (HRI 1992b). From an inspection of the materials submitted by HRI, staff have not found any instances where the Brushy Basin Shale is absent beneath the Crownpoint or Unit 1 sites.

## Table 3.12. Town of Crownpoint water quality data[a]

| Parameter | Well NTUA-1 (mg/L) | Well NTUA-2 (mg/L) | Wells BIA-5&6 (mg/L) | Well BIA-6 (mg/L) | EPA (and NNEPA) drinking water standards (mg/L) |
|---|---|---|---|---|---|
| Calcium | 5.0 | 1.3 | 9.2 | 1.8 | |
| Magnesium | 2.0 | 0.08 | 4.5 | 0.14 | |
| Sodium | 131.0 | 121.0 | 119.0 | 111.0 | |
| Potassium | 4.9 | 1.2 | 2.3 | 1.7 | |
| Carbonate | 17.0 | 20.0 | 1.0 | 8.0 | |
| Bicarbonate | 234.0 | 221.0 | 249.0 | 223.0 | |
| Sulfate | 82.0 | 52.0 | 98.0 | 49.0 | 250.0 |
| Chloride | 7.7 | 3.2 | 3.2 | 2.0 | 250.0 |
| Nitrate | 0.01 | 0.02 | 0.02 | 0.01 | 10.0 |
| Fluoride | 1.1 | 0.32 | 0.34 | 0.27 | 4.0 or 2.0 |
| Silica | 10.0 | 18.0 | 20.0 | 18.0 | |
| TDS | 402.0 | 351.0 | 406.0 | 325.0 | 500.0 |
| Conductivity[b] | 625.0 | 529.0 | 603.0 | 484.0 | |
| Alkalinity | 220.0 | 215.0 | 206.0 | 197.0 | |
| pH[c] | 8.79 | 8.91 | 8.33 | 8.7 | 6.5–8.5 |
| Arsenic | <0.001 | <0.001 | <0.001 | <0.001 | 0.05 |
| Barium | 0.02 | 0.05 | 0.05 | 0.06 | 2.0 |
| Cadmium | 0.0002 | <0.0001 | <0.0001 | <0.001 | 0.01 |
| Chromium | <0.01 | <0.01 | <0.01 | <0.01 | 0.05 |
| Copper | <0.01 | <0.01 | <0.01 | <0.01 | 1.0 |
| Iron | 0.02 | <0.01 | 0.01 | <0.01 | 0.3 |
| Lead | <0.001 | 0.002 | <0.001 | <0.001 | 0.05 |
| Manganese | 0.01 | 0.01 | <0.1 | <0.01 | 0.05 |
| Mercury | <0.0001 | <0.0001 | <0.0001 | <0.0001 | 0.002 |
| Molybdenum | <0.01 | <0.01 | <0.01 | <0.01 | |
| Nickel | <0.01 | <0.01 | <0.01 | <0.01 | 0.1 |
| Selenium | <0.001 | <0.001 | <0.001 | <0.001 | 0.05 |
| Silver | <0.01 | <0.01 | <0.01 | <0.01 | 0.1 |
| Uranium | <0.001 | <0.001 | 0.007 | <0.001 | |
| Vanadium | <0.01 | <0.01 | <0.01 | <0.01 | |
| Zinc | 0.01 | 0.01 | <0.01 | <0.01 | 5.0 |
| Boron | 0.05 | 0.06 | 0.07 | 0.05 | |
| Ammonia | <0.01 | <0.01 | <0.01 | <0.01 | |
| Radium-226[d] | 0.6 | 0.3 | 0.6 | 0.3 | 5.0 |

[a]Data collected September 1990 (HRI 1996i).
[b]$\mu$mhos/cm.
[c]Units.
[d]pCi/L.

**Table 3.13. Crownpoint site water quality data,[a] Westwater Canyon aquifer**

| Parameter | Mean (mg/L) | Maximum (mg/L) | Minimum (mg/L) | EPA (and NNEPA) drinking water standard |
|---|---|---|---|---|
| Calcium | 2.68 | 7.8 | 0.07 | |
| Magnesium | 0.44 | 2.5 | 0.0 | |
| Sodium | 120.3 | 184.0 | 97.0 | |
| Potassium | 10.58 | 56.0 | 1.5 | |
| Carbonate | 26.42 | 127.0 | 0.0 | |
| Bicarbonate | 201.22 | 260.0 | 54.0 | |
| Sulfate | 54.9 | 177.0 | 19.0 | 250.0 |
| Chloride | 10.9 | 54.0 | 1.8 | 250.0 |
| Nitrate | 0.05 | 0.26 | 0.0 | 10.0 |
| Fluoride | 0.35 | 0.5 | 0.23 | 4.0 or 2.0 |
| Silica | 16.2 | 20.0 | 1.0 | |
| TDS | 367.8 | 666.0 | 318.0 | 500.0 |
| Conductivity[b] | 700.5 | 1040.0 | 463.0 | |
| Alkalinity | 209.3 | 256.0 | 193.0 | |
| pH[c] | 9.0 | 10.4 | 8.26 | 6.5–8.5 |
| Arsenic | 0.0 | 0.001 | 0.0 | 0.05 |
| Barium | 0.05 | 1.0 | 0.0 | 2.0 |
| Cadmium | 0.0 | 0.0008 | 0.0 | 0.01 |
| Chromium | 0.0 | 0.0 | 0.0 | 0.05 |
| Copper | 0.0 | 0.92 | 0.0 | 1.0 |
| Iron | 0.03 | 0.1 | 0.0 | 0.3 |
| Lead | 0.0 | 0.013 | 0.0 | 0.05 |
| Manganese | 0.0 | 0.029 | 0.0 | 0.05 |
| Mercury | 0.0 | 0.0 | 0.0 | 0.002 |
| Molybdenum | 0.0 | 0.02 | 0.0 | |
| Nickel | 0.0 | 0.0 | 0.0 | 0.1 |
| Selenium | 0.0 | 0.0 | 0.0 | 0.05 |
| Silver | 0.0 | 0.0 | 0.0 | 0.1 |
| Uranium | 0.001 | 0.021 | 0.0 | |
| Vanadium | 0.0 | 0.0 | 0.0 | |
| Zinc | 0.0 | 0.03 | 0.0 | 5.0 |
| Boron | 0.06 | 0.11 | 0.0 | |
| Ammonia | 0.03 | 0.31 | | |
| Radium-226[d] | 65.85 | 806.0 | 0.1 | 5.0 |

[a]Values obtained from Wells CP-3, CP-5, CP-6, CP-7, CP-9, and well CP-2 (for parameters from arsenic to radium-226, (*Source:* HRI 1992b).
[b]$\mu$mhos/cm.
[c]Units.
[d]pCi/L.

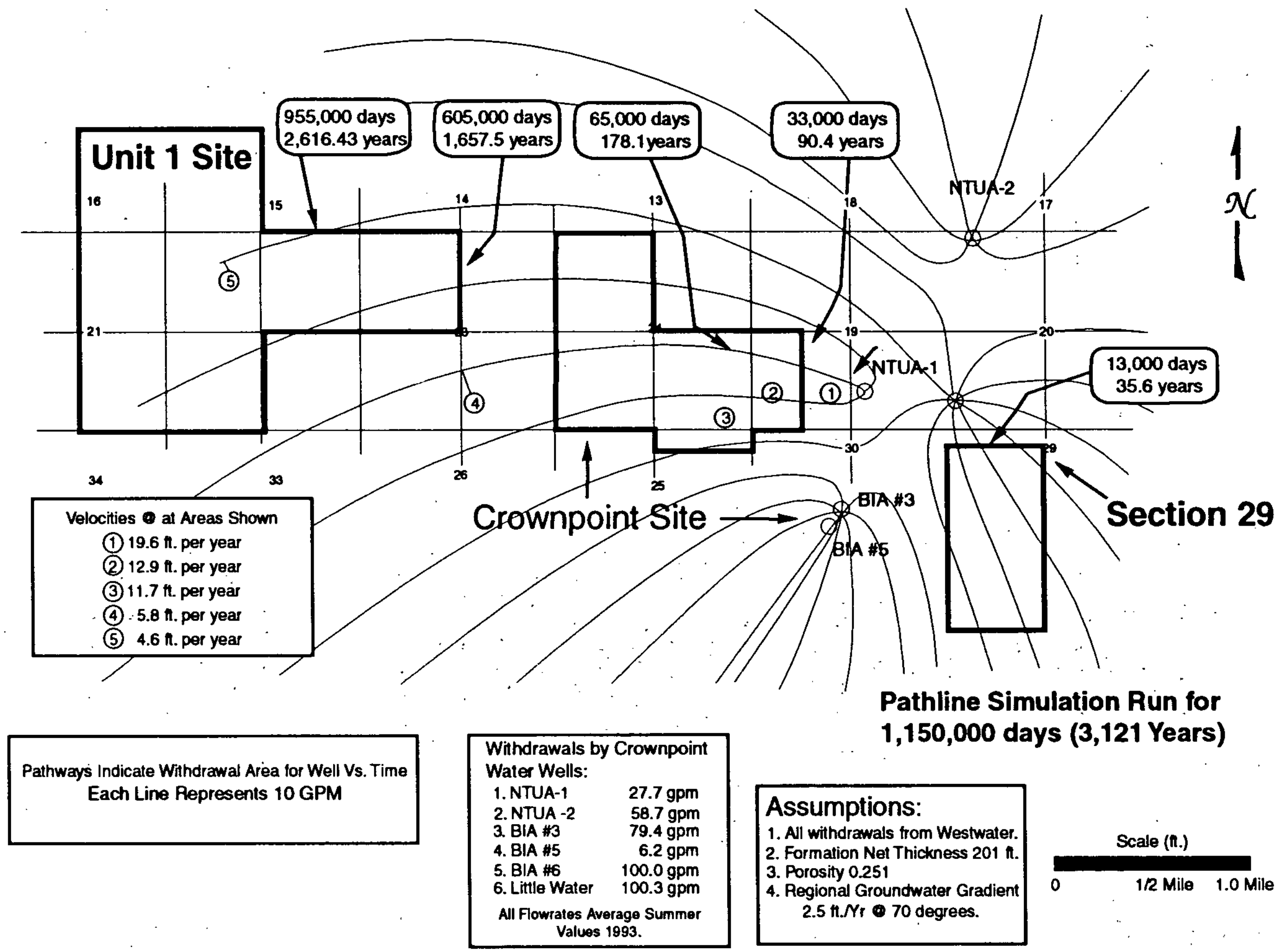


**Figure 3.10. Modeled groundwater flow pathways for the Unit 1 and Crownpoint sites.**

The Dakota Sandstone is an artesian aquifer that overlies the Brushy Basin Shale. Water quality in the Dakota Sandstone aquifer is good and meets New Mexico drinking water quality standards (Table 3.14). Three of the town water-supply wells are completed into the Dakota Sandstone. Comparisons of water-level data between the Dakota Sandstone aquifer and the Westwater Canyon aquifer indicate that the vertical flow in the Dakota Sandstone is downward (HRI 1992b). Lateral groundwater flow in the Dakota Sandstone at the Crownpoint site has not been accurately determined because of insufficient numbers of monitoring wells (HRI 1996a). Natural groundwater flow in the Dakota prior to Crownpoint water well pumping is projected to be toward the north. The hydraulic gradient in the Dakota Sandstone aquifer, in the Crownpoint area, is believed to be similar to the Westwater due to groundwater pumping by the town of Crownpoint. Given the lack of data on lateral flow in the Dakota sandstone, NRC staff have conservatively assumed that groundwater in the Dakota Sandstone beneath the Crownpoint property flows towards the town of Crownpoint wells.

Between 183 and 213 m (600 and 700 ft) of Mancos Shale lie above the Dakota Sandstone. The Mesaverde Group lies on top of the Mancos Shale. The Mesaverde Group contains a number of sands, the lowermost being the Gallup Sandstone. There are no other geologic units above the Mesaverde, since it forms the surficial unit at the sites. One well is drilled in the Gallup Sandstone in the Mesaverde Group at the southwest corner of the Crownpoint site boundary in Section 25.

HRI has monitored water levels and conducted pump tests at the Crownpoint site. Pump tests were conducted in the Westwater Canyon aquifer to determine the hydraulic properties of the ore-bearing sandstone and to determine the degree of vertical hydraulic confinement between the Dakota Sandstone and the Westwater Canyon aquifer. The test was performed for 72 hours from April 17 through April 20, 1992, pumping from a Westwater Canyon well located near the Crownpoint site surface facilities. One monitor well was completed in the Dakota Sandstone, and five monitor wells were completed in the Westwater Canyon. Analysis of the pump test data was complicated by the pumping influence from the town of Crownpoint water-supply wells, which occurred during the test. The results indicated that transmissivities range from 237 $m^2$/day to 251 $m^2$/day (2556 gal/day/ft to 2698 gal/day/ft) (Table 3.15). No aquifer interconnection was detected by the test (i.e., no draw down was detected by the Dakota Sandstone monitor wells).

### 3.3.1.3 Unit 1

No wells are located within the Unit 1 site boundary. Operating private wells in the area are widely dispersed. The nearest operating private well is located 0.4 km (0.25 miles) west of the site boundary. This is a private well drilled into the aquifers in the Mesaverde Group. The next nearest operating private well is more than 0.8 km (0.5 miles) southeast of the site boundary and is completed in Gallup Sandstone of the Mesaverde Group. No other private wells occur within 3.2 km (2 miles) of the Unit 1 site boundary. The nearest public water-supply wells are located 3.2 km (2 miles) away in the town of Crownpoint.

The aquifer formations located beneath the Unit 1 site are the same as those beneath the Crownpoint site. One well is known to have penetrated the entire thickness of the Recapture Shale at the Unit 1 site. Mobil well TWW-1 was drilled to 2903 ft in Section 16, T17N R13W, but has since been plugged in

**Table 3.14. Crownpoint site water quality data,[a] Dakota Sandstone aquifer**

| Parameter | Mean (mg/L) | Maximum (mg/L) | Minimum (mg/L) | EPA (and NNEPA) drinking water standard |
|---|---|---|---|---|
| Calcium | 2.0 | 2.2 | 1.9 | |
| Magnesium | 0.1 | 0.17 | 0.11 | |
| Sodium | 225.3 | 231.0 | 217.0 | |
| Potassium | 2.5 | 3.8 | 1.5 | |
| Carbonate | 38.5 | 58.0 | 16.0 | |
| Bicarbonate | 207.0 | 243.0 | 161.0 | |
| Sulfate | 244.8 | 251.0 | 227.0 | 250.0 |
| Chloride | 6.0 | 9.6 | 3.9 | 250.0 |
| Nitrate | 0.1 | 0.24 | 0.0 | 10.0 |
| Fluoride | 0.6 | 0.72 | 0.55 | 4.0 or 2.0 |
| Silica | 13.0 | 18.0 | 3.0 | |
| TDS | 682.8 | 693.0 | 671.0 | 500.0 |
| Conductivity[b] | 991.3 | 1000.0 | 981.0 | |
| Alkalinity | 233.0 | 251.0 | 225.0 | |
| pH[c] | 9.0 | 9.31 | 8.81 | 6.5–8.5 |
| Arsenic | 0.0 | 0.0 | 0.0 | 0.05 |
| Barium | 0.05 | 0.05 | 0.01 | 2.0 |
| Cadmium | 0.0 | 0.0 | 0.0 | 0.01 |
| Chromium | 0.0 | 0.0 | 0.0 | 0.05 |
| Copper | 0.0 | 0.0 | 0.0 | 1.0 |
| Iron | 0.1 | 0.13 | 0.0 | 0.3 |
| Lead | 0.0 | 0.004 | 0.0 | 0.05 |
| Manganese | 0.01 | 0.01 | 0.01 | 0.05 |
| Mercury | 0.0 | 0.0 | 0.0 | 0.002 |
| Molybdenum | 0.0 | 0.01 | 0.0 | |
| Nickel | 0.0 | 0.0 | 0.0 | 0.1 |
| Selenium | 0.0 | 0.0 | 0.0 | 0.05 |
| Silver | 0.0 | 0.0 | 0.0 | 0.1 |
| Uranium | 0.0 | 0.0 | 0.0 | |
| Vanadium | 0.0 | 0.0 | 0.0 | |
| Zinc | 0.0 | 0.0 | 0.0 | 5.0 |
| Boron | 0.2 | 0.2 | 0.14 | |
| Ammonia | 0.05 | 0.08 | 0.03 | |
| Radium-226[d] | 0.6 | 0.9 | 0.4 | 5.0 |

[a]*Source*: HRI 1992b.
[b]$\mu$mhos/cm.
[c]Units.
[d]pCi/L.

**Table 3.15. Crownpoint site hydrologic parameters**

| Geologic unit | Transmissivity: Well | Transmissivity: $m^2$/d (gal/day/ft) | Storage coefficient (dimensionless) |
|---|---|---|---|
| Westwater Canyon | CP-2 | 245 (2641) | 9.00E-5 |
| Westwater Canyon | CP-3 | 237 (2556) | 7.80E-5 |
| Westwater Canyon | CP-6 | 274 (2953) | 1.13E-4 |
| Westwater Canyon | CP-7 | 237 (2556) | 1.39E-4 |
| Westwater Canyon | CP-8 | 251 (2698) | 4.50E-5 |

*Source*: HRI 1992b.

accordance with New Mexico law (BLM 1996). As discussed in Section 3.3.1.2, water quality in the Westwater Canyon beneath the Crownpoint and Unit 1 sites is good and usually meets New Mexico drinking water quality standards (Table 3.16).

Similarly, water quality in the Dakota Sandstone aquifer is good and meets New Mexico drinking water quality standards (Table 3.17).

A potentiometric surface map of the Westwater aquifer for the Unit 1 and Crownpoint sites was prepared using a calibrated flow model to match monitor well level data collected in the summer of 1992 (Figure 3.10). For the Unit 1 site, calculated groundwater flow velocities based on the piezometric surface map averaged 1.5 m/year (5 ft/year) in the Westwater aquifer (HRI 1996a).

HRI's application provides water quality, water level, and pump test data collected by Mobil Oil Company at the Unit 1 site. (Further data collection by HRI will be required as discussed in this EIS.) Pump tests were conducted by Mobil in the Westwater Canyon aquifer to determine the hydraulic properties of the ore-bearing sandstone and to determine the degree of vertical hydraulic confinement between the Dakota Sandstone and the Westwater Canyon aquifer (HRI 1996c; HRI 1995a; HRI 1995b). The test was performed from August 16 through 18, 1982, with two wells completed in the Dakota Sandstone and 27 wells completed in the Westwater Canyon Member. The results indicated that transmissivities ranged from 84 to 133 $m^2$/day (905 to 1432 gal/day/ft) (Table 3.18). No aquifer interconnection was detected by the test (i.e., no draw down was detected by the Dakota Sandstone monitor wells).

### 3.3.1.4 Church Rock

With the exception of HRI-owned wells, there are no wells within the Church Rock site boundary. This site is far away from any towns, and any operating private wells in the area are widely dispersed. The nearest operating private well is located just outside the southern boundary of the site and is completed in the Dakota Sandstone. There are no other wells within 1.6 km (1 mile) of the site.

**Table 3.16. Unit 1 site water quality data,[a] Westwater Canyon aquifer**

| Parameter | Mean (mg/L) | Maximum (mg/L) | Minimum (mg/L) | EPA (and NNEPA) drinking water standard |
|---|---|---|---|---|
| Calcium | 3.75 | 18.0 | 1.1 | |
| Magnesium | 0.145 | 9.2 | 0.0 | |
| Sodium | 113.0 | 1100.0 | 82.0 | |
| Potassium | 1.95 | 12.0 | 0.7 | |
| Carbonate | 12.0 | 120.0 | 0.0 | |
| Bicarbonate | 206.0 | 270.0 | 89.0 | |
| Sulfate | 35.5 | 220.0 | 20.0 | 250.0 |
| Chloride | 5.5 | 41.0 | <3.0 | 250.0 |
| Nitrate | 0.03 | 1.8 | <0.05 | 10.0 |
| Fluoride | 0.1 | 0.4 | <0.5 | 4.0 or 2.0 |
| Silica | 18.5 | 23.0 | 11.0 | |
| TDS | 285.0 | 590.0 | 0.0 | 500.0 |
| Conductivity[b] | 402.5 | 820.0 | 0.0 | |
| pH[c] | 8.75 | 9.1 | 7.5 | 6.5–8.5 |
| Arsenic | <0.005 | <0.005 | <0.005 | 0.05 |
| Barium | <0.2 | 0.4 | <0.2 | 2.0 |
| Cadmium | <0.005 | <0.005 | <0.005 | 0.01 |
| Chromium | 0.003 | 0.008 | <0.005 | 0.05 |
| Copper | 0.0405 | 0.980 | <0.005 | 1.0 |
| Iron | 0.04 | 1.0 | <0.01 | 0.3 |
| Lead | 0.0095 | 0.170 | <0.005 | 0.05 |
| Manganese | 0.0035 | 0.034 | <0.005 | 0.05 |
| Mercury | <0.0001 | <0.0001 | <0.0001 | 0.002 |
| Molybdenum | 0.0035 | 0.016 | <0.005 | |
| Nickel | <0.02 | 0.02 | <0.02 | 0.1 |
| Selenium | <0.005 | <0.006 | <0.005 | 0.05 |
| Silver | <0.005 | <0.005 | <0.005 | 0.1 |
| Uranium | 2.0 | 2.7 | 0.68 | |
| Zinc | 0.023 | 0.800 | <0.005 | 5.0 |
| Boron | 0.01 | 0.5 | <0.1 | |
| Radium-226[d] | 10.3 | 200.0 | 0.0 | 5.0 |
| Gross alpha[d] | 42.0 | 610.0 | 0.0 | |
| Gross beta[d] | 43.0 | 510.0 | 0.0 | |
| Radon[d] | 81699.0 | 1100000.0 | 22.0 | |

[a]*Source*: HRI 1992b.
[b]$\mu$mhos/cm.
[c]Units.
[d]pCi/L.

**Table 3.17. Unit 1 site water quality data,[a] Dakota Sandstone aquifer**

| Parameter | Mean (mg/L) | Maximum (mg/L) | Minimum (mg/L) | EPA (and NNEPA) drinking water standard |
|---|---|---|---|---|
| Calcium | 17.0 | 18.0 | 16.0 | |
| Magnesium | 8.53 | 9.2 | 7.5 | |
| Sodium | 163.0 | 170.0 | 150.0 | |
| Potassium | 3.3 | 3.6 | 2.9 | |
| Carbonate | 0.0 | 0.0 | 0.0 | |
| Bicarbonate | 263.0 | 270.0 | 250.0 | |
| Sulfate | 209.0 | 220.0 | 187.0 | 250.0 |
| Chloride | 4.0 | 6.0 | <3.0 | 250.0 |
| Nitrate | 0.02 | 0.07 | <0.05 | 10.0 |
| Fluoride | 0.1 | 0.5 | <0.2 | 4.0 or 2.0 |
| Silica | 18.0 | 21.0 | 15.0 | |
| TDS | 554.0 | 590.0 | 536.0 | 500.0 |
| Conductivity[b] | 786.0 | 820.0 | 740.0 | |
| pH[c] | 7.6 | 7.7 | 7.5 | 6.5–8.5 |
| Arsenic | <0.005 | <0.005 | <0.005 | 0.05 |
| Barium | 0.1 | 0.4 | <0.2 | 2.0 |
| Cadmium | <0.005 | <0.005 | <0.005 | 0.01 |
| Copper | 0.001 | 0.005 | <0.005 | 1.0 |
| Iron | 0.01 | 0.02 | <0.01 | 0.3 |
| Lead | <0.005 | <0.005 | <0.005 | 0.05 |
| Manganese | 0.032 | 0.034 | 0.030 | 0.05 |
| Mercury | <0.0001 | <0.0001 | <0.0001 | 0.002 |
| Molybdenum | 0.002 | 0.008 | <0.005 | |
| Nickel | <0.02 | <0.02 | <0.02 | 0.1 |
| Selenium | <0.005 | <0.005 | <0.005 | 0.05 |
| Silver | <0.005 | <0.005 | <0.005 | 0.1 |
| Uranium | 0.68 | 2.0 | 0.68 | |
| Zinc | 0.004 | 0.01 | <0.005 | 5.0 |
| Boron | <0.1 | 0.2 | <0.1 | |
| Radium-226[d] | 1.3 | 2.0 | 0.0 | 5.0 |
| Gross alpha[d] | 2.0 | 5.0 | 0.0 | |
| Gross beta[d] | 6.0 | 10.0 | 3.0 | |
| Radon[d] | 1175.0 | 4400.0 | 22.0 | |

[a]*Source*: HRI 1996b.
[b]$\mu$mhos/cm.
[c]Units.
[d]pCi/L.

**Table 3.18. Unit 1 site hydrologic parameters**

| Geologic unit | Transmissivity | | Storage coefficient (dimensionless) |
|---|---|---|---|
| | Well | $m^2$/day (gal/day/ft) | |
| Westwater Canyon | 15L5 | 102 (1102) | 8.9E-5 |
| Westwater Canyon | 15L7 | 114 (1228) | 7.0E-5 |
| Westwater Canyon | 15L17 | 84 (905) | 1.6E-4 |
| Westwater Canyon | 15L17a | 133 (1432) | 5.4E-5 |
| Westwater Canyon | 15L36 | 84 (914) | 4.6E-5 |
| Westwater Canyon | 15L45 | 109 (1177) | 9.4E-5 |
| Westwater Canyon | 15L64 | 114 (1228) | 4.6E-5 |
| Westwater Canyon | 15L73 | 110 (1194) | 9.1E-5 |
| Westwater Canyon | 15M12 | 133 (1432) | 8.5E-5 |
| Westwater Canyon | 15M35 | 99 (1062) | 6.9E-5 |
| Westwater Canyon | 15M39 | 100 (1074) | 1.1E-4 |
| Westwater Canyon | 15M63 | 109 (1177) | 6.0E-4 |
| Westwater Canyon | 15M67 | 114 (1228) | 2.8E-4 |
| Westwater Canyon | 15M92 | 133 (1432) | 6.7E-5 |
| Westwater Canyon | 15M94 | 131 (1409) | 7.9E-5 |
| Westwater Canyon | 16I11 | 114 (1228) | 6.6E-5 |
| Westwater Canyon | 16I23 | 119 (1283) | 5.0E-5 |
| Westwater Canyon | 16I51 | 119 (1283) | 4.9E-5 |
| Westwater Canyon | 16I81 | 114 (1228) | 3.7E-5 |
| Westwater Canyon | 16I85 | 107 (1162) | 1.1E-4 |
| Westwater Canyon | 16P11 | 113 (1211) | 6.4E-5 |
| Westwater Canyon | 16P37 | 106 (1146) | 5.4E-5 |
| Westwater Canyon | 16P65 | 117 (1264) | 5.5E-5 |
| Westwater Canyon | 16P80 | 117 (1264) | — |
| Westwater Canyon | 16P94 | 123 (1322) | 5.9E-5 |
| Westwater Canyon | 16P96 | 131 (1409) | 6.5E-5 |
| Westwater Canyon | 16P102 | 131 (1409) | 7.2E-5 |

*Source*: HRI 1996a.

The aquifer formations located beneath the Church Rock site are similar to those beneath the Crownpoint and Unit 1 sites. The Recapture Shale at the Church Rock site is about 55 m (180 ft) thick. At the Church Rock site, drill hole 2.8/17/7 penetrated the total section of Recapture Shale. Most of the holes drilled at the Church Rock site only penetrated the upper 1.5 to 12.2 m (5 to 40 ft) of the Recapture Shale. Water quality in the Westwater Canyon beneath the Church Rock site is good and usually meets New Mexico drinking water quality standards (Table 3.19).

A piezometric surface map of the Church Rock property was prepared by mapping water level data collected in March 1993. The potentiometric surface slopes north-northeastward and is roughly parallel to the structural dip of the sedimentary rocks in the region. The potentiometric surface slopes approximately 0.41 degrees from 2012 to 1995 m mean sea level (msl) (6600 to 6550 ft msl) in elevation (Figure 3.11). The calculated groundwater flow velocity is 2.7 m/year (8.7 ft/year) (Reed 1993).

At the Church Rock site, the top of the Brushy Basin Shale contains the "B" sand. The "B" sand is an artesian aquifer that is 4 to 9 m (13 to 28 ft) thick, with 5 to 10 m (16 to 32 ft) of mudstone between it and the top of the Westwater Canyon aquifer and 5 to 10 m (16 to 33 ft) of mudstone between it and the bottom of the Dakota Sandstone aquifer. Water quality in the Brushy Basin "B" sand is good (Table 3.20).

Similarly, water quality in the Dakota Sandstone aquifer at the Church Rock site is good and meets New Mexico drinking water quality standards (Table 3.21). Vertical flow in the Dakota Sandstone is believed to be downward because the Dakota Sandstone aquifer is over-pressured relative to the Westwater Canyon aquifer. HRI believes that the lateral direction of groundwater flow in the Dakota Sandstone at the Church Rock site is northerly (HRI 1996a). However, lateral groundwater flow has not been determined accurately at this time due to the lack of sufficient monitoring wells (HRI 1996a). (Collection of additional groundwater data will be required of HRI.)

HRI has monitored water levels and conducted pump tests at the Church Rock site. In September and October 1988, pump tests were conducted in the Westwater Canyon aquifer to determine the hydraulic properties of ore-bearing sandstone and to determine the degree of vertical hydraulic confinement between the Dakota Sandstone aquifer, the Brushy Basin "B" Sand aquifer, and the Westwater Canyon aquifer. Additional data from monitor wells were used to determine the degree of hydraulic communication that exists between the mineralized zone and perimeter monitoring points. Four wells were completed in the Westwater Canyon aquifer, one was completed in the Brushy Basin "B" Sand aquifer, and one was completed in the Dakota Sandstone aquifer. The results indicated that transmissivities ranged from 86 to 123 $m^2$/day (926 to 1326 gal/day/ft) (Table 3.22). No aquifer interconnection was detected by the test (i.e., no draw down was detected by the Dakota Sandstone or Brushy Basin "B" Sand monitor wells). To further verify the properties of the aquitards, HRI undertook a laboratory study. Through this study, HRI tested core samples of the aquitard materials and found that they have sufficiently less vertical permeability than the Westwater Canyon aquifer.

The Church Rock site also contains another preexisting hydrologic feature. In Section 17 at the southern end of the site, large vertical mine workings are connected to tunnels constructed in the

**Table 3.19. Church Rock site water quality data,[a] Westwater Canyon aquifer**

| Parameter | Mean (mg/L) | Maximum (mg/L) | Minimum (mg/L) | EPA (and NNEPA) drinking water standard |
|---|---|---|---|---|
| Calcium | 2.775 | 5.8 | 1.5 | |
| Magnesium | 0.235 | 0.81 | 0.07 | |
| Sodium | 129.75 | 148.0 | 114.0 | |
| Potassium | 2.46 | 6.6 | 0.85 | |
| Carbonate | 28.75 | 80.0 | 0.0 | |
| Bicarbonate | 246.25 | 331.0 | 185.0 | |
| Sulfate | 37.0 | 46.0 | 32.0 | 250.0 |
| Chloride | 6.15 | 12.0 | 2.8 | 250.0 |
| Nitrate | 0.02 | 0.16 | 0.01 | 10.0 |
| Fluoride | 1.628 | 22.0 | 0.21 | 4.0 or 2.0 |
| Silica | 16.5 | 68.0 | 11.0 | |
| TDS | 369.75 | 435.0 | 322.0 | 500.0 |
| Conductivity[b] | 556.25 | 651.0 | 485.0 | |
| Alkalinity | 256.0 | 491.0 | 218.0 | |
| pH[c] | 8.923 | 9.67 | 8.15 | 6.5–8.5 |
| Arsenic | 0.0025 | 0.012 | 0.001 | 0.05 |
| Barium | 0.0675 | 0.12 | 0.02 | 2.0 |
| Cadmium | 0.00028 | 0.005 | 0.0001 | 0.01 |
| Chromium | 0.0125 | 0.07 | 0.01 | 0.05 |
| Copper | 0.0125 | 0.08 | 0.01 | 1.0 |
| Iron | 0.0375 | 0.29 | 0.01 | 0.3 |
| Lead | 0.001 | 0.003 | 0.001 | 0.05 |
| Manganese | 0.01 | 0.01 | 0.01 | 0.05 |
| Mercury | 0.0001 | 0.0001 | 0.0001 | 0.002 |
| Molybdenum | 0.01 | 0.04 | 0.01 | |
| Nickel | 0.01 | 0.01 | 0.01 | 0.1 |
| Selenium | 0.00125 | 0.01 | 0.001 | 0.05 |
| Silver | 0.01 | 0.01 | 0.01 | 0.1 |
| Uranium | 1.8 | 10.9 | 0.002 | |
| Zinc | 0.01 | 0.03 | 0.01 | 5.0 |
| Boron | 0.1 | 0.65 | 0.04 | |
| Ammonia | 0.0775 | 0.16 | 0.01 | |
| Radium-226[d] | 10.225 | 26.0 | 1.1 | 5.0 |

[a]*Source*: HRI 1996b.
[b]μmhos/cm.
[c]Units.
[d]pCi/L.

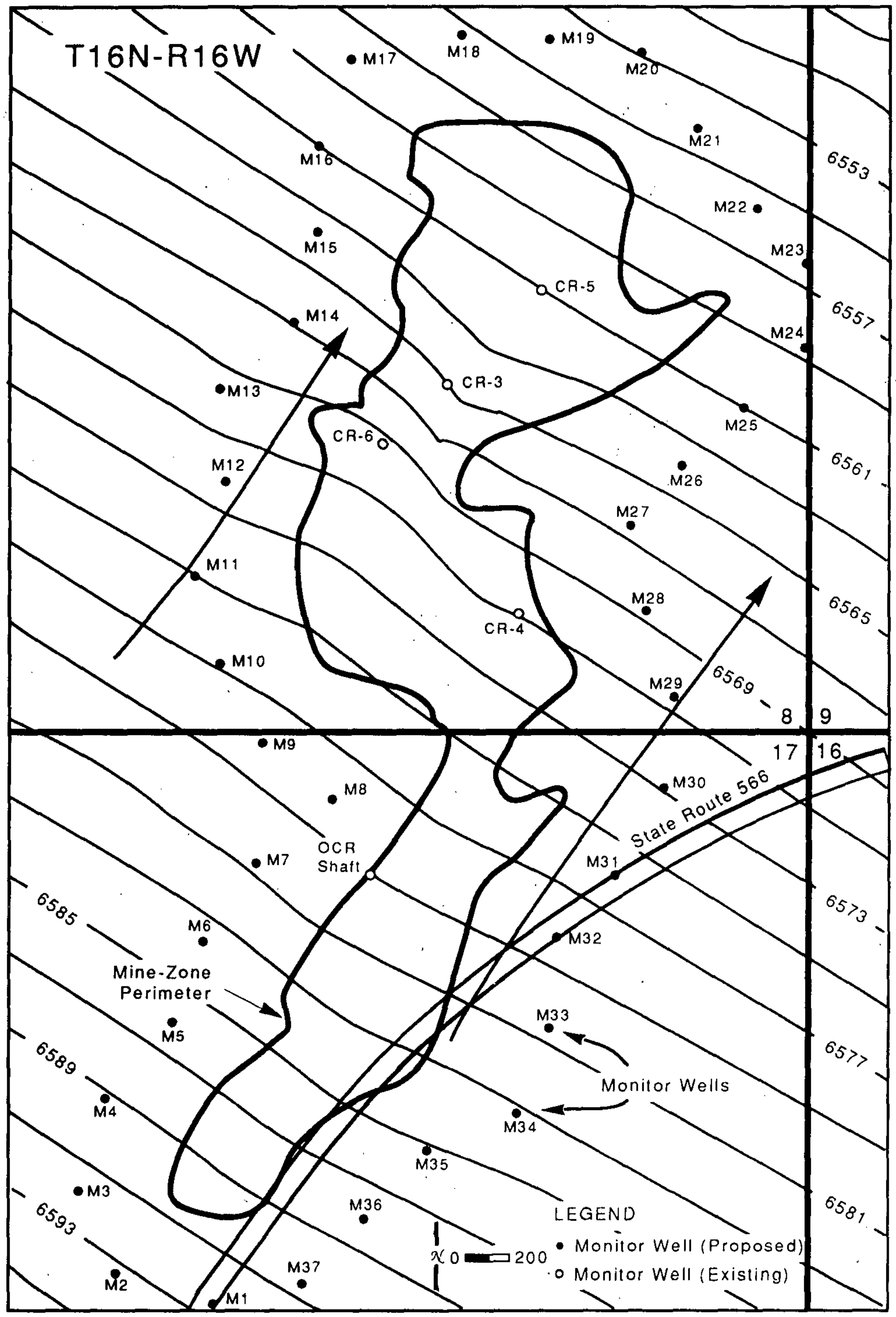


**Figure 3.11. Potentiometric surface of the Westwater Canyon Sandstone at the Church Rock site.**

**Table 3.20. Church Rock site water quality data,[a] Brushy Basin "B" Sandstone aquifer**

| Parameter | Mean (mg/L) | Maximum (mg/L) | Minimum (mg/L) | EPA (and NNEPA) drinking water standard |
|---|---|---|---|---|
| Calcium | 7.5 | 32.0 | 1.9 | |
| Magnesium | 0.03 | 0.05 | 0.01 | |
| Sodium | 166.0 | 248.0 | 141.0 | |
| Potassium | 10.8 | 31.0 | 3.9 | |
| Carbonate | 92.0 | 146.0 | 27.0 | |
| Bicarbonate | 66.0 | 148.0 | 0.0 | |
| Hydroxide | 36.0 | 160.0 | 0.0 | |
| Sulfate | 77.0 | 96.0 | 71.0 | 250.0 |
| Chloride | 3.8 | 6.1 | 1.6 | 250.0 |
| Nitrate | 0.03 | 0.07 | 0.01 | 10.0 |
| Fluoride | 0.66 | 0.79 | 0.57 | 4.0 or 2.0 |
| Silica | 23.0 | 37.0 | 15.0 | |
| TDS | 480.0 | 658.0 | 415.0 | 500.0 |
| Conductivity[b] | 1073.0 | 2520.0 | 391.0 | |
| Alkalinity | 319.0 | 560.0 | 249.0 | |
| pH[c] | 10.5 | 12.0 | 9.77 | 6.5–8.5 |
| Arsenic | 0.002 | 0.004 | 0.001 | 0.05 |
| Barium | 0.03 | 0.16 | 0.01 | 2.0 |
| Cadmium | 0.0002 | 0.001 | 0.0001 | 0.01 |
| Chromium | 0.01 | 0.01 | 0.01 | 0.05 |
| Copper | 0.03 | 0.14 | 0.01 | 1.0 |
| Iron | 0.04 | 0.08 | 0.02 | 0.3 |
| Lead | 0.019 | 0.121 | 0.001 | 0.05 |
| Manganese | 0.01 | 0.01 | 0.01 | 0.05 |
| Mercury | 0.0001 | 0.0001 | 0.0001 | 0.002 |
| Molybdenum | 0.01 | 0.03 | 0.01 | |
| Nickel | 0.01 | 0.02 | 0.01 | 0.1 |
| Selenium | 0.002 | 0.009 | 0.001 | 0.05 |
| Silver | 0.01 | 0.01 | 0.01 | 0.1 |
| Uranium | 0.005 | 0.013 | 0.001 | |
| Vanadium | 0.01 | 0.02 | 0.01 | |
| Zinc | 0.01 | 0.03 | 0.01 | 5.0 |
| Boron | 0.21 | 0.72 | 0.1 | |
| Ammonia | 0.59 | 2.8 | 0.04 | |
| Radium-226[d] | 1.1 | 9.6 | 0.01 | 5.0 |

[a]*Source*: HRI 1996b.
[b]μmhos/cm.
[c]Units.
[d]pCi/L.

**Table 3.21. Church Rock site water quality data,[a] Dakota "B" Sandstone aquifer**

| Parameter | Mean (mg/L) | Maximum (mg/L) | Minimum (mg/L) | EPA (and NNEPA) drinking water standard |
|---|---|---|---|---|
| Calcium | 3.0 | 3.7 | 2.5 | |
| Magnesium | 0.43 | 0.66 | 0.29 | |
| Sodium | 300.0 | 317.0 | 285.0 | |
| Potassium | 2.1 | 4.4 | 1.3 | |
| Carbonate | 23.0 | 67.0 | 5.0 | |
| Bicarbonate | 550.0 | 600.0 | 441.0 | |
| Sulfate | 126.0 | 130.0 | 120.0 | 250.0 |
| Chloride | 35.0 | 43.0 | 31.0 | 250.0 |
| Nitrate | 0.04 | 0.14 | 0.01 | 10.0 |
| Fluoride | 4.7 | 5.1 | 4.3 | 4.0 or 2.0 |
| Silica | 14.0 | 19.0 | 11.0 | |
| TDS | 835.0 | 875.0 | 812.0 | 500.0 |
| Conductivity[b] | 1287.0 | 1360.0 | 1230.0 | |
| Alkalinity | 491.0 | 514.0 | 474.0 | |
| pH[c] | 8.7 | 9.25 | 8.45 | 6.5–8.5 |
| Arsenic | 0.001 | 0.002 | 0.001 | 0.05 |
| Barium | 0.04 | 0.11 | 0.01 | 2.0 |
| Cadmium | 0.0003 | 0.0015 | 0.0001 | 0.01 |
| Chromium | 0.01 | 0.01 | 0.01 | 0.05 |
| Copper | 0.01 | 0.01 | 0.01 | 1.0 |
| Iron | 0.06 | 0.18 | 0.01 | 0.3 |
| Lead | 0.006 | 0.022 | 0.001 | 0.05 |
| Manganese | 0.01 | 0.02 | 0.01 | 0.05 |
| Mercury | 0.0002 | 0.001 | 0.0001 | 0.002 |
| Molybdenum | 0.01 | 0.03 | 0.01 | |
| Nickel | 0.01 | 0.01 | 0.01 | 0.1 |
| Selenium | 0.001 | 0.003 | 0.001 | 0.05 |
| Silver | 0.01 | 0.01 | 0.01 | 0.1 |
| Uranium | 0.038 | 0.342 | 0.001 | |
| Vanadium | 0.01 | 0.01 | 0.01 | |
| Zinc | 0.02 | 0.04 | 0.01 | 5.0 |
| Boron | 0.87 | 1.2 | 0.76 | |
| Ammonia | 0.14 | 0.25 | 0.05 | |
| Radium-226[d] | 0.6 | 1.0 | 0.2 | 5.0 |

[a]*Source*: HRI 1996b.
[b]$\mu$mhos/cm.
[c]Units.
[d]pCi/L.

Table 3.22. Church Rock site hydrologic parameters

| Geologic unit | Well | Transmissivity $m^2$/day (gal/day/ft) | Storage coefficient (dimensionless) |
|---|---|---|---|
| Westwater Canyon | CR-5 | 86 (926) | 8.90E-5 |
| Westwater Canyon | CR-6 | 112 (1208) | 4.13E-4 |
| Westwater Canyon | CR-8 | 123 (1326) | 3.00E-4 |

*Source*: HRI 1993a.

Westwater Canyon aquifer and the "B" Sand aquifer. HRI believes that most of the mine workings are intact and have not collapsed (HRI 1993a). However, it is likely that many of the workings have collapsed because the type of underground mining employed at the site would have caused some of the workings to collapse while the mine was still in operation (HRI 1996a). A review by HRI of the mine workings maps indicates that no tunnels extend beyond the boundaries of the proposed solution mining areas (HRI 1993a).

## 3.3.2 Surface Water

### 3.3.2.1 Regional

Western New Mexico's semiarid climate gives the project area characteristically high surface evaporation rates. Significant runoff is rarely observed in the project sites because most of the runoff collects, infiltrates the ground, or evaporates locally. The average annual pan evaporation rate for Gallup is 190 cm (75 in.) (HRI 1988). Information on pond evaporation rates varies, but the average is approximately 218 cm (86 in.) per year.

### 3.3.2.2 Crownpoint

Runoff from the Crownpoint area results from rainfall and snowmelt occurring on-site and in the sandstone highlands to the south. The surficial drainage network is poorly developed in the area and consists mainly of numerous unnamed subparallel ephemeral washes originating in the highlands and crossing the area. All the washes coalesce to the north and ultimately drain to the Chaco River 48 km (30 miles) north of Crownpoint.

Runoff occurs in the area mainly during peak periods of precipitation, typically during the wettest time of year from July through October. Surface runoff is unlikely from October through June. Surficial deposits commonly intercept and absorb much of the precipitation and snowmelt.

### 3.3.2.3 Unit 1

The Unit 1 site's general surface water characteristics are similar to those of the Crownpoint site. TVA (1979) analyzed several watersheds, including the Unit 1 area, and determined that calculated mean annual discharges from various drainage basins in the area would be 0.63 to 1.07 cm (0.25 to 0.42 in.). Table 3.23 describes a watershed heading in the highlands and encompassing most of Unit 1.

**Table 3.23. Unit 1 site watershed characteristics**

| | |
|---|---|
| Drainage area | 9.7 $miles^2$<br>25.12 $km^2$ |
| Average slope | 0.040<br>212 ft/miles<br>40.16 m/km |
| Mean annual discharge | 0.28 cfs[a]<br>7.93 L/second<br>202 acre-ft<br>0.249 hectare-meter |
| Runoff | 0.39 in.<br>0.99 cm |
| 50-year flood peak discharge | 1390 cfs<br>39 cms[b] |

[a]Cfs = cubic feet per second.
[b]cms = cubic meters per second.

*Source:* TVA 1979.

### 3.3.2.4 Church Rock

The Church Rock site is located near Pipeline Canyon, a tributary to the North Fork of the Puerco River. All of the water courses within the North Fork drainage are ephemeral washes. The Church Rock site is crossed by a small unnamed arroyo draining a small watershed that heads in the sandstone highlands to the north.

Downstream use of surface water is limited to occasional livestock watering. Shallow groundwater in the alluvium in the North Fork is tapped by several shallow wells. This water is derived from storm flows passing down the arroyos and is pumped for domestic and stock-watering use.

HRI has analyzed the Church Rock site's surface hydrology (HRI 1993d). The land surface in the Church Rock lease area exhibits gentle slopes between 1 and 3 degrees toward the arroyo that traverses southwesterly across the site. The unnamed arroyo is a tributary to the Puerco River and is incised from 1 m (3 ft) at the downstream location to 5 m (17 ft) in the northernmost portion of the site. The watershed drained by this arroyo is approximately 10 $km^2$ (3.9 $miles^2$).

Surface hydrology and erosion potential in the channels were analyzed using U.S. Army Corps of Engineers models HEC-1 and HEC-2. The arroyo's 100-year water level is found within the steep banks formed by the arroyo walls throughout most of the site. Therefore, flow concentrations in the site area during a 100-year runoff event would be confined to the arroyo channel, except at the southern end of the site where flood water would spread onto a floodplain. The remainder of the site would experience sheet runoff or insignificant flow concentrations. The predicted depth of channel scour during runoff events of this magnitude is approximately 30 cm (1 ft). The results of runoff modeling are summarized in Table 3.24.

**Table 3.24. Calculated peak runoff flow rates from the 25- and 100-year frequency storm events at Church Rock**

| | Peak runoff flow rates | |
|---|---|---|
| Storm frequency | $ft^3$/second | $m^3$/second |
| 25-year | | |
| 2-hour duration | 1557 | 44 |
| 6-hour duration | 1740 | 49 |
| 24-hour duration | 1953 | 55 |
| 100-year | | |
| 2-hour duration | 1959 | 55 |
| 6-hour duration | 2389 | 68 |
| 24-hour duration | 2767 | 78 |

*Source:* HRI 1993d.

## 3.4 TRANSPORTATION

This section provides a description of the existing road network in the region surrounding the project sites. The road network would be used for (1) shipments of yellowcake slurry or resin from the satellite processing facilities to the main processing facility, (2) shipments of refined yellowcake from the main processing facility to a uranium conversion facility in Illinois, (3) shipments of process chemicals from suppliers to the processing facilities, and (4) shipments of 11e(2) by-product material for disposal in Utah. Only road transportation is proposed for this project. Truck accident rates for roads in the region are specified based on 1990–1994 State of New Mexico and/or Navajo Nation data.

### 3.4.1 Regional Roads

Roads of interest in the vicinity of the project sites are shown in Figure 3.12. The roads are maintained by the Federal government (I-40 and U.S. 666), the State of New Mexico (NM 371 and 566), and the Navajo Nation (Navajo 9, 49, and 11). Primary access to the region is from I-40, which is a major east-west transportation corridor that runs from Barstow, California to Greensboro, North Carolina. I-40 is generally a four-lane, divided highway constructed to full freeway standards with full access control.

Primary access to the Crownpoint site is from I-40, north on NM 371, west on Navajo 9, and southwest on Church Road in Crownpoint. Primary access to the Unit 1 site is from I-40, north on NM 371, west on Navajo 9, and southwest on Navajo 11 (also known as Picnic Road). Primary access to the Church Rock site is from I-40, north on NM 566.

As indicated in Figure 2.6, shipments from the Unit 1 site to the Crownpoint site would travel northeast on Picnic Road, east on Navajo 9, and southwest on Church Road. Shipments from the Church Rock site to the Crownpoint site would travel north on NM 566, east on NM 11/49, north on NM 371, west on Navajo 9, and southwest on Church Road.

NM 371 is a two-lane, paved highway that extends north from I-40 to Farmington, New Mexico. It would be the direct route for hauling chemicals and yellowcake between the Crownpoint site and I-40. The posted speed limit on NM 371 is 55 miles per hour (mph) except in the town of Thoreau where it is 40 mph.

Navajo 9 is a two-lane, paved highway that extends east from U.S. 666 to Torreon, New Mexico. The 2-mile segment between Church Road and NM 371 would be part of the direct route between the Crownpoint site and I-40. The first mile of Navajo 9 west of NM 371 is multilane, and the posted speed limit is 35 mph. The approximately 1.5-mile segment between Church Road and Picnic Road has a posted speed limit of 55 mph.

NM 566 is a two-lane, paved road that extends north 12 miles from I-40. The segment from I-40 to the Church Rock site is the primary access to the site from the south. The approximately 1-mile segment between the proposed Church Rock facility on NM 566 and the junction with Navajo 49/11 would be used to transport yellowcake slurry to the Crownpoint site. The posted speed limit in this segment is 55 mph.

Navajo 11/49 is a two-lane, paved road that extends east 12 miles from NM 566 to the junction of Navajo 11 and 49 just west of Mariano Lake, New Mexico. Navajo 11 (Picnic Road), a two-lane, unpaved road, extends north from the junction to Navajo 9. Navajo 49 extends east from the junction another 12 miles to NM 371. The posted speed limit on NM 11/49 and 49 is 55 mph.

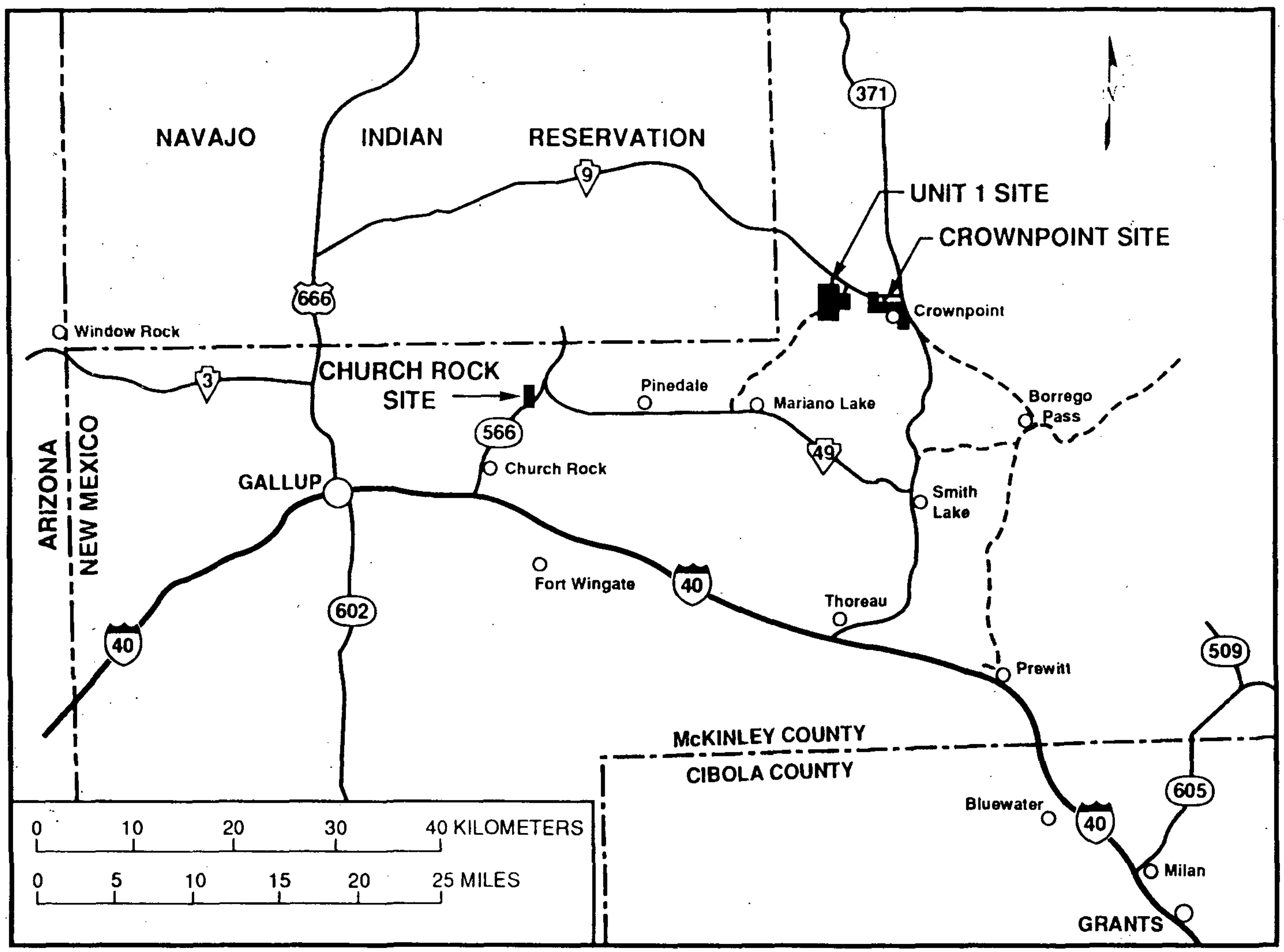


Figure 3.12. Roads in the vicinity of the three project sites.

Church Road connects the Crownpoint site with Navajo 9 to the north and provides access to the town of Crownpoint to the east. The east-west segment of Church Road is a two-lane, paved road. Shipments to and from the Crownpoint facility would be over 0.2 miles of paved and 0.5 miles of unpaved segments of Church Road. The posted speed limit on Church Road is 30 mph.

### 3.4.2 Truck Accident Data

The truck accident data presented in this section will be used in Section 4 to determine truck accident frequencies. The total number of truck accidents for the 5-year period 1990–1994 is given in Table 3.25 for each road that HRI would use in the vicinity of the project sites.

**Table 3.25. Accident data for roads in the vicinity of the three project sites**

| Route | Truck accidents 1990-94 | Trucks per day | Calculated truck accidents/km | Truck accidents/km used in analysis |
|---|---|---|---|---|
| NM 371 | 11 | 420 | 3.5E-7 | 1.4E-6 |
| NM 566 | 0 | 209 | 0 | 1.4E-6 |
| Navajo 9 | 2 | unknown | unknown | 1.4E-6 |
| Navajo 11/49 | 0 | unknown | 0 | 1.4E-6 |
| Church Road | 0 | unknown | 0 | 1.4E-6 |

*Source*: State of New Mexico; Navajo Nation.

The New Mexico State Highway and Transportation Department defines an accident as involving all of the following:

1. involves at least one motor vehicle in motion;
2. occurs on a roadway that is open to the public;
3. does not occur on private property;
4. involves a death, injury, or property damage over $500; and
5. must be reported to the State Highway and Transportation Department on the State's Uniform Accident Report form.

No truck accidents occurred in the 1990–1994 period for several of the routes listed in Table 3.25. A truck accident rate of 1.4E-6/km (2.2E-6/miles) is a widely cited value for two-lane rural roads (Harwood and Russell 1990), and this value will be used both where data are lacking and to ensure a conservative analysis where a lower value is calculated.

The calculated accident rate per trip between the Unit 1 site and the Crownpoint site is 4.2E-6. The distance between the Church Rock site and the Crownpoint site is 1 mile on NM 566, 24 miles on

Navajo 49, 14 miles on NM 371, 2 miles on Navajo 9, and 1 mile on Church Road (a total of 42 miles per trip). The calculated accident rate per trip on this route is 5.9 E-5. Between the Crownpoint site and I-40 the calculated accident rate is 3.9E-5.

## 3.5 ECOLOGY

### 3.5.1 Regional

Ecological conditions at the three project sites were examined in detail during surveys related to earlier uranium mining developments. Site-specific surveys of the Crownpoint area were conducted for the TVA-Mobil joint venture and were published by TVA (1979) and Mobil (1980a).

#### 3.5.1.1 Terrestrial Vegetation

The following discussion of vegetation describes regional conditions, but certain site-specific differences exist among the three project sites.

Within the region, vegetation patterns relate to topography. For example, a broad band of shrub- and herb-dominated vegetation occupies the floodplain that runs diagonally across State Highway 9, approximately 8 km (5 miles) northwest of Crownpoint. Widely scattered pinyon pines or junipers occur on the escarpment just west of the floodplain. Dominant species on the uplands range from annuals to perennial herbs to shrubs.

Grassland vegetation of the central San Juan Basin northeast of the project area grades into pygmy-conifer woodland along the southern edge of the basin. Grasslands predominate on the gently or moderately sloping uplands, with mixed shrub-grass associations on the floodplains and widely scattered pinon-juniper woodland on the escarpments.

Typical grassland sites in the region consist of rolling hills with a few sandstone outcrops. The grassland vegetation is a combination of mixed prairie, grama-galleta steppe, plains and Great Basin grassland, snakeweed grassland, and the alkali sacaton-saltbrush series of the Great Basin region. The most obvious vegetation elements are grasses, shrubs, and introduced annuals, especially tumbleweed or Russian-thistle (*Salsola iberica*). Blue grama (*Bouteloua gracllis*), alkali sacaton (*Sporobolus airoides*), galleta (*Hilaria jamesii*), squirreltail (*Sitanion hystrix*), and Indian ricegrass (*Oryzopsis hymenoides*) are the most abundant grass species. Mixed with these are a number of subshrubs and shrubs including snakeweed, rabbitbrush, four-wing saltbush (*Atriplex canescens*), and pale wolfberry or desert-thorn (*Lycium pallidum*). Transitional pinyon pine (*Pinus edulis*) or one-seeded juniper (*Juniperus monosperma*) may be found on sandstone outcroppings. Vegetation in the arroyos is generally dominated by four-wing saltbush, pale wolfberry, western wheatgrass (*Agropyron smithii*), and alkali sacaton. A few arroyos also contain stands of greasewood (*Sarcobatus vermiculatus*).

The Crownpoint and Church Rock areas are utilized as grazing ranges by ranchers for cattle, sheep, and other domestic livestock. The characteristics defining a Range Site association include vegetation, topography, soils, elevation, and climate. These characteristics have been developed and presented by the American Ag International (AAI) range specialist (Mobil 1980a). Six of the seven range types defined by AAI are found in the project area and are described as follows.

The loam association is a grassland association found on gently rolling to rolling plains with moderate slopes that are located throughout the project area. Soils are normally deep and well drained with a high water-holding capacity. Characteristic plant species found in loam are galleta, blue grama, alkali sacaton, Indian ricegrass, and globe-mallow (*Sphaeralcea* sp.); shrubs and half-shrubs are scattered throughout. The average loam crown cover is 9.5 percent.

Rock outcrop is a grass/shrub association found on gently rolling plains interrupted by rather sharp drop offs at the rock outcrops. Soils are shallow with little development and gravelly surfaces; where vegetated, water permeability is good. Characteristic plant species found in rock outcrops are alkali sacaton, galleta, blue grama, Indian ricegrass, snakeweed, four-wing saltbush, winterfat (*Ceratoides lanata*), shadscale (*Atriplex confertifolia*), and big rabbitbrush (*Chrysothamnus nauseosus*). The average rock outcrop crown cover is 8.5 percent.

Sand-bottomland association is a shrub/grass association of variable composition that is found on very gentle slopes at the base of gently rolling to rolling plains. This association is located on most of the east half of Section 8, Section 15, and the southeast quarter of Section 16. Soils are relatively deep and coarse with high permeability and a moderate to low water-holding capacity. As the vegetative cover declines, wind erosion tends to occur. Characteristic plant species found here are greasewood, four-wing saltbush, wolfberry, galleta, Indian ricegrass, alkali sacaton, and squirreltail. Annuals occur seasonally in the sand-bottomland association. The average crown cover is 5.5 percent.

Sandy associations are grass/shrub complexes found on gently rolling or undulating plains of moderate slope (1 to 10 percent). Soils are deep, coarse textured, and rapidly permeable and have a relatively moderate to low water-holding capacity. When the vegetative cover is removed, severe wind erosion can occur. Characteristic plant species found here are galleta, blue grama, Indian ricegrass, squirreltail, little rabbitbrush (*C. viscidiflorus*), snakeweed, greasewood, and big rabbitbrush. Curly dock (*Rumex hymenosepulus*) is a sandy perennial form. The average crown cover in this grass/shrub complex is 16.9 percent.

Bottomland is characterized as grassland with shrubs or as shrubs with an understory of grasses. It is found in relatively narrow drainages that are periodically covered with water and with slopes between 1 and 3 percent. A tiny area is located at the west edge of Section 16. Soils are usually deep with a moderate to high water-holding capacity. Characteristic plant species in bottomland are greasewood, alkali sacaton, and galleta. The average crown cover there is 18.9 percent.

Shallow sandstone, scattered shrubs with an understory of grasses, is found on gently rolling to steep hills, often with sandstone outcrops, exposed veins of coal, and occasional boulders. Soils are shallow with a low water-holding capacity. Characteristic plant species found in this range type are juniper, Bigelow sagebrush (*Artemisia bigelovii*), buckwheat (*Eriogonum* sp.), pinyon, and galleta. Other commonly occurring species include alkali sacaton, blue grama, four-wing saltbush, and rabbitbrush. The average crown cover is 17 percent.

#### 3.5.1.2 Terrestrial Fauna

The following discussion of wildlife describes regional conditions, but certain site-specific differences exist among the three project sites.

**Mammals.** Big game animals are not common in the region. Mule deer (*Odocoileus hemionus*) and pronghorn (*Antilocapra americana*) occur in the project area, but the preferred habitat of both these big game species is lacking in the immediate vicinity of the project sites.

Mule deer prefer broken landscape and tree cover. The pinyon-juniper vegetation adjacent to the project area is the nearest available mule deer habitat.

In northwestern New Mexico, pronghorns occur in grassland-desert shrub habitat wherever high densities of food can be found. One herd occurs east of Farmington, about 100 km (60 miles) north of the project area, in San Juan County; another is located south of Grants. The State of New Mexico has not reported any pronghorn herds north of Grants in McKinley County. However, it is possible that pronghorns could occasionally wander into the Crownpoint area from their preferred habitats to the north and south.

Mountain lions (*Felis concolor*) have been sighted west of the project area, and black bears (*Ursus americanus*) have been recorded in the highlands south of Crownpoint. Preferred ground cover is lacking in the project area, but because these predators range over large tracts of land, they may occasionally pass through the area.

Coyote (*Canis latrans*) and kit fox (*Vulpes macrotis*), both of which adapt well to arid conditions, may occur on or near the project sites. Scat similar to that of a coyote has been observed, and kit and red foxes (*V. vulpes*) have been sighted southeast of Section 12, T17N R13W. Red fox sighted during mine-area surveys were the first recorded in McKinley County. This species is generally found in more mesic conditions than those represented by the project sites, and its presence is considered accidental. Badgers (*Taxidea taxus*) have not been observed but may occur because the project sites are well within their known range.

Desert cottontails (*Sylvilagus audubonî*) and black-tailed jackrabbits (*Lepus californicus*) are present but not abundant. These animals serve as a prey base for medium-sized and large mammalian carnivores and large avian predators.

A Gunnison's prairie dog (*Cynomys gunnisoni*) town of approximately 50 burrows was identified in the Mobil Crownpoint project area (TVA 1979), but no activity was observed in the town during a summer survey. One prairie dog was observed moving along a perimeter fence some distance from the colony. This lack of activity is highly unusual for an active prairie dog colony, as the young are usually above ground in late May and early June. There have been reports of prairie dog die-offs from bubonic plague in the Crownpoint area. This may explain the discrepancy between an active colony appearing in 1976, but not in 1978.

Small rodents were snap-trapped near Crownpoint in September 1978 and live-trapped and marked in November 1978 and June 1979. The most abundant species were the silky pocket mouse (*Perognathus flavus*) and deer mouse (*Peromyscus maniculatus*).

**Avifauna.** The most abundant bird in the region is the horned lark (*Eremophila alpestris*). This species is well adapted to areas with low, sparse cover. Songbird diversity, in general, is expected to be very low because of the sparse nesting cover. Waterfowl and shorebirds may pass through the region during migration, and some may use small intermittent ponds or the sewage lagoon near Crownpoint.

Mourning doves (*Zenaidura macroura*) and scaled quail (*Callipepla squamata*) have been observed locally and undoubtedly occur in the project area, although neither species was reported as abundant. Scaled quail are frequently found in arid grasslands, usually nesting on the ground under bushes. Mourning doves are more cosmopolitan but can also adapt to arid conditions.

The open grasslands of the region provide good hunting areas for raptors. The sandstone escarpment within the project area may provide nesting or roosting sites, and the scattered pinyon pines and junipers could provide refuge. Raptors were not included in the TVA (1979) study, but burrowing owls (*Speotyto cunicularia*) were sighted in Section 12, T17N R13W. The American kestrel (*Falco sparverius*) has been observed nearby and undoubtedly occurs in the project area. Other raptors may also occur in the project area; however, their presence is probably occasional, and their density is expected to be low.

**Reptiles and Amphibians.** Six species of lizards were seen on or near Section 12, T17N R13W (HRI 1992a) and are very likely to occur in similar habitats elsewhere in the project area. Four snake species were also observed near the project area, including a western rattlesnake (*Crotalus viridis*). Additionally, HRI's (1992a) analysis indicates the presence of the Western spadefoot toad (*Scaphiopus hamondi*). This species is usually found in the sandy soil area of arroyos or floodplains, and a few shallow, incised arroyos are found in the project area.

#### 3.5.1.3 Aquatic Biota

No permanent aquatic habitat exists in the project area that would provide stable conditions for supporting aquatic life. All surface drainages traversing the project area are ephemeral. Similarly, all surface runoff observed in the project area is derived from short, intense rainfall events and quickly percolates into the soil. All stock ponds are temporary and normally dry out after a few weeks.

#### 3.5.1.4 Endangered, Threatened, and Other Special-Status Species

The following description provides background information regarding plant and animal species that have been afforded protected status by Federal law and are known to occur in the region or in habitats similar to those found in the project sites. The information on Federally listed threatened and endangered species was provided by the U.S. Fish and Wildlife Service (FWS) (Fowler-Propst 1994). There is no designated critical habitat for Federally listed species in the project sites. Species of concern in the State of New Mexico that could occur on the project sites are also discussed briefly.

**Federally Endangered Species.** The black-footed ferret (*Mustela nigripes*) is usually found in association with prairie dog towns in grassland plains and surrounding mountain basins up to 3200 m (10,500 ft) in elevation. A survey for black-footed ferrets is required if a prairie dog town is present and is larger than 32 ha (80 acres) with black-tailed prairie dogs or 80 ha (200 acres) with white-tailed and Gunnison's prairie dogs. If the prairie dog town is larger than 400 ha (1000 acres), the area should be evaluated for possible reintroduction of black-footed ferrets.

There are no active prairie dog towns reported in the project area. The Gunnison's prairie dog town with approximately 50 burrows in Unit 1 was reportedly unoccupied in 1978. A site visit in 1995 confirmed the absence of activity. It is therefore unlikely that any black-footed ferrets occur in the project area.

The Southwestern willow flycatcher (*Empidonax trallil extimus*) inhabits thickets, riparian woodlands, pastures, and brushy areas. The project area does not contain the preferred habitat for this species, which is not currently known to exist in or frequent the project sites.

The American peregrine falcon (*Falco peregrinus anatum*) prefers areas with steep (e.g., more than 60 m) rocky cliffs near water. No such habitat is present in the project area, so the species is unlikely to occur there.

**Federally Threatened Species.** The bald eagle (*Haliaeetus leucocephalus*) occupies New Mexico primarily as a winter resident but also occurs as a migrant with several nesting pairs in the State. Bald eagles roost in large trees, which may or may not be close to their feeding areas. Bald eagles are found in riparian areas adjacent to rivers, reservoirs, and ponds. Rabbits, fish, and waterfowl are their primary prey. The lack of permanent water in the project area should preclude the presence of the bald eagle, and there had been no confirmed sightings of the bird in McKinley County as of 1978 (Hubbard et al. 1978).

The Mexican spotted owl (*Strix occidentalis lucida*) has a range that includes the project area. A recovery plan for the species was released in 1995 (FWS 1995). The spotted owl is found in suitable forested habitat (e.g., closed canopy forest in canyons and riparian zones) in northern Mexico and the southwestern United States (Arizona, Colorado, New Mexico, Texas, and Utah). Because the spotted owl requires timbered habitat, none of which occurs within miles of the project area, it is highly unlikely to occur in the project area.

The Zuni (rhizome) fleabane (*Erigeron rhizomatous*) is often found in close association with Chinle Formation and Baca Formation outcrops with elevations of 2225 to 2400 m (7300 to 8000 ft) in the Zuni, Datil, and Sawtooth Mountains. The preferred habitat for this species consists of sandstone slopes and clay banks. This species was not listed in HRI's analysis of plants noted for the project area (HRI 1988, 1989a, 1992a). The likelihood of this plant species being present is significantly reduced because the project area is below an elevation of 2100 m (6900 ft) and neither the Chinle Formation nor the Baca Formation crops out in the project sites.

**Federal Species of Concern (Formerly Category 2 Candidate Species).** The following Species of Concern are not likely to occur frequently or at all in the project area, primarily because the project sites are at elevations too low to provide the species' preferred habitats.

The occult little brown bat (*Myotis lucifugus occultus*) is a montane dweller and roosts in natural caves, mine tunnels, hollow trees, or buildings. The spotted bat (*Euderma maculatum*) is found in several national forests in New Mexico. This species usually occurs in remote areas, selecting specialized roosting sites near streams and cliffs or steep hillsides with loose rocks. The northern goshawk (*Accipiter gentilis*) primarily uses moderately to highly canopied mature coniferous forests with minimal understory. Nest sites are found in forest stands with a high density of large trees and closed canopy. The ferruginous hawk (*Buteo regalis*) is found almost statewide during migration. Birds seem to favor wide, open grasslands and prairies, especially for nesting. Although the ferruginous hawk could pass through the region, the project sites contain neither high quality habitat nor sufficient game species and land area essential for this hawk.

The Zuni Mountain sucker (*Catostomus discobolus yarrowi*) inhabits small streams, preferring a rock rubble substitute in New Mexico. Morphometric and biochemical methods demonstrate that the Zuni Mountain sucker is the product of hybridization between the Colorado River mountain sucker and the Rio Grande mountain sucker (Smith et al. 1983). It is found in Redosenit Creek, Dean Creek, Rio Nutrias, Rio Pescado, and Zuni River in McKinley County, New Mexico.

The Acoma fleabane (*Erigeron acomanus*) is a mat-forming perennial wildflower. It grows in sandy soils at the base of sandstone cliffs. Associated plant species include one-seeded juniper, pinyon pine, hairy golden aster (*Chrysopsis villosa*), and mountain mahogany (*Cercocarpus montenus*). The Sivinski fleabane (*Erigeron sivinski*) is a perennial with a thick taproot and numerous, short, upright branches. Known only in McKinley County (Zuni Mountains) at elevations from 2130 to 2450 m (7300 to 8000 ft), this species occurs in association with Chinle Shale outcrops in selenium-bearing soils.

**State-Listed Species.** The New Mexico Heritage Program lists additional plant species from McKinley County that are considered sensitive. These are *Astragalus fucatus*, found on sand dunes; *Penstemon lentus*, associated with pinyon-juniper woodlands; *Penstemon comarrhenus*, which has not been collected since 1935; *Mitella pentandra*, collected 13 km (8 miles) southeast of Crownpoint at the head of Long Canyon on the mesa rim; *Clematis hirsutissima arizonica*, found in the Zuni Mountains along the roadside; *Carex elynoides*, found 6.5 km (4 miles) north-northeast of Prewitt on gray shale and powdery soil at 3750 m (6800 ft); and *Aletes sessiliflorus*, also found 6.5 km (4 miles) north-northeast of Prewitt on top of a sandstone bluff.

Most of these species are typical of the pinyon-juniper vegetation type and occur at elevations higher than those found in the project area. Sparse pinyon-juniper vegetation is found only along the southern edges of the Unit 1 site. As a result, it is unlikely that any of these plant species would be found in the proposed well field areas. *S. mesae-verdae* is found on barren mesas at lower elevations than the project area and, as yet, has not been found as far south as McKinley County. *M. pentandra, C. elynoides*, and *A. sessiliflorus* are found on bluffs and mesas. These plant species might occur on sandstone escarpments in the project area but not in the three project sites.

## 3.5.2 Crownpoint

### 3.5.2.1 Terrestrial Vegetation

The Crownpoint site exhibits vegetation communities similar to those discussed for the region (Section 3.5.1.1). Within the site, a variety of vegetation types exists, dependent on soil and moisture conditions.

### 3.5.2.2 Terrestrial Fauna

Wildlife characteristics of the Crownpoint site are similar to those discussed for the region (Sections 3.5.1.2, 3.5.1.3, and 3.5.1.4).

## 3.5.3 Unit 1

### 3.5.3.1 Terrestrial Vegetation

The Unit 1 site exhibits vegetation communities similar to those discussed for the region (Section 3.5.1.1). Within the site, a variety of vegetation types exists, dependent on soil and moisture conditions.

### 3.5.3.2 Terrestrial Fauna

Wildlife characteristics of the Unit 1 site are similar to those discussed for the region (Sections 3.5.1.2, 3.5.1.3, and 3.5.1.4).

## 3.5.4 Church Rock

### 3.5.4.1 Terrestrial Vegetation

The Church Rock site exhibits vegetation communities similar to those discussed for the region (Section 3.5.1.1). Within the site, a variety of vegetation types exists, dependent on soil and moisture conditions.

In the Church Rock area, sagebrush-grasslands predominate up to elevations of 2100 m (6900 ft). Vegetation patterns have been greatly influenced by overgrazing, primarily by sheep. Cattle, goats, and horses also graze the area. At most locations all palatable plant species have been cropped close to the ground and completely eliminated in many areas. Large patches of bare ground are common, and many areas are severely eroded. Conversely, unpalatable subshrubs and shrubs, principally snakewood

(*Gutierrezia* spp.) and slenderleaf rabbitbrush (*Chrysothamnus greenei* var. *filifolius*), are abundant. The vegetative cover generally ranges from 2 to 20 percent, sporadically reaching 40 percent.

#### 3.5.3.2 Terrestrial Fauna

Wildlife characteristics of the Church Rock site are similar to those discussed for the region (Sections 3.5.1.2, 3.5.1.3, and 3.5.1.4).

## 3.6 LAND USE

### 3.6.1 Regional

The three project sites are located in McKinley County, New Mexico, which is largely rural and consists mostly of open range grazing land and areas used for timber and crop production. McKinley County is the sixth largest county in the State, comprising approximately 14,000 $km^2$ (5500 $miles^2$) or 1.4 million ha (3.5 million acres).

Of the nearly 1.4 million ha (3.5 million acres) in McKinley County, over 85 percent [1.2 million ha (3 million acres)] is used for agricultural purposes. Agricultural uses include livestock grazing (sheep, cattle, goats, and horses), forestry (timber production), and crop production. Livestock grazing is the predominant agricultural land use with 1 million ha (2.7 million acres), while timber production is second with 105,000 ha (260,000 acres). In contrast, irrigated and dry crop land occupies only 7100 ha (17,640 acres).

Extractive land uses, primarily coal and uranium mining, account for less than 1 percent of the total land area in McKinley County. Although coal mining has been ongoing in the county since the 1880s, and uranium mining became widespread beginning in the 1950s, the relatively small land areas attributed to these extractive uses can be explained in part by the fact that many of the mining operations involve underground activities that do not affect surface land areas.

Only 0.5 percent of McKinley County's total land area is used for urban land uses (i.e., characterized by various kinds of concentrated residential areas with single- and multi-family dwellings and mobile home parks, commercial districts, and municipal facilities). The county's population is concentrated in the urban areas in and around Gallup.

### 3.6.2 Crownpoint

The Crownpoint site is located in Sections 24 and 25, T17N R13W, and Sections 19 and 29, T17N R12W, on the western and eastern edges of the town of Crownpoint. The site is composed of mixed private land owned by HRI and others and would be mined through private minerals operating leases or claimed mineral rights. The Crownpoint lease areas include sections of the town of Crownpoint, and well fields and monitor wells would be found in close proximity to residences. Additionally, several churches serving the Crownpoint community are found along the road that would provide access to the central processing facility and overlying ore bodies.

The Crownpoint site covers 365 ha (912 acres), of which approximately 70 percent [255 ha (638 acres)] would be disturbed during project construction and operation. The estimate of 255 ha (638 acres) includes areas that have been previously disturbed as well as those that would be newly disturbed. Existing processing facilities and settling ponds, which occupy approximately 5.5 ha (14 acres) in the southeastern quarter of Section 24, would be used. Well fields would occupy approximately 205 ha (510 acres). Additional acreage would be required for access roads, on-site wastewater land application areas, and evaporation ponds. If HRI disposes of wastewater using off-site land application, it would occur in Section 12, T17N R13W. Because Section 12 would also be used for land application for the Unit 1 site under this scenario, its 256 ha (640 acres) are included below in the land disturbance calculations for Unit 1 (Section 3.6.3). Thus, the total land area that would be disturbed at the Crownpoint site would be approximately 255 ha (638 acres).

### 3.6.3 Unit 1

The Unit 1 site is located in Sections 15, 16, 21, 22, and 23, T17N R13W, approximately 3.2 km (2 miles) west of the town of Crownpoint. The site is composed of a block of allotted lands; the mineral and surface rights are owned by Navajo allottees, held in trust and administered by the BIA. The Unit 1 site consists primarily of open range land, although some of the allotted land is occupied by a number of scattered residences, including a traditional Navajo family group. The residences consist of small, wooden frame houses or mobile homes. Separate field interviews, conducted by HRI and the NRC in July 1993, indicated that there were seven residences occupied by 26 persons in the Unit 1 lease area. There were seven additional unoccupied residences owned by persons who live permanently in Crownpoint or elsewhere. The area is otherwise undeveloped and provides open range land suitable only for livestock grazing.

Considerable mineral exploration has taken place within the boundaries of the Unit 1 site. Exploratory drilling took place in the area before 1980 and was conducted on a grid of approximately 60 m (200 ft). The drilled areas can still be delineated by observing aerial photographs and include the inhabited area of the site. Related mineral extraction took place in the early 1980s when Mobil Oil Corporation (Mobil) conducted the Section 9 pilot project less than 1.6 km (1 mile) outside the Unit 1 site.

All the persons living within the Unit 1 site boundaries are Navajo allottees (who own the surface and mineral rights) or their tenants. Leases for both the surface use and mineral rights on this land are administered by the BIA. The BIA and allottees affected by the proposed project have each signed agreements with HRI authorizing mineral leases and surface use of the land for mining activities. All the residences are located outside the areas to be used for uranium recovery during HRI's initial 5-year mine plan.

The Unit 1 site covers 512 ha (1280 acres), of which approximately 70 percent [358 ha (896 acres)] would be disturbed during project construction and operation. The estimate of 358 ha (896 acres) includes areas that have been previously disturbed as well as those that would be newly disturbed. The satellite processing facility's buildings, plant areas, parking lots, and settling ponds would occupy approximately 2.5 ha (6 acres). Well fields would occupy approximately 280 ha (700 acres). Additional acreage would be required for access roads, on-site wastewater land application areas, and evaporation ponds. If HRI disposes of wastewater using off-site land application (i.e., in Section 12, T17N R13W), an additional area of up to 256 ha (640 acres) could be disturbed. Thus, the total land area that would be disturbed at the Unit 1 site ranges from 358 ha (896 acres) (on-site land application) to 614 ha (1536 acres) (off-site land application in Section 12).

### 3.6.4 Church Rock

The Church Rock site is located in Sections 8 and 17, T16N R16W, approximately 10 km (6 miles) north of the town of Church Rock. The site consists primarily of undeveloped range land. A portion of the site was previously developed with surface facilities for an underground uranium mine, and the site has been only partly restored. A few scattered residences are located within 3 km (2 miles) of the site, but only some of them are inhabited throughout the year.

The Church Rock site covers 145 ha (360 acres), of which approximately 90 percent [130 ha (324 acres)] would be disturbed during project construction and operation. The estimate of 130 ha (324 acres) includes areas that have been previously disturbed as well as those that would be newly disturbed. The satellite processing facility's buildings, plant areas, parking lots, and settling ponds would occupy approximately 2.5 ha (6 acres). Well fields would occupy approximately 32 ha (80 acres). Additional acreage would be required for access roads, on-site wastewater land application areas, and evaporation ponds. If HRI disposes of wastewater using off-site land application (i.e., in Section 16, T16N R16W), an additional area of up to 256 ha (640 acres) could be disturbed. Thus, the total land area that would be disturbed at the Church Rock site ranges from 130 ha (324 acres) (on-site land application) to 386 ha (964 acres) (off-site land application in Section 16).

## 3.7 SOCIOECONOMICS

The proposed project would be located in McKinley County in northwestern New Mexico. The local communities in the immediate vicinity of the project are located within the borders of the Crownpoint and Church Rock chapters of the Navajo Nation. In the Navajo Nation governmental structure, chapters are the smallest jurisdictions. The Crownpoint and Church Rock chapters are part of the Eastern Navajo Agency, which includes 31 chapters.

The Crownpoint Chapter includes 67,364 acres and had an estimated population of 2597 in 1993. The Church Rock Chapter includes 52,719 acres and had an estimated population of 1742 in 1993. Although the towns of Crownpoint and Church Rock are located outside the boundaries of the Navajo Reservation, they are represented in the Navajo Nation, the governing body that provides local public services including water, sewer, social services, and police protection.

The Crownpoint and Church Rock chapters are located in the area of McKinley County known as the "checkerboard" for its mixed private tribal and government property rights. Much of the area includes property that is under the Navajo Tribal Trust and individual Navajo allotments that are privately held with some BIA oversight.

### 3.7.1 Demographics

McKinley County had a population of 60,686 in 1990 and an estimated population of 65,006 in 1995. The county is projected to grow to 69,286 persons by 2000 and to 77,823 by 2010. McKinley County's annual population growth rate between 1980 and 1995 was 0.9 percent and is projected to be 1.2 percent between 1995 and 2010. This compares to the State of New Mexico's population growth of 1.5 percent and 1.3 percent over the same periods (University of New Mexico 1994).

Recent population increases in McKinley County can be attributed to the increase in Native American population. The Native American population increased by over 6,000 (+11.4 percent) from 1980 to 1990, while the non-Native American population decreased by over 2,000 (-13.0 percent). The percentage of the county's total population composed of Native Americans was 66 percent in 1980 and 72 percent in 1990 (Table 3.26). Persons of Hispanic origin represented about 13 percent of McKinley County's 1990 population. In 1990, over 70 percent of McKinley County's white population resided in Gallup. Outside of Gallup, 85 percent of the population was Native American.

The town of Crownpoint has also experienced rapid population growth recently, doubling in size from 1980 to 1993. Between 1980 and 1993, Crownpoint's population growth averaged 5.5 percent annually, compared to that of the Church Rock Chapter (0.6 percent annually from 1980 to 1993) and Gallup (0.5 percent annually from 1980 to 1990). This rapid population growth in Crownpoint is partially explained by improved access to the town with the completion of the fully paved State Highway 371. Also, Crownpoint is the "agency" town for the Eastern Navajo Agency and, as such, is a key center for Navajo Nation social services for the surrounding area. Crownpoint's population growth in the 1980s can also be attributed, in part, to the addition of a new hospital, high school, and shopping center. During this period of rapid growth, the Navajo Nation Governmental offices were expanded and an airport was built approximately 6 km (3.7 miles) west of the community (Rodgers 1993).

### 3.7.2 Income

Tables 3.27 and 3.28 present income characteristics for the residents of McKinley County by race. The tables indicate that McKinley County is relatively poor compared to the rest of the State. Although the county's per capita income increased from $6148 in 1984 to $9668 in 1990, the number of residents living in poverty also increased from 20,773 in 1979 to 26,118 in 1989 (U.S. Bureau of the Census 1994). The number of residents below the poverty level in 1989 represented about 43.5 percent of McKinley County's population, compared to about 20.6 percent for the State (U.S. Bureau of the Census 1994).

**Table 3.26. 1990 population and racial characteristics of the State of New Mexico, McKinley County, Crownpoint, and Gallup**

| | Total | White | Black | Native American | Other[a] | Hispanic origin[b] |
|---|---|---|---|---|---|---|
| New Mexico | 1,515,069 | 1,146,028 | 30,210 | 134,097 | 204,734 | 579,224 |
| (percent of total)[c] | | 75.6% | 2.0% | 8.9% | 13.5% | 38.2% |
| McKinley County | 60,686 | 13,295 | 295 | 43,570 | 3526 | 7764 |
| (percent of total) | | 21.9% | 0.5% | 71.8% | 5.8% | 12.8% |
| Crownpoint (Census designated place) | 2108 | 153 | 12 | 1,929 | 14 | 28 |
| (percent of total) | | 7.3% | 0.6% | 91.5% | 0.7% | 1.3% |
| Gallup city | 19,154 | 9544 | 223 | 6363 | 3024 | 4185 |
| (percent of total) | | 49.8% | 1.2% | 33.2% | 15.8% | 21.8% |
| McKinley County not including Gallup | 41,532 | 3751 | 72 | 37,207 | 502 | 3579 |
| (percent of total) | | 9.0% | 0.2% | 89.6% | 1.2% | 8.6% |

[a]Other includes Asians and Pacific Islanders.

[b]Hispanic origin can be any race and is calculated as a separate component of the total population (i.e., if added to the other 3 racial cohorts the total will be more than 100 percent).

[c]Percentages do not add to 100 because of rounding and because "Hispanic origin" is not a racial category.

*Source*: U.S. Bureau of the Census 1990.

**Table 3.27. McKinley County household income distribution by race**

| Income interval ($) | White (%) | Native American (%) | Other race (%) |
|---|---|---|---|
| 0 to 4999 | 2.2 | 16.4 | 0.5 |
| 5000 to 9999 | 2.3 | 10.1 | 1.1 |
| 10,000 to 14,999 | 2.9 | 8.1 | 0.9 |
| 15,000 to 24,999 | 6.1 | 11.8 | 1.6 |
| 25,000 to 34,999 | 6.1 | 7.0 | 1.2 |
| 35,000 to 49,999 | 6.2 | 4.4 | 1.1 |
| 50,000 to 74,999 | 4.1 | 1.9 | 0.4 |
| 75,000 to 99,999 | 1.3 | 0.8 | 0.3 |
| Above 100,000 | 0.8 | 0.1 | 0.2 |
| Percentage of all households | 32.0 | 60.6 | 7.4 |

*Source*: U.S. Bureau of the Census 1990.

As Tables 3.27 and 3.28 indicate, McKinley County's Native American population makes up a disproportionate number of its poorest residents. The Native American poverty rate is about five times that of the white population in McKinley County. According to 1990 Census data, about 27 percent of the Native American households had incomes below $5000 and about 24 percent had incomes above $25,000. The comparable figures for white households in 1990 were 7 percent and 58 percent, respectively.

**Table 3.28. Comparison of income and poverty status in 1989 between McKinley County and the State of New Mexico**

| | New Mexico | McKinley County |
|---|---|---|
| Per capita income | $11,246 | $6628 |
| Median household income | $24,087 | $17,468 |
| Per capita income by race | | |
| White | $12,678 | $13,780 |
| Black | $8579 | $15,865 |
| American Indian, Eskimo, or Aleut | $5141 | $4094 |
| Asian or Pacific Islander | $10,655 | $17,075 |
| Other | $7320 | $9496 |
| Percentage below poverty level—all persons | 20.6% | 43.5% |
| White | 16% | 11% |
| Black | 26% | 27% |
| American Indian, Eskimo, or Aleut | 45% | 54% |
| Asian or Pacific Islander | 17% | 0% |
| Other | 29% | 34% |

*Source*: U.S. Bureau of the Census 1990.

## 3.7.3 Earnings and Employment Structure

McKinley County has a relatively high unemployment rate. In August 1995, McKinley County's unemployment rate was 8.3 percent, compared to 6.4 percent for New Mexico and 5.6 percent for the United States By July 1996, McKinley County's unemployment rate had increased to 10.9 percent, compared to 7.5 percent for New Mexico and 5.1 percent for the United States. McKinley County's July 1996 unemployment rate indicates a significant decline in the regional economy. The Native American labor force generally suffers from higher unemployment rates than the total labor force. For example, in 1990 the total unemployment rate for McKinley County was 13.6 percent, with Native American unemployment at 15.5 percent and non-Native American unemployment at only 6.7 percent.

Government employment is the single largest source of jobs (about 19 percent of wage and salary employment in 1994) and earnings (about 31 percent of total county earnings in 1990) in McKinley

County (U.S. Bureau of the Census 1994). Other types of employment that are important to McKinley County's economy include the health care professions, coal mining, timber milling, jewelry manufacturing and wholesaling, and elementary and secondary education (U.S. Bureau of the Census 1995).

In 1990, the goods-related industry (including mining, manufacturing, and construction) represented a higher proportion of total county earnings (20.5 percent) than it did for total State earnings (17.4 percent). However, manufacturing wages in McKinley County averaged only $13,000 per year compared to the New Mexico average of $25,000 per year.

Agriculture is another source of employment and earnings in McKinley County. In 1987, there were 240 farms in the county with an average value of products sold of about $38,000. The farm population in 1990 was 568, with farm earnings of about $5 million (about 1.2 percent of total county earnings).

These agricultural statistics do not, however, capture the economic significance of subsistence agriculture in McKinley County, as common activities such as gardening and livestock grazing are not included under employment, earnings, or income. Conversely, the adverse effects of livestock grazing indicate the importance of subsistence agriculture in the Navajo areas of McKinley County. According to the May 24, 1996, *Gallup Independent*, Navajo Nation President Albert Hale indicated that overgrazing was one of the primary factors making existing drought conditions worse. Referring to temporary solutions such as emergency feed and water for livestock, he said:

> They didn't get at the basic problem, which is overgrazing. . . . You only need to look at the land outside the right-of-way fences to see how well vegetation can survive despite the drought. . . . Inside the fences, the land needs to rest for years. . . . Hopefully, the livestock owners will understand what we're trying to do when they see what is happening to the land. . . . There's just too much livestock on the land.

Tourism is also very important to McKinley County's economy. There are many attractions in and around Gallup, including the Hubbell Trading Post National Historic Site, ceremonial Native American dances, and retail outlets for jewelry and rugs. Crownpoint is well known for its periodic rug auctions and is the last chance for food and fuel on the way to the Chaco Culture National Historic Park via I-40. The Chaco Culture National Historic Park includes displays of Chacoan trade goods, pottery, turquoise, and jewelry and has about 80,000 visitors annually (Van Dyke 1996a).

The town of Crownpoint's main economic activity is education, with three schools that had a total combined enrollment of over 1400 in 1992. These schools include a public elementary school with an enrollment of about 400, a public high school with an enrollment of about 600, and a BIA-operated Native American boarding school with an enrollment of about 400. The two public schools are run by the State of New Mexico and have both Native American and non-Native American enrollment. The town of Crownpoint also has several small parochial schools and the Crownpoint Institute of Technology. There are several retail and service businesses in Crownpoint, including convenience stores, gas stations, a restaurant, two laundromats, a video store, a super market, and a rug cooperative that has periodic rug sales. Table 3.29 lists the largest employers in Crownpoint.

Table 3.29. Major employers in Crownpoint

| Employer | Number of employees |
|---|---|
| Navajo Nation | 455 |
| Bureau of Indian Affairs | 350 |
| Indian Health Services | 248 |
| Gallup-McKinley County Schools | 200 |
| Crownpoint Institute of Technology | 75 |
| Bashas (Supermarket) | 35 |
| Navajo Housing Authority | 11 |
| Thriftway | 6 |
| Crownpoint Country Store | 4 |
| Navajo Communications Company | 3 |

*Source*: Rodgers 1993.

Because the Eastern Navajo Agency is headquartered in Crownpoint, several Navajo governmental functions are located there, including a Native American hospital. However, despite the various governmental activities, Crownpoint per unit housing value is only 25 percent of that in Gallup, reflecting the lower incomes of the predominantly Native American population. The relative lack of retail businesses in Crownpoint given the town's population may reflect (1) policies of the Navajo Nation that affect business development (Van Dyke 1996b) and/or (2) consumer preferences for shopping in larger cities and (3) relatively low expendable income.

Retail establishments in Church Rock include a gas station, two convenience stores, a restaurant, a trading post, and a laundromat. The major employers in Church Rock include local schools (57 employees), the Meridian Oil Company (39), Hamilton Construction Company (25), Indian Plaza (18), and the Red Rock State Park (17). There are also about 40 to 50 family farms in the area.

## 3.7.4 Housing and Public Infrastructure

### 3.7.4.1 Housing

Table 3.30 presents a comparison of housing statistics for Crownpoint, Gallup, McKinley County, and the State of New Mexico. There is a significant difference in the value of housing in Gallup compared to the rest of McKinley County, reflecting the higher incomes of residents in Gallup.

Although the official vacancy rate in McKinley County is high (Table 3.30), local sources indicate that housing availability is very limited (Van Dyke 1996b, 1996c). This inconsistency between Census data

**Table 3.30. Households, housing, and rent in McKinley County**

| | Crownpoint | Gallup Division | McKinley County | New Mexico |
|---|---|---|---|---|
| Total housing units | 1911 | 7471 | 20,933 | 632,058 |
| Median value owner-occupied housing | $14,999 | $67,300 | $40,700 | $70,100 |
| Median contract rent | $158 | $276 | $221 | $312 |
| Occupied housing units (households) | 1339 | 6832 | 16,588 | 542,709 |
| Vacant housing units | 572 | 1725 | 4345 | 89,349 |
| Percent vacant | 0 | 0 | 0 | 0 |
| For seasonal, recreational, or occasional use | 65 | 926 | 940 | 21,862 |
| Owner occupied | 864 | 4230 | 11,700 | 365,965 |
| Percent owner occupied | 0 | 1 | 1 | 1 |
| Renter occupied | 475 | 2602 | 4888 | 176,744 |
| Percent renter occupied | 0 | 0 | 0 | 0 |
| Aggregate value of owner occupied housing | $9,011,500 | $201,167,000 | $354,459,000 | |
| Average value of owner-occupied houses | 10,430 | 47,557 | 30,296 | |
| Average value of owner-occupied houses for McKinley County outside Gallup—$20,521 | | | | |
| Persons per occupied housing unit | ?? | ?? | ?? | ?? |
| Persons per occupied housing unit for McKinley County outside Gallup—4.04 | | | | |

*Source*: Bureau of the Census 1990.

and individual assessments is probably due to the many vacant dwellings in the county that are substandard. In addition, private land for residential development is very limited in McKinley County due to extensive Federal and State land ownership. Some housing, including trailers, is available in the Thoreau area just off I-40 south of Crownpoint. Housing is also quite limited in other parts of McKinley County, including Gallup. Because of the county's lack of available housing, choice is limited and extended waiting periods for housing are not uncommon (Van Dyke 1996b, 1996c).

#### 3.7.4.2 Water and Wastewater Services

Water and wastewater services for Crownpoint residents are provided by the NTUA. NTUA serves 776 water customers and 575 wastewater customers. Three NTUA water-supply wells in Crownpoint provide 24,000 $m^3$ (90.6 million gal) per year. Approximately 300,000 to 500,000 barrels per year are hauled to surrounding areas at a price of about $0.50 per barrel. NTUA could supply additional customers with water, but wastewater service is limited because of the difficulty in attaining land for expanding treatment facilities. The alternative for new residential development is septic tanks (NTUA 1996).

The Church Rock community has a water and wastewater system with adequate capacity for expansion. The community's water-supply well is completed in a different formation than the town of Crownpoint's and is located about 8 km (5 miles) south of the Church Rock site (NTUA 1996).

### 3.7.4.3 Police, Fire, and Emergency Protection

Police protection in the vicinity of the project area is provided by the Navajo Nation. According to the Northwest New Mexico Council of Government Deputy Director, police protection in the Crownpoint area may be inadequate with a recent surge in juvenile crime (Van Dyke 1996b).

Fire protection in the area is provided by various volunteer fire departments. There are 20 fire districts in McKinley County; the districts that cover the area of the proposed project are Crownpoint, White Cliffs, Pinedale, and Thoreau. The Crownpoint Volunteer Fire Department consists of 24 volunteers, is funded by McKinley County, and has basic firefighting equipment (Van Dyke 1996d). The Pinedale fire district, which is responsible for the Church Rock area, has 15 members but no formal fire station.

Emergency medical service (EMS) in the project area is provided through a two-tier system. The first tier is a voluntary rescue unit located in and responsible for a specific area. The second tier is a response-by-ambulance service provided through either McKinley County or the Navajo Nation EMS. The voluntary rescue unit includes medical equipment and extraction capabilities.

The Crownpoint Indian Health Care Facility is an ambulatory care hospital with 32 beds serving about 26,000 Navajo in the Eastern Navajo Agency. The hospital provides general and obstetrics care (Van Dyke 1996e).

### 3.7.4.4 Education Resources

There are a total of 15 public and private schools in the area surrounding the proposed project sites. These include Crownpoint (five schools with over 1600 students), Church Rock (five schools with over 1000 students), Mariano Lake (two schools with approximately 245 students), and Smith Lake (two schools with approximately 120 students). The schools in Crownpoint include a public elementary school with an enrollment of about 400, a public high school with an enrollment of about 600, and a BIA-operated Native American boarding school with an enrollment of over 400. The two public schools are run by the State of New Mexico and have both Native American and non-Native American enrollment. The town of Crownpoint also has several small parochial schools and the Crownpoint Institute of Technology, which is an accredited post-secondary vocational institute with an enrollment of about 300 (Van Dyke 1996f). The Crownpoint Institute of Technology is an important educational resource in providing Navajos with the training necessary to access the skilled labor market.

### 3.7.5 Taxes and Local Finance

Sources of tax revenue for McKinley County include property and gross receipts taxes. The county's tax rate on real and personal property is $30.823 per $1000 of assessed value. Assessed value is set at one-third of fair market value. Therefore, the annual property tax on a house on private property with a market value of $70,000 would be approximately $700. Business assets are also classified as personal property but for tax purposes can be depreciated at various schedules down to a floor of 12.5 percent. Therefore, a piece of equipment with a market value of $1 million when new would generate approximately $60,000 in personal property taxes for the county over a 10-year period assuming a Federal tax depreciation schedule of 10 years.

The assessed value of uranium production for tax purposes is 50 percent of the sales price. Therefore, at the current property tax rate, McKinley County would collect $15,412 ($1,000,000 × 0.5 × 0.030823) for each million dollars of yellowcake produced and sold (Van Dyke 1996g).

McKinley County can collect property taxes on equipment and improvements for any non-Navajo operation outside the Navajo Reservation. The county can also tax any Navajo Reservation lands that have been acquired as private property. Mining property is taxed at 50 percent of the sales value of the ore. Therefore, if a mining operation sold $1 million of ore per year from privately owned property, the McKinley County tax rate would be applied on $500,000 annually.

McKinley County receives a 0.25 percent gross receipts tax revenue as part of the gross receipts tax on goods and services collected by the State. Although this tax is applied to businesses, it is passed on to customers and resembles a sales tax. With the gross receipts tax, for every $10,000 of purchases made in McKinley County, the county receives $25 from the State.

The Navajo Nation can levy taxes in an area outside the Navajo Reservation if the area is classified as being in "Indian country." Navajo taxes include a 5 percent business activities tax on business gross receipts. Gross receipts are reduced by a 10 percent standard deduction plus deductions for compensation paid to Navajo employees. This tax could be levied on uranium production off the Navajo Reservation if the production is determined to occur in "Indian country". The Navajo business activities tax on construction is a 3 percent tax on payments to contractors and subcontractors without deductions for various construction activities including well drilling.

The State of New Mexico levies a 3.5 percent severance tax and a 0.75 percent natural resources tax on the sales price of uranium.

The town of Crownpoint receives public funding from the Federal government, the Navajo Nation, the State of New Mexico, and McKinley County. For example, the Crownpoint Indian Health Care Facility is funded by the Federal government, water and wastewater services and police protection are provided by the Navajo Nation, and public education is provided by the State of New Mexico and McKinley County.

## 3.8 AESTHETICS

The primary viewers of the proposed project would be Navajo residents living on and near the three project sites. Because they would be the primary observers, their notion of aesthetic resources as expressed at the landscape scale is important. In general, Native American thought is "integrative and comprehensive. It does not separate intellectual, moral, emotional, aesthetic, economic, and other activities, motivations, and functions" (Norwood and Monk 1987). The Navajo language often combines two or more of these categories:

> The Navajo concept of beauty is expressed in the suffix *-zho-*. This is usually preceded by *ni*, meaning something specific, or *ho*, conditions in general. A beautiful rug is *nizhoni* and a beautiful place is *hozhoni*. Both these terms connote order, good, harmony, health, and happiness. For both the Navajo and Zuni, moral good tends to be equated with aesthetic good: that which promotes or represents human survival and human happiness tends to be experienced as "beautiful." The landscape is beautiful by definition because the Holy People designed it to be a beautiful, harmonious, happy, and healthy place (Norwood and Monk 1987).

The Navajo language does not contain the word "landscape." Navajos have not created an abstract category for unspecified vistas; the emphasis is on specific mountains, specific trees, and specific colors of the soil rather than on the "Navajo landscape" (Norwood and Monk 1987). Thus, to Navajo readers, references to the visual quality of the study areas may be more meaningful when in reference to an identifiable place, not to generalized landscapes across the study areas. Navajo feel that because the landscape is *the* land that supports life for the Navajo, it is therefore beautiful.

### 3.8.1 Regional

Aesthetics features of the three project sites were evaluated during field reconnaissance in October 1995. Natural and scenic attractions near the project sites are minimal. Regionally, the Chaco Culture National Historic Park, El Malpais National Monument, El Morro National Monument, Bisti Wilderness, and the Red Rock State Park, among many other features, attract tourists for their aesthetic features as well as for their historic and cultural prominence.

The three project sites are generally visible from the area roads. These roads are used mainly for local travel. There are no regionally, or particularly locally, important or high-quality views associated with the project sites.

Extant vegetation patterns relate to the topography quite closely. There are widely scattered piñon pines along the higher grounds and escarpment in the study area. Junipers are less plentiful. The three sites are dominated by sparse grasslands, generally severely damaged by overgrazing by sheep and, less frequently, cattle, horses, and goats. Rolling hills also characterize the study area, often punctuated by sandstone outcrops. Lower floodplains have mixed shrub-grass associations, with the arroyos having saltbush and some greasewood (see Section 3.5).

### 3.8.2 Crownpoint

The more urban character of the Crownpoint area dominates the aesthetic values at the Crownpoint site. The presence of the existing HRI facilities and the nearby churches, residences, and other structures reflect the area's small New Mexican town appearance. The evaporation ponds, chain link fences, parking lots, and metal HRI buildings give a low-intensity industrial appearance to eastern portions of the Crownpoint site. Because of overgrazing in many areas in the past, bare soil and erosion are commonplace. The sandstone outcrops, on the other hand, provide a most natural-looking character to some of the area. Views to the west are the best on the site. These look out over rolling hills toward the Unit 1 site, over an intervening arroyo, with distant mountains in the background.

### 3.8.3 Unit 1

Unit 1 is the most natural appearing of the three sites. The area is characterized by rolling grass-covered hills used for sheep grazing, small arroyos, and scattered piñon trees. Rock outcrops are few, and access by vehicle is on an unpaved road. Because of overgrazing in many areas in the past, large patches of bare soil and erosion are commonplace. Grass is cropped closely to the ground. Vegetative cover for the project area ranges from only 2 to 8 percent, occasionally covering an extent of 10 to 12 percent. Some evidence of past habitation (old foundations and potsherds) is visible. Views are best to the south, with an immediate ridge providing some enclosure to the otherwise open, undistinguished site. The unpaved road to Route 49 provides some higher-elevation views back to the Unit 1 site as it ascends an intervening saddle.

### 3.8.4 Church Rock

The Church Rock site has been overgrazed by cattle more than sheep. It is characterized by a large, shallow, grassland valley between two large sandstone bluffs. The area is entirely consistent with the greater regional landscape and is well integrated into it. Evidence of past deep mining for uranium exists, with a metal utility building in good condition on the west end of the site. There is a large concrete pad for the shaft for the old mine. Platforms for past exploratory drilling are visible but are only slightly incongruous with the general landscape. Temporary drill-site markers (< 1 m tall) punctuate the potential mining areas. The best views are from the northern portion of the site where one can look down-valley and out toward a distant mountain range. The views from the western bluffs are also of higher quality as one looks toward the proposed mining areas in the valley to the southeast. The views from the road up the project site are of lower quality.

## 3.9 CULTURAL RESOURCES

### 3.9.1 Regional

This section discusses the history of human habitation in the region in which the three project sites are located. The information is the baseline against which the potential for impacts to cultural resources will be assessed. It also serves as background for the socioeconomic and environmental justice assessments in this EIS.

Much of the American Southwest in general, and the Crownpoint region in particular, is distinctive because of the combination of ethnic groups that predominate in the area: Native American, Hispanic, and European-American. To understand the modern human environment, it is essential to understand the role of these groups in the region. History and prehistory continue to have a very real influence on the lives of these citizens even today. Native American culture and resources are emphasized in this section because Native Americans have occupied the area longer and much of the land proposed for uranium mining is held in trust for or allotted to Native Americans. Thus, cultural resources overwhelmingly are from Native American cultures.

For purposes of this EIS, a widely accepted, National Park Service definition of "culture" will be used. It states:

> [Culture] is understood to mean the traditions, beliefs, practices, lifeways, arts, crafts, and social institutions of any community, be it Indian tribe, a local ethnic group, or the people of the nation as a whole (Parker and King 1992).

Cultural resources are objects, structures, locations, or natural features that reflect or have come to have significant meaning in or importance to the culture of some group of humans. Such resources are potentially eligible for inclusion on the National Register of Historic Places if they meet criteria set forth in 36 CFR § 60.4 as follows:

> The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and that (a) are associated with events that have made a significant contribution to the broad patterns of our history; or (b) that are associated with the lives of persons significant in our past; or (c) that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant distinguishable entity whose components may lack individual distinction; or (d) that have yielded or may be likely to yield information important in history or prehistory.

"Significance" as defined in the preceding quotation from the National Historic Preservation Act is not equivalent to "significant" impacts in the NEPA context. Varying degrees of Federal protection and appropriate management procedures are set forth in several U.S. statutes and their amendments, including the National Historic Preservation Act of 1966, as amended through 1992, 16 U.S. Code § 470 and Public Laws 91-243, 93-243, 96-515, and 102-575; the Archeological and Historic Preservation Act of 1974, 16 U.S.Code § 469; the Archaeological Resources Protection Act of 1979, 16 U.S. Code §470; the American Indian Religious Freedom Act of 1978, 42 U.S. Code § 1966; and the Native American Graves Protection and Repatriation Act of 1990, 25 U.S. Code §§ 3001–3013.

Three categories of cultural resources are of interest in the NEPA process: archaeological, historical, and traditional cultural resources. Such resources are considered to be "cultural properties" when their significance is deemed by professionals to make them eligible for inclusion in the National Register. Such eligibility or inclusion requires that any Federal agency contemplating some action consider the potential for effects or adverse effects to such a cultural property. The three categories of cultural property are defined as follows.

An archaeological property is an archaeological resource that is eligible for inclusion in the National Register as specified previously. An archaeological resource is defined in the Archaeological Resources Protection Act of 1979 and 16 U.S. Code §§ 470bb as

> Any material remains of past human life or activities which are of archaeological interest, as determined under uniform regulations promulgated pursuant to this Act. Such regulations containing such determination shall include, but not be limited to: pottery, basketry, bottles, weapons, weapon projectiles, tools, structures or portions of structures, pit houses, rock paintings, rock carvings, intaglios, graves, human skeletal materials, or any portion or piece of any of the foregoing items. Nonfossilized and fossilized paleontological specimens, or any portion or piece thereof, shall not be considered archaeological resources, under the regulations under this paragraph, unless found in an archaeological context. No item shall be treated as an archaeological resource under regulations under this paragraph unless such item is at least 100 years of age.

The term "historic property" is defined as "any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the National Register." The term includes artifacts, records, and remains that are related to and located in such properties (Advisory Council on Historic Preservation 1986).

A traditional cultural property can be defined as a property "that is eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community" (Parker and King 1992). The authors of this definition, which is the basis for the guidelines for evaluating such properties, recognize its vagueness in the definition and provide the analyst with further assistance:

> Traditional cultural properties are often hard to recognize, however. A traditional ceremonial location may look like merely a mountaintop, a lake, or a stretch of river; a culturally important neighborhood may look like any other aggregation of houses, and an area where culturally important economic or artistic activities have been carried out may look like any other building, field of grass, or piece of forest in the area. As a result, such places may not necessarily come to light through the conduct of archeological, historical, or architectural surveys. The existence and significance of such locations often can be ascertained only through interviews with knowledgeable users of the area, or through other forms of ethnographic research. The subtlety with which the significance of such locations may be

expressed makes it easy to ignore them; on the other hand it makes it difficult to distinguish between properties having real significance and those whose putative significance is spurious.

Because of the difficulty in distinguishing and evaluating traditional cultural properties, it is essential to involve in the assessment both traditional practitioners, who make use of such resources, and trained professionals, who can make an independent assessment of their importance.

It should be noted that simply because a property from any of these three categories is eligible for or is on the National Register does not mean it must be protected from destruction. Rather, Federal officials must consider the property in any Federal or Federally assisted or regulated action. If a public interest justifies a property's destruction, it can be destroyed.

The following discussion is intended to provide a broad overview of human development in the project region. Few project-specific data exist, except for data produced from the cultural resources surveys conducted primarily in conjunction with this project. As a result, the prehistory and history of the three sites must be inferred to a great extent from the broader regional history. Such regional history may be as broad as the "Southwest" or as narrow as the "San Juan Basin" or the "Four Corners."

To facilitate discussion, the section is divided into two major time periods: 10,000 BC to 1540 AD and 1540 AD to the present. In 1540, Francisco Coronado undertook an expedition in search of the legendary Seven Cities of Cibola. That year marks the beginning of contact between the region's Native Americans and Europeans and of profound changes in its history and culture.

### 3.9.1.1 Precontact (10,000 BC to 1540 AD)

#### Paleo-Indian and Archaic Periods

The prevailing view among archaeologists is that humans are thought to have migrated into what is now the American Southwest by 10,000 BC. This date must be viewed as establishing only a very approximate time frame, as what little physical evidence exists is hard to date. Human settlement in the Southwest appears to have been influenced greatly by climatic conditions, with wetter periods generally being more conducive to increased populations. The sparse archaeological record for the older half of this period implies a dramatic ebbing and flowing of human populations, quite possibly in response to parallel changes in game populations (Woodbury 1979; Irwin-Williams 1979).

The Paleo-Indian period was composed, successively, of the Clovis, Folsom, and Cody cultures, the last of which came to an end around 6000 BC. Human populations during this extensive period were mobile and followed the herds of large mammals, such as mammoth, horse, and camel, which provided them with most of their subsistence (Irwin-Williams 1979). It is believed that these early populations ultimately left the Southwest entirely, perhaps as a result of changing climatic conditions.

The Archaic period succeeded the Paleo-Indian, lasting from around 6000 BC to about 400 BC. With the larger mammals extinct, humans of the Oshara culture, as it was called in the Southwest, hunted bison, deer, and smaller mammals and gathered seeds and plants for their subsistence. Gradually, human populations began to settle in more permanent locations, and there is evidence of attempts to cultivate corn and squash.

Archaeological surveys completed for the three project sites discovered no artifacts from the Paleo-Indian or Archaic periods. The lack of artifacts does not mean that humans from these periods did not live in or traverse the Crownpoint area. Rather, it reflects the probability that sparse populations, the meagerness of human belongings, and the actions of the elements on rather fragile artifacts over many thousands of years minimized chances of finding artifacts from the Paleo-Indian and Archaic periods without archaeological excavation.

### Basketmaker II–III

The Basketmaker cultures followed the Oshara culture in the Four Corners region, enduring from about 400 BC to about 700 to 750 AD. Human populations became much more sedentary than in previous periods, living often in small settlements of semiburied pithouses under large rock overhangs. They wove baskets, clothing, and many other personal goods out of fibers (from which their name is derived), grew much of their own food, and hunted game (Ferguson and Rohn 1987). Continuing human development led to the Basketmaker III culture beginning about 400 AD, which was characterized by "pithouse villages, ceramics, the bow and arrow replacing the atlatl and dart, domesticated turkeys, a developing agriculture, and some large structures that are the prototypes of the later great kivas of the Anasazi" (Ferguson and Rohn 1987). A complex trade in marine shells and pottery with Mexico and the Pacific Coast appears to have existed.

Basketmaker III sites have been found at the Crownpoint and Unit 1 sites, and perhaps the Church Rock site as well. Artifacts include pithouses, stone slab circles, hearths, several masonry rooms, potsherds, and lithic scatter. Detailed descriptions are found subsequently and in Marshall 1988, 1991, 1992, and Klager 1979. Marshall (1991) believes there is evidence of the Basketmaker II culture in the form of a hearth and lithic scatter at the Unit 1 site. If so, this site would be the oldest site identified at the three project sites.

### Anasazi[1]

The Anasazi culture is divided into three periods with the approximate dates of Pueblo I, 700–900; Pueblo II, 900–1100; and Pueblo III, 1100–1300 (Woodbury 1979). As a generalization, the Anasazi social organization, architecture, irrigation, horticulture, pottery, trade, and communications developed with each succeeding period. Settlements became larger, and residential quarters changed from the semi-underground Basketmaker III structures to the aboveground, small units of the Pueblo I period, finally culminating in the large masonry structures called pueblos (after the Spanish word for village) in the Pueblo II and III periods.

[1]The name Anasazi originates from the Navajo; it today is popularly translated as "the ancient ones" but is more accurately translated as "ancient enemies" (Holt 1983). For their part, the Hopi and Zuni, who claim direct ancestry to the Anasazi, use the names *Hisatsinon* and *Enote*, respectively, for Anasazi (Frazier 1986).

It is the surviving architectural monuments of the Pueblo II and III periods that have created so much interest in, and recognition of, Anasazi culture. Spruce Tree House and Cliff Palace in Mesa Verde and Pueblo Bonito in Chaco Canyon are among the best known archeological sites in the United States. The large, 3 to 4 story structures were constructed over several generations. They feature extraordinary masonry, siting that takes advantage of natural heating and cooling regimes, often times unique topographic placement to maximize defensibility, and large circular structures called kivas for cultural activities. The structures are true monuments to their builders, who possessed only stone tools, knew nothing of the wheel, and were illiterate (except for rock art) (Ferguson and Rohn 1987). In addition, the Anasazi built substantial irrigation systems that captured periodic storm runoff in side canyons for diversion and use on farming sites on the main valley floors. An impressive network of roads, often 12 m (30 ft) wide and running in straight lines in defiance of local topography, emanates from Chaco Canyon to numerous outlier sites. Two of these outliers are Kin Ya'a, approximately 1.6 km (1 mile) east of the Crownpoint site, and Muddy Water, which adjoins the Unit 1 site (Frazier 1986).

The Anasazi culture began a long period of decline between the mid-1100s and 1300. Evidence indicates that long periods of drought accompanied by human-induced environmental damage may have brought an end to Anasazi culture. People gradually migrated out of the region encompassing the project sites and left it virtually devoid of inhabitants. The Anasazi moved to the south and west, where they most probably mixed with local populations to create the Acoma, Zuni, and Hopi peoples of today—all of whom claim lineage to the Anasazi. The migration legends of the Zuni (Ferguson and Hart 1990) and the Hopi (Courlander 1987) relate how their member clans migrated for many years throughout the Anasazi region in their quests to find the final homes they believe their gods destined them to have.

Numerous Anasazi sites have been identified at all three project sites. Although the structures and other artifacts are not as spectacular as those found at such well-known protected areas as Chaco Canyon and Mesa Verde, they are deemed worthy of preservation and scientific study (Marshall 1989, 1991, 1992; Klager 1979; Ford and Dehoff 1977). See Sections 3.9.2, 3.9.3, and 3.9.4.

### Pueblo IV

Pueblo IV defines the period between the end of the Anasazi culture and the entrance into the Southwest from Mexico of Francisco Vasquez de Coronado, the first Spanish conquistador in 1540. Perhaps because of deteriorating environmental conditions, warfare, or other reasons, the regional population declined by as much as half over the Pueblo IV period (LeBlanc 1989). Local populations in Acoma and Zuni left many smaller pueblos and congregated in larger ones of hundreds of rooms (Cordell and Gumerman 1989).

It was during this period that the Navajo likely migrated into what is now northwestern New Mexico. The Navajo entered the area perhaps as early as 1000 or as late as 1525. It is reasonably certain that the Navajos, members of the Apachean tribes, who in turn were associated with the Athapaskan culture, were at least on the northern periphery of the Anasazi region around 1300. This dating, minimally, would put the Navajo in contact with the declining Anasazi culture. However, "it is still uncertain whether they [the Navajo] had any influence on the Puebloan abandonment of vast regions about this time" (Brugge 1983). Locke argues that it is unreasonable to presume that wandering bands of hunters and seed gatherers with a distinctly poorer culture could have been able to do much real damage to the more advanced Anasazi (Locke 1992).

The Navajo apparently migrated along the Rocky Mountains from much farther north; they may have been joined by smaller numbers of their kinsman from what is now California. This migration could have begun a thousand years ago and involved a lengthy process in which small bands were on the move, eventually settling throughout much of the Southwest (Locke 1992; Brugge 1983). Upon reaching the Four Corners region, they stopped their migration and took up a nomadic lifestyle within the region. They began borrowing various attributes of the Puebloans cultures. Little is known about the Navajo during this time. Their nomadic lifestyle apparently brought them into conflict with the Puebloan cultures. Their legends tell of inhabiting abandoned Anasazi structures as the need arose (Locke 1992). Generally, Navajo and other Apachean tribes of this period can be viewed as relative newcomers endeavoring to establish themselves in whatever niches they could.

To date, no artifacts from the Pueblo IV period have been identified at the three project sites. Permanent settlements may not have been established in the Crownpoint area following its general depopulation during the end of the Anasazi period; consequently, far fewer artifacts would be expected to be found in the area.

### 3.9.1.2 Postcontact (1540 A.D. to Present)

#### Spanish Period

The Spanish conquistadores, who arrived in 1540 and returned intermittently until the end of the century, were catalysts of cultural change to Native American societies in the Southwest. Expeditions brought considerable death and destruction to the Puebloan tribes. The Spanish made their presence permanent in northern New Mexico with the 1598 expedition of Juan de Onate, who brought 400 soldiers, colonists, priests, and servants to colonize the upper Rio Grande Valley and convert the Native Americans to Christianity (Simmons 1979). Onate implemented harsh measures against those tribes who opposed his attempt to establish Spanish dominion over the region.

In the ensuing century, the Spanish instituted their control over the region, engaging in ranching, trading with the Native Americans, missionary activities, and generally trying to settle the region. The Spanish introduced sheep, cattle, and horses to the Southwest; Native Americans quickly tried to capitalize on these resources even though they were prohibited from owning their own herds. During this period, the Navajo changed from a nomadic culture based on agriculture, hunting, and gathering to a culture based on livestock herding (Locke 1992). The Puebloan, Navajo, and Apache peoples were subject to continuous efforts by Spanish missionaries to destroy native religions and substitute Roman Catholicism, having profound effects on the Native Americans. In addition, almost all pueblos suffered substantial population declines because of battles with the Spanish and with the Navajo, susceptibility to European diseases, and famines (Simmons 1979). Mixing among the Native Americans tribes and between Native Americans and Spanish brought about significant change in the ethnic composition of many groups.

In response to Spanish oppression, some Puebloans along the northern Rio Grande fled west to the Acoma, Zuni, Navajo, or Hopi tribes, where Spanish control was much reduced. The Hopi welcomed a group of Tewa Native Americans as permanent residents in exchange for their help in fending off the Spanish and other interlopers. The Hopi also destroyed one of their own pueblos, Awatovi, in 1700 because of anger that its people had become too close to, and subverted by, the Spanish (Courlander 1987). Even today these western Pueblos, particularly the Hopi, are highly resistant to outside influences. This point is critical today in understanding the potential for affecting Native Americans lands, artifacts, and traditional cultural properties. These modern day tribes are determined to preserve their cultures.

In 1821, a newly independent Mexico assumed control of the Southwest from the Spanish. Although Native Americans were granted equality of citizenship with other people and the status of the Catholic Church continued to decline, the fate of the Native Americans continued as before (Simmons 1979). Unlike the other tribes, the Navajo continued to improve its conditions in terms of land and livestock.

No artifacts have been identified at any of the three project sites that can be assigned to the 300 years of Spanish and Mexican rule. The Navajo apparently did not enter the Crownpoint and Unit 1 area, except as transients, until about the late 1860s following the Bosque-Redondo imprisonment discussed subsequently (Marshall 1991). The area could have been used for hunting and gathering by other tribes, but no physical evidence yet has been found to support such a presence.

### American Period

The American period began in 1846 with the occupation of the Southwest by American military forces and the establishment of American civil government. The traditional, agrarian society of the Spanish and, briefly, Mexicans was replaced by a far more commercial American culture committed to the precepts of Manifest Destiny.

American officials initially pursued an even-handed policy toward all the region's inhabitants. However, after continued livestock raids, kidnaping, and depredations, the American authorities eventually singled out the Navajo as the culprits. Several punitive expeditions were mounted against them which ultimately led to the imprisonment of as many as 10,000 Navajo at Bosque Redondo between 1864 and 1868. The ordeal subjected them to starvation, disease, emotional trauma, murder, and pillaging from virtually all their army, settler, or other Native Americans antagonists (Locke 1992; Roessel 1983). After the imprisonment was ended in 1868, the Navajo returned to their land, which had been reduced to one-tenth its original size (Roessel 1983). Reestablishing ownership and control of their former land became a continuing objective of the Navajo from that time onward.

All regional tribes suffered from Federal policies to "civilize" the Native Americans. Most tribes experienced cultural threats from Christian missionaries; forced removal of children to distant boarding schools for "white education"; Federally imposed, wealth-threatening stock reduction programs; and centralized forms of tribal governments. Some tribes continued to lose their land; the Zuni lost land as late as 1939 (Ferguson and Hart 1990).

In the 1920s and 1930s, Federal policy shifted from assimilation and neglect of tribal rights to assistance through protection of tribal lands, increased tribal self-government, and economic development. In recent decades, Federal policy has shifted toward protection, development, and reinvigoration of tribal culture.

Some Navajo artifacts from this period have been found at the project sites. These artifacts include hearths, corrals, trash piles, and hogans. These finds correspond to the prevailing viewpoint that the Navajo did not maintain a significant presence in the area until after 1868.

The cultural history documented here is important in understanding the present day culture of the region in which HRI proposes to construct and operate its ISL project. The cultural history reveals the complex relationship among Native American peoples that evolved over thousands of years before contact with European civilization. The relative balance of power among Native American tribes was upset by the arrival of the Spanish in the mid-sixteenth century. The result was the forced partial displacement and partial assimilation of the indigenous cultures by Spanish culture. This situation lasted for about three centuries until the American government asserted control over the region.

Today in the American Southwest, the dominant Anglo population is influenced in localities with sizeable Native American or Hispanic populations. Such localities typically manifest a blend of multiple cultures. Whereas past American government policy was to assimilate these cultures into the American "melting pot," policy in recent decades has been to encourage preservation of minority cultures, particularly Native American cultures. Such devices as increased tribal autonomy, an end to programs intended to assimilate Native Americans into the Anglo culture, protection of Native American religion, preservation of traditional cultural properties, and repatriation of human remains and important cultural artifacts to appropriate tribes have been established to help preserve Native American cultures. This NEPA analysis, partnered with the provisions of the National Historic Preservation Act of 1966 (as amended), appropriately reflects the goal of avoiding adverse impacts upon Native American cultures. Because the proposed project would occur on Native American land rich in cultural artifacts, and because its operation would affect the everyday lives mostly of Native Americans, this cultural resource analysis attempts to establish the context into which the project and its potential impacts would be introduced.

### 3.9.2 Ongoing Cultural Resource Surveys and the National Historic Preservation Act Review Process

Section 106 of the National Historic Preservation Act of 1966 (as amended) requires Federal agencies to take into account the effects of their undertakings on cultural resources (i.e., archaeological, historic, and traditional properties eligible for or listed in the National Register of Historic Places). The first step in this process is the identification of cultural resources in the potentially affected area. To this end, archaeological surveys of areas within the proposed project sites that have not previously been surveyed are under way. Also under way is a detailed traditional culture property survey, which is being conducted by professional archaeologists and ethnographers with input from local Native American practitioners and residents and which builds on the preliminary traditional cultural property assessment work conducted for this EIS.

The results of these surveys will be reviewed by the New Mexico State Historic Preservation Office and the Navajo National Historic Preservation Department (pursuant to the Navajo National Cultural Resources Protection Act). Other parties invited to participate in the review are the Pueblo of Zuni, the Pueblo of Acoma, the Pueblo of Laguna, the Hopi Tribe, and the All Indian Pueblo Council.

Once the survey work is complete, a determination of the potential for effects or adverse effects to properties listed on or eligible for listing on the National Register will occur. The determination will incorporate HRI's plan for avoidance of all sites as described in Section 4.11 and the nature of the sites identified. Mitigation measures to minimize effects or adverse effects may include those identified in Section 4.11 and others designed specifically for the particular cultural properties. These mitigation measures, in accordance with the Section 106 process, will be developed in consultation with the parties named previously.

The following sections (3.9.3, 3.9.4, and 3.9.5) discuss the occurrence of cultural resources at each project site as can be determined without the additional surveys being conducted under the Section 106 process.

### 3.9.3 Crownpoint

Most of the Crownpoint site has been surveyed for archaeological resources (Marshall 1989; Klager 1979; Marshall 1992). No sites were identified that are presently on the National Register of Historic Places. However, Marshall (1992) reports that

> numerous cultural properties that qualify for nomination to the National Register are probably present in the lease area. Other sites that qualify for preservation under the American Indian Religious Freedom Act and the Navajo Nation Policy to Protect Traditional Cultural Properties are also likely to be present.

For all practical purposes, current knowledge about people living in the Crownpoint area begins with the Anasazi since no records or artifacts for the area exist before the Anasazi period. Two protected areas that are components of the Chaco Culture National Historical Park, Muddy Water, and Kin Ya'a (the latter of which is on the National Register) are located as close as 1.6 km (1 mile) to the northwest and east, respectively, of the Crownpoint site. The Anasazi people inhabited these communities from as early as 400 to 1150 AD. These 750 years encompass the early Basketmaker III to early Pueblo III cultural periods.

Kin Ya'a is a so-called tower kiva approximately four stories tall. It is considered by the Navajo to be the home of their *Kii ya anii* clan, one of the original four clans portrayed in the Navajo origin legend, and is associated with an important Navajo rite known as the Blessingway. Kin Ya'a is on the "Great South Road" that connected outlying Anasazi communities with Chaco Canyon; an additional Anasazi road may connect Kin Ya'a to Muddy Water.

Most of the 15 Anasazi sites that have been identified in the eastern two-thirds of the Crownpoint site are associated with the Kin Ya'a community. Based on a density of 50 to 100 sites per square mile, Marshall (1992) estimates that an additional 20 Anasazi sites are present in this portion of the Crownpoint site.

Nine additional Anasazi sites encompassing Basketmaker III through Pueblo II eras have been identified in the western third of the Crownpoint site in separate surveys conducted by Marshall (1989) and Klager (1979). These sites are believed to be associated with the Muddy Water community. Two Chacoan road segments pass through the area from the southwest.

In the potential land application area (Section 12, T17N R13W) north of Crownpoint, five Anasazi sites were identified in an archaeological survey conducted about 20 years ago (Brooks n.d.). This is a surprisingly small number in view of the size of the area and its proximity to areas with far greater densities of sites. The Anasazi sites date from approximately the 10th to 12th centuries AD and have been severely damaged by natural forces and livestock. They consist of small campsites, hearths, perhaps the remains of one or two small structures, and potsherds. These sites do not appear to be of great consequence from an archaeological standpoint (Brooks n.d.).

The Anasazi sites in the Crownpoint site appear to be typical of those found throughout the San Juan Basin. They range from Basketmaker III sites composed mostly of potsherds, hearths, and pithouses to the more elaborate, larger buildings and specialized structures associated with the Pueblo II and III eras.

The structures, which are collapsed to one or perhaps two stories and filled in with wind- and water-borne soil, are difficult for the untrained eye to identify. While some structures originally were fairly large roomblocks, none approaches the spectacular pueblos still standing in Chaco Canyon. Nevertheless, much can be learned about how Chacoan communities evolved over their lengthy history, how agriculture was practiced in such dry climates, how trade in exotic goods occurred, and what functions were performed by the wide, straight Chacoan roads for a people without knowledge of the wheel or beasts of burden (Marshall 1992).

Ultimately, the Crownpoint area was repopulated by the seminomadic Navajo. No Navajo sites from the period have been identified at the Crownpoint site; indeed, virtually all sites discovered in the archaeological surveys have been from the last 100 years (Marshall 1992). The earliest historical records for Navajo habitation are the late 1860s after the tribe's resettlement following its 4-year imprisonment at Bosque Redondo. Most settlement occurred after 1910 when the village of Crownpoint was established as the location of the BIA office for managing the eastern part of the reservation.

Navajo artifacts have been identified at eight locations in the eastern two-thirds of the Crownpoint site; more are expected to be found in a thorough survey. The artifacts are mostly the remains of hogans but also include hearths and trash piles (Marshall 1992). Five Navajo sites identified in the western third of the Crownpoint site include remains of hogans, hearths, sheep pens, masonry walls, and trash piles. These sites also are believed to date from about the last century (Klager 1979; Marshall 1988). Although nine 20th-century Navajo ruins have been identified in the Section 12 parcel, they do not qualify as archaeological sites because of their recent age; they also are not considered to have historical significance. One burial site would require protection, however.

A traditional cultural properties survey conducted by Navajo practitioners and a cultural resource specialist in the Crownpoint site did not identify any sacred sites (Becenti 1996; HRI 1996c).

### 3.9.4 Unit 1

Approximately half of the Unit 1 site has been surveyed by a qualified archaeologist (Marshall 1991). Unit 1 adjoins both segments of the Muddy Water Chaco Protection Site, which is a component of the Chaco Culture National Historical Park as well as a New Mexico State Register archaeological district. No National Register sites occur on Unit 1. The archaeology and history of Unit 1 are similar to the Crownpoint site, as the two sites are virtually contiguous. Artifacts identified date to the Anasazi. A total of 33 Anasazi sites associated with the Muddy Water community have been identified, and an estimated additional 40 sites are present in the lease area (Marshall 1991). Marshall estimates that the 650 to 750 year-old Muddy Water community consists of 750 sites in a "halo of habitation" extending out 3 to 5 km (2 to 3 miles) from its center.

The Anasazi sites discovered so far can be dated as early as Basketmaker III. Nine of these sites show evidence of continuous use into the Pueblo I era. Among the artifacts discovered are pithouses, hearths, small masonry room blocks, lithic (chips of worked stone) and ceramic scatter and stone slabs used for various purposes (Marshall 1991). Seven sites jointly represent the Pueblo I–II years (700 to 1100 AD) and include masonry room blocks, middens (trash heaps), ceramic and lithic scatter, and a kiva. The Pueblo II period is represented by another 10 sites, including masonry roomblocks and artifact scatter. The Pueblo II–III era is represented jointly by five sites that comprise smaller masonry structures, scattered artifacts and potsherds, and a midden. Two other sites have not been associated with a particular cultural period.

In addition to these artifacts, one confirmed and one possible Anasazi road pass through the Unit 1 site. The confirmed road enters the Muddy Water community from the north and then splits in two branches. One branch angles southwest where it crosses diagonally through Section 22 of the Unit 1 site. It is very difficult to detect, and its ultimate destination is unknown. The second road is a possible one that joins Muddy Water and Kin Ya'a. This road appears to date from the historical period, but conceivably a more recent road was superimposed on the path of an Anasazi road (Marshall 1991 and 1992).

The post-Anasazi history of the Unit 1 site follows that of the Crownpoint site, as discussed in Section 3.9.3. Although Puebloan and perhaps nomadic tribes used the area for hunting and food gathering, there is no evidence to indicate settlement by these groups. The Navajo eventually filled the void left by the departed Anasazi. Even though the Navajo are thought to have inhabited the Lobo Plateau region since at least 1700, their settlement in the Unit 1 area appears to postdate their imprisonment at Bosque Redondo, which ended in 1868. A total of 14 Navajo sites have been located in the Unit 1 lease area, consisting of hogans, hearths, trash piles, corrals, and other artifacts (Marshall 1991).

From the partial survey of the Unit 1 site, it has been determined that the area is rich in very old artifacts and that considerable research is required (Marshall 1991 and 1992). Marshall (1991 and

1992), who assessed existing surveys, completed several of his own, and developed a management plan for further archaeological research in the lease area, argues that, "Numerous cultural properties that qualify for nomination to the National Register are clearly present in the lease area."

A preliminary traditional cultural properties survey conducted by Navajo practitioners and a cultural resource specialist in the Unit 1 site did not identify any Navajo sites (Becenti 1996; HRI 1996c).

### 3.9.5 Church Rock

The Church Rock site has been surveyed by qualified archaeologists in two separate surveys (Ford and Dehoff 1977; Hurley and Marshall 1988). None of the sites identified are on the National Register or precede the Basketmaker III period. Four Anasazi archaeological sites, three of which appear to constitute a single complex, have been identified south of a mesa and about 1.6 km (1 mile) north of the Rio Puerco in the Church Rock site (Ford and Dehoff 1977). Whereas the far more numerous Crownpoint and Unit 1 archaeological sites are affiliated either with the Kin Ya'a or Muddy War protected areas, the Church Rock sites appear to be part of a rather extensive Anasazi complex known to have existed in the Springstead area. Ford and Dehoff (1977) date the sites to the Pueblo II–III period, whereas Hurley and Marshall (1988) believe there is sufficient Basketmaker III evidence to argue for a 500 to 600 AD settlement period at those locations.

All four sites have moderately sized room blocks, in some cases up to 20 to 30 rooms, along with detached small units and middens. Some sites have hearths and kivas. One has a roasting pit and two 10-m (33-ft) long check dams composed of stacked stones, apparently intended to reduce the velocity of storm water runoff from the mesa (Hurley and Marshall 1988).

Although some looting of burial middens apparently has occurred and bulldozers have damaged structures at two sites, archaeologists believe the sites warrant protection (Hurley and Marshall 1988). Little excavation by qualified professionals has been done at the sites. As with the Crownpoint and Unit 1 sites, the Church Rock sites are essentially collapsed structures that have been covered by wind- and water-borne soil.

Less post-Anasazi history is known about Church Rock than the other two project sites. The Anasazi probably abandoned the Church Rock settlements and migrated to join other communities or to start new ones.

It is uncertain when the Navajo migrated into the Church Rock area. Only one Navajo site, a late historic (within the last 100 years) 2-m (7-ft) circle of unmortared sandstone rocks of unknown purpose, has been located in the Church Rock site.

A traditional cultural properties survey conducted by a Navajo practitioner in the Church Rock site did not identify any sacred Navajo sites (Becenti 1996). Important cultural resources generally were considered by local Navajos to be located in the mountains 1 or more miles (1.6 or more km) away and to be unaffected by HRI's proposed project (Becenti 1996; HRI 1996c).

# 3.10 ENVIRONMENTAL JUSTICE

## 3.10.1 Background and Approach

Environmental justice is

> "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no groups of people, including racial, ethnic, or socioeconomic groups, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations of the execution of Federal, State, local, and tribal programs and policies." (EPA 1995)

Executive Order 12898, issued February 1994, requires that Federal agencies consider environmental justice in their programs, policies, and actions.

The NRC Office of Nuclear Material Safety and Safeguards (NMSS) has developed interim guidance for addressing environmental justice in EISs (NRC 1995). NMSS guidance is to be revised as appropriate based on guidance from the Council on Environmental Quality (CEQ). The CEQ issued draft guidance in April 1996, which has not yet been incorporated formally into the NMSS guidance. Therefore, the approach outlined here and in Section 4.12 is in keeping with the NMSS guidance and the general direction of the CEQ guidance.

Impacts that may have environmental justice implications are health, ecological (including water quality and water availability), social, cultural, economic, and aesthetic. NMSS guidance identifies a significant environmental justice impact as one that is high and adverse (i.e., significant, unacceptable, or above generally accepted norms) and disproportionately borne by minority or low-income populations. CEQ guidance generally concurs, but states that an environmental impact that is not significant within the meaning of NEPA is not rendered significant if it disproportionately and adversely affects a low-income or minority population. However, CEQ indicates that the identification of effects borne by a minority or low-income population should heighten agency attention to mitigation strategies, consideration of alternatives, and preferences expressed by the affected population.

The following sections discuss the composition of the potentially affected community, public health data, the population's subsistence consumption of natural resources, and the sensitivity of the community to the potential for impacts from the proposed project.

## 3.10.2 Minority and Low-Income Populations in the Area of Potential Effect

The proposed project would be located in the Navajo communities of Crownpoint and Church Rock. These communities and much of the area within 80 km (50 miles) of the project sites are in "Indian country" as defined in 18 U.S. Code 1151.[2] The 80-km (50-mile) area of potential effect also includes almost all of McKinley County, large parts of San Juan and Cibola counties and the Navajo, Ramah Navajo, and Zuni reservations, and a small part of Sandoval County. By nearly any definition, the entire area of impact constitutes an "environmental justice population."

General demographic characteristics of the population near the proposed project sites are found in Section 3.7. Native Americans comprise 8.9 percent of the population of New Mexico, 71.8 percent of McKinley County, and 91.5 percent of the Crownpoint census designated place. Hispanics are the next largest minority group in the area, comprising 11.4 percent of the population of McKinley County.[3]

In 1990, 43.5 percent of McKinley County's population was below the poverty level, up from 36.8 percent in 1980. Median household income in McKinley County is $17,468, compared to $24,087 for New Mexico. Section 3.7.1 indicates that the Native American population makes up a disproportionate number of those in poverty: 54 percent of Native Americans in McKinley County were below the poverty level in 1990.

Table 3.31 provides demographic information about the population within 16 and 80 km (10 and 50 miles) of the Church Rock and Crownpoint sites. Data for New Mexico are included as reference points. Figure 3.13 verifies that the population near the project is predominantly Native American. Figure 3.14 shows the distribution of the population within 80 km (50 miles) by median income. Gallup and Crownpoint are the two areas near the project sites having median incomes ≥75 percent of the State's median income.

## 3.10.3 Health Status of the Native American Population in the Area of Potential Effect

The Indian Health Service (IHS) provides health care to and records mortality statistics of the Native American population in the United States. The IHS is organized into several area offices, one of which serves only the Navajo and Hopi populations of New Mexico and Arizona. Therefore, some Navajo-specific information about current health exists (see Tables 3.32, 3.33, 3.34, and 3.35).

[2]Indian country is defined as: (a) All land within the limits of any Indian reservation under the jurisdiction of the United States government, notwithstanding the issuance of any patent, and, including rights-of-way running through the reservation; (b) All dependent Indian communities within the borders of the United State whether within the original or subsequently acquired territory thereof, and whether within or without the limits of a State; and (c) All Indian allotments, the Indian titles to which have not been extinguished, including rights-of-way running through the same (18 U.S. Code 1151).

[3]This percentage excludes persons who reported themselves as both American Indian and Hispanic.

**Table 3.31. Selected demographic characteristics of the population within 16 and 80 km (10 and 50 miles) of the Crownpoint and Church Rock sites**

| | Native American Percent | Hispanic Percent | Median household income ($) |
|---|---|---|---|
| New Mexico | 8.9 | 38.2 | 24,087 |
| Crownpoint: population within 16 km (10 miles) | 93.5 | 1.1 | 17,008 |
| Crownpoint: population within 80 km (50 miles) | 62.0 | 18.5 | 16,335 |
| Church Rock: population within 16 km (10 miles) | 97.2 | 2.0 | 9,874 |
| Church Rock: population within 80 km (50 miles) | 74.5 | 11.3 | 15,735 |

*Source:* LandView™ II. U.S. Environmental Protection Agency and U.S. Department of Commerce.

**Table 3.32. Life expectancy and infant mortality: Navajo and U.S. comparison[a]**

| | Navajo (1990–1992) | U.S. (1991) |
|---|---|---|
| Infant mortality rate (under 1 year, per 1000 live births) | 9.4 | 8.9 |
| Life expectancy at birth (years) | 72.3 | 75.5 |

[a]Statistics for "Navajo" are for those Native Americans served by the Navajo Area Office of the Indian Health Service. This office serves the entire Navajo reservation, the Navajo population in Indian country, and the Hopi reservation.

*Source:* Indian Health Service 1995.

Life expectancy at birth of the Navajo is 3.2 years less than for the U.S. population as a whole (Table 3.32). There are several possible contributing factors to this lower life expectancy. First, the infant mortality rate is higher among the Navajo than the total U.S. population. Second, accidents play a much larger role in Navajo mortality than for the United States as a whole; they account for 22.6 percent of Navajo deaths compared with only 4.1 percent of U.S. deaths (Table 3.33). A higher incidence of accident-related deaths affects life expectancy statistics for the Navajo population because accidents occur to persons of all ages, while other causes of death (e.g., heart disease) tend to affect

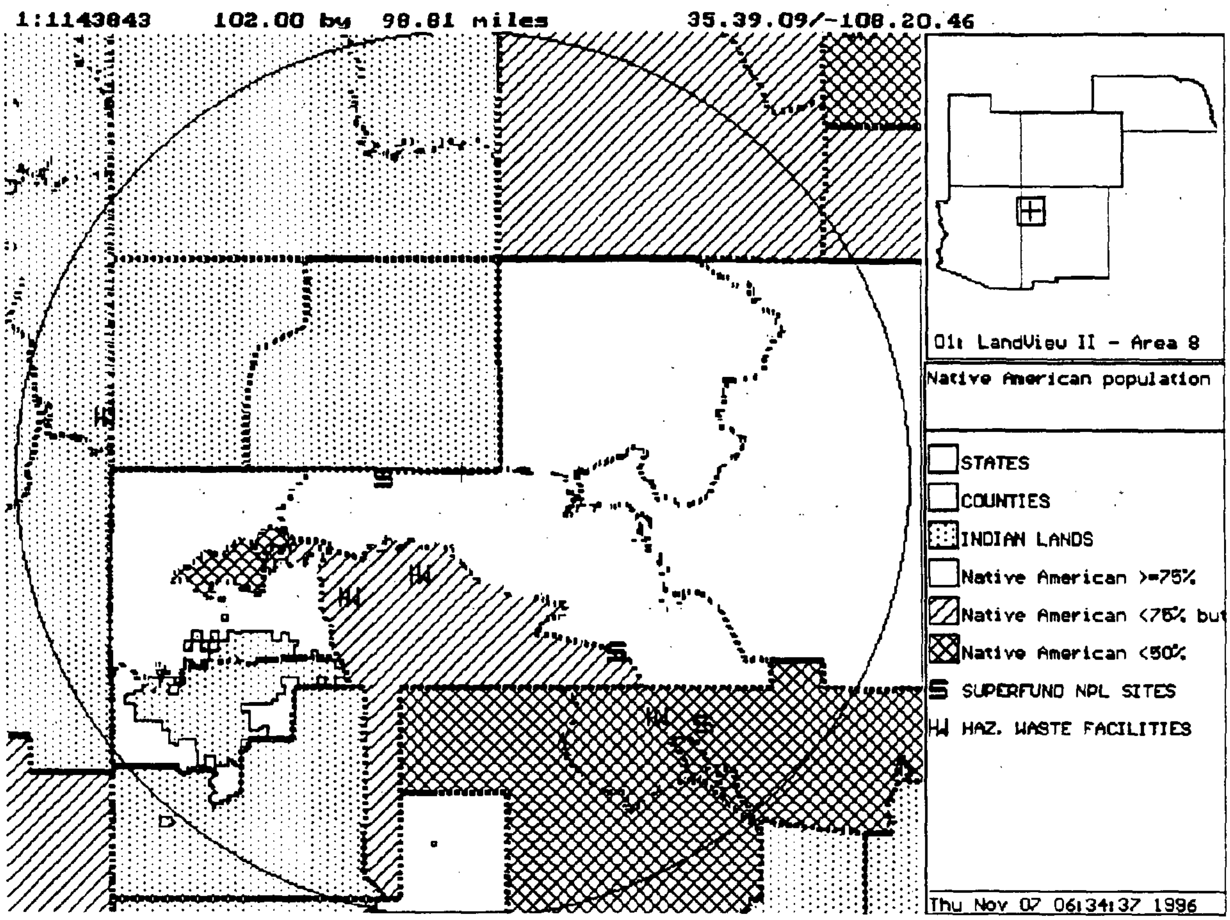


Figure 3.13. Distribution of the Native American population within 50 miles of the proposed project sites.

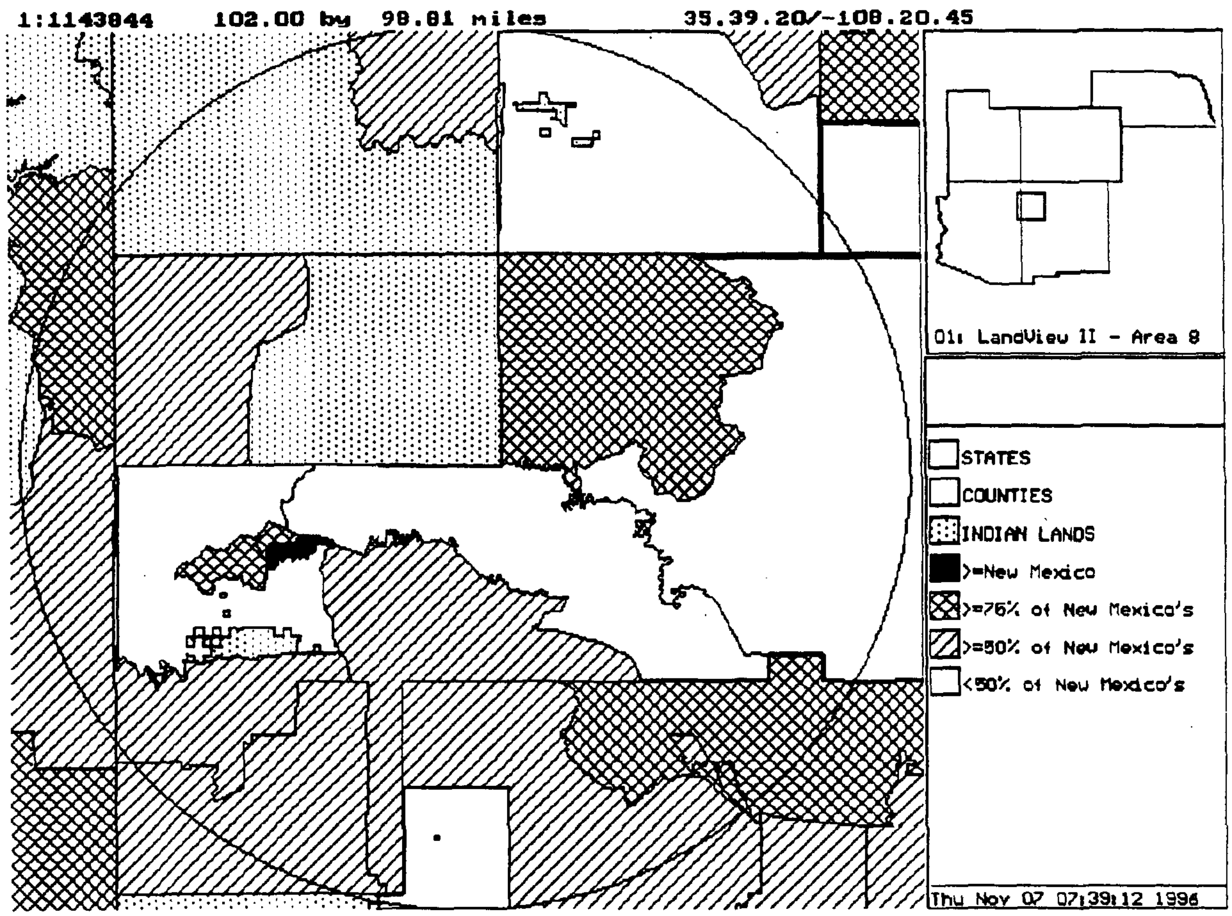


Figure 3.14. Distribution of the population within 50 miles of the proposed project sites by median income.

**Table 3.33. Leading causes of death: Navajo, Native American, and total U.S. comparison[a,b]**

| | Causes of death (percentage of total deaths) | | | | | | |
|---|---|---|---|---|---|---|---|
| Population | Heart disease | Accidents and adverse effects | Malignant neoplasms | Diabetes mellitus | Cerebro-vascular diseases | Chronic obstructive pulmonary diseases | Pneumonia and influenza |
| Navajo | 15.7 | 22.6 | 11.0 | 3.8 | *c* | *c* | 5.7 |
| Native American | 21.9 | 15.1 | 15.0 | 4.5 | 4.4 | *c* | *c* |
| U.S. | 33.2 | 4.1 | 23.7 | *c* | 6.6 | 4.2 | *c* |

[a]Statistics for "Navajo" are for those Native Americans served by the Navajo Area Office of the Indian Health Service. This office serves the entire Navajo reservation and Navajo population in Indian country and the Hopi reservation. "Native Americans" here means those served by all area offices of the Indian Health Service.

[b]Data for the Navajo and Native American populations are for 1990–1992; data for the United States are for 1991.

[c] This cause of death is not among the five leading causes of death for this population. Data are reported only for the five leading causes of death.

*Source:* Indian Health Service 1995.

**Table 3.34. Mortality rates by disease or cause: Navajo and total U.S. comparison[a]**

| Cause/disease | Navajo (1990–1992) | United States (1991) |
|---|---|---|
| Diseases of the heart | 101.7 | 148.2 |
| Malignant neoplasm | 78.5 | 134.5 |
| Cerebrovascular | 18.7 | 26.8 |
| Gastrointestinal diseases | 1.7 | 1.3 |
| Diabetes mellitus | 29.0 | 11.8 |
| Tuberculosis | 4.1 | 0.5 |
| Accidents | 143.3 | 31.0 |
| Alcoholism[b] | 56.8 | 6.8 |

[a]Age adjusted; rates are per 100,000 population.

[b]Alcoholism-related deaths include those occurring from diseases caused by alcoholism (e.g., alcoholic liver disease) and those resulting from alcohol overdose and psychoses.

*Source*: Indian Health Service 1995.

**Table 3.35. Leading causes of infant death: Navajo, Native American, and total U.S. comparison[a, b]**

| Population | Sudden infant death syndrome | Congenital anomalies | Disorders related to short gestation and low birth weight | Respiratory distress syndrome | Accident and adverse effects | Newborn affected by maternal completion of pregnancy |
|---|---|---|---|---|---|---|
| | Causes of death (percentage of total deaths) | | | | | |
| Navajo | 14.7 | 35.0 | 5.5 | 5.5 | 8.6 | [c] |
| Native Americans | 24.3 | 23.7 | 3.5 | 3.8 | 6.3 | [c] |
| U.S. | 14.5 | 20.9 | 11.3 | 7.0 | [c] | 4.2 |

[a]Statistics for "Navajo" are for those Native Americans served by the Navajo Area Office of the Indian Health Service. This office serves the entire Navajo reservation, the Navajo population in Indian country, and the Hopi reservation. "Native Americans" here means those served by all area offices of the Indian Health Service.

[b]Data for the Navajo and Native American populations are from 1990–1992; data for the U.S. are for 1991.

[c] This cause of death is not among the five leading causes of infant mortality for this population. Data are reported only for the five leading causes of infant death.

*Source*: Indian Health Service 1995.

older persons. Both causes of death affect life expectancy, but a cause of death, such as accidents, that happens to a younger population can have a larger effect on life expectancy.

Although leading cause of death figures are informative, they are not ideal for comparing Navajo health status to that of the U.S. population. This limitation exists because the IHS reports causes of death as the percentage of total deaths, and the high accident-related death rate among the Navajo makes other causes of death pale by comparison. Mortality rates, on the other hand, provide a measure of deaths per population, which is a more informative measure for comparison. The mortality rates (by cause—e.g., heart disease and alcoholism) reported in Table 3.34 conform to the patterns expected for populations with and without high accident-related death rates. Mortality rates resulting from heart disease, cancer, and cerebrovascular disease are lower for Navajo than for the United States. Mortality rates resulting from alcoholism, diabetes, tuberculosis, and gastrointestinal diseases are higher among the Navajo than the U.S. population. Because of the high rate of death from alcoholism and accidents (most of which likely are related to alcohol use), Navajo may not be living as long as the rest of the U.S. population to experience diseases that are more prevalent in the elderly, such as cancer and heart disease.

Perhaps the most informative comparisons between Navajo and U.S. populations—for the purpose of identifying overall health status—are the higher infant mortality rates occurring among the Navajo[4] and those diseases that can occur at any age. In this context, tuberculosis and diabetes are appropriate foci. Both diseases are more likely to be causes of death among Navajo than among the U.S. population. Possible reasons are that these diseases are more prevalent among the Navajo or that interventions for these diseases are less likely to occur for Navajo or are less successful for Navajo than for the U.S. population.

Although congenital anomalies[5] are the leading cause of infant death in the Navajo and U.S. populations alike, the percentage of deaths by congenital anomalies among Navajo infants is 15 points higher than for U.S. infants (Table 3.35). This difference is noteworthy because there is some evidence to indicate that radiation exposure may be related to the incidence of congenital anomalies (Shields et al. 1992). Researchers investigated the birth outcomes of Navajo infants born between 1964 and 1981 at the IHS hospital in Shiprock. The research concluded that there were trends in occurrences of adverse birth outcomes that lend limited support for the hypothesis that adverse genetic outcomes are related to radiation exposure. The associations were weak between unfavorable birth outcomes (including congenital anomalies and stillbirths) and radiation exposure of the parents. The only statistically significant association was identified when the mother lived near uranium mill tailings or mine waste sites. However, when placing these conclusions in context, the researchers state that given the extensive uranium mining operations that have gone on for decades, including radiation exposures at levels greatly exceeding what would be allowed today, the lack of clear evidence for increased risk of adverse birth outcomes should be reassuring (Shields et al. 1992).

### 3.10.4 Subsistence Consumption of Natural Resources by the Native American Population in the Area of Potential Effect

Subsistence is a regular pattern of eating fish or wildlife caught or hunted for oneself or one's family, and/or eating vegetation or livestock raised for oneself or one's family. Subsistence activities are relevant in environmental justice analyses because the activities could introduce exposure pathways or pathway scenarios[6] that potentially affect a population's exposure to—and health consequences of—contamination.

Although no detailed examination of the subsistence activities of either the modern Navajo, Zuni, or Acoma population exists, some Navajo and Pueblo Native Americans still practice traditional lifeways.

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[4]The higher infant mortality rate among the Navajo may be affected by access to health care, which also is relevant here because lack of access to health care can affect one's health. The high rate of accidental deaths among the Navajo may also be a contributing factor to infant mortality rates.

[5]Congenital anomalies are those defects that occur during the infant's development in the uterus and are not acquired by heredity.

[6]Exposure pathways are the physical means through which contaminants enter the human body (e.g., ingestion and contact with skin); pathway scenarios are the activities in which people participate that might introduce an exposure pathway. An example of a pathway scenario is a child playing in contaminated dirt.

Some Navajo and pueblo Indians who do not have adequate or reliable wage work to provide for themselves and their families rely heavily on their livestock and gardens (Aberle 1983). These lifeways of the Navajo include herding sheep, goats, and cattle that graze on the land and that are watered from shallow wells or the Rio Puerco. Diets of some Navajo and Pueblo Native Americans include subsistence consumption of domestic plants (e.g., squash, corn, beans, and chiles). Both groups also harvest indigenous plants to eat and use for medicinal purposes.

### 3.10.5 Sensitivity of the Community to Potential Impacts of the Proposed Project

The community's sensitivity to potential adverse impacts of the proposed project is heightened by its previous experience with natural resource extraction activities, particularly uranium mining, and concern that the Navajo Nation has not been involved sufficiently in mining oversight and regulation to protect the interests of the Navajo people, particularly to safeguard their health and environment. Further, community sensitivity is heightened in the context of Navajo Nation struggles for greater self-determination and control of its resources and by the ongoing jurisdictional dispute regarding "checkerboard" lands.

Extraction of natural resources—timber and nonrenewable energy resources (coal, oil, gas, and uranium)—constitutes the primary economic development on the Navajo reservation and in nearby Indian country (see Section 3.7.1; Aberle 1983). These industries, located in an arid environment, use large volumes of groundwater, a situation that by itself heightens sensitivity. Although these extraction industries have employed Navajo people and provided royalties to the Nation,[7] some Navajo perceive this industrial development to have depleted Tribal resources while most of the economic benefits accrue to other people (scoping and public meeting comments; Tome 1983). This perception occurs, in part, because much of the profit from these developments accrue to private corporations outside the reservation[8] and because fixed royalty contracts were disadvantageous when prices rose. Also, there is a history, beginning with the livestock reduction of the 1930s, of compensation for negative effects being provided to others than those primarily affected by the activity. Lastly, some of these industrial developments have had adverse environmental consequences. For example, United Nuclear Corporation's uranium mill tailings dam broke in 1979. This dam break contributed to the contamination of the Rio Puerco. As a consequence, livestock that drink Rio Puerco water have high radionuclide levels (CDC 1980).

The Navajo Nation's history of not controlling or regulating resource developments on the reservation and in Indian country has influenced two pervasive beliefs among Navajo people. The first is that Navajo interests, particularly protecting the people and the environment, were not adequately addressed in the planning, implementation, and regulation of many of the industrial developments (scoping

[7]In fact, royalties paid to the Navajo Nation have been more favorable than those paid to non-Native American owners of similar resources (Aberle 1983).

[8]While it is theoretically possible for the Navajo Nation to have spearheaded the developments, lack of encouragement, expertise, and risk capital prevented them from doing so (Aberle 1983).

comments, Aberle 1983). Second, uranium developers are viewed as having been irresponsible (Robinson 1994). The 1979 dam break accident contributed greatly to this perception. This specific situation occurs in the context of the Navajo Nation, like other Native American tribes, struggling for greater self-determination and control of their resources and during the ongoing jurisdictional dispute regarding "checkerboard" lands.

Sensitivity is increased by concern about the health effects of uranium mining, specifically, and radiation exposure, in general. These concerns are the legacy of a period when uranium miners were exposed to radiation levels greatly exceeding what would be allowed today and were poorly informed of the potential health effects of radon gas (Radiation Exposure Compensation Act).

The Navajo Nation's sensitivity to uranium mining activities that could adversely affect Navajo people and its desire to exercise control over its resources is so great that the moratorium it issued on uranium mining in 1983 was renewed by tribal executive order in 1992. The moratorium on all uranium mining activity is to be effective on Navajo lands until such a time that the Navajo people are assured that the safety and health hazards associated with uranium mining activity can be addressed and resolved. There are, however, conflicts between the Navajo Nation's position and that of the chapters and individuals involved. Referenda held at the Church Rock and Crownpoint chapters, where the proposed project would be located, supported the HRI proposal despite the moratorium. Also, many allottees have agreed to lease their land to HRI. Navajo organizations have arisen to support and to object to the proposed action. The community conflict that results from this difference in opinion also contributes to a heightened sensitivity to the proposed action.

# 4. ENVIRONMENTAL CONSEQUENCES, MONITORING, AND MITIGATION

## 4.1 AIR QUALITY AND NOISE

### 4.1.1 Alternative 1 (The Proposed Action)

The environmental impacts of the proposed project on air quality in the local and regional area can be divided into those caused by construction and those due to normal operations. During construction of well fields, the gaseous and particulate releases from drilling equipment would have a minor local impact on air quality. During operations, air quality impacts would be largely limited to airborne effluents generated from processing and dust suspension due to transportation. Local increases in background noise levels would be caused by the construction vehicles, trucks, and facility operations.

#### 4.1.1.1 Construction Activities

During well field construction, principal emissions to the air would be suspended particulates and gaseous pollutants from vehicle and drill rig exhausts, dust from vehicular traffic on unpaved roads, and dust from disturbed and unprotected soil. HRI estimates that well fields at each project site would require drilling rigs and support vehicles as summarized in Table 4.1. Estimated source terms for pollutants discharged by construction vehicles are displayed in Table 4.2.

**Table 4.1. Estimated vehicle requirements for well field construction, operations, and maintenance[a]**

| | Church Rock | Unit 1 | Crownpoint |
|---|---|---|---|
| **Drilling contractors** | | | |
| Drilling rigs, water trucks, support vehicles | 7 | 6 | 4 |
| **Company support** | | | |
| Pick-up trucks | 8 | 8 | 8 |
| Forklift | 1 | 1 | 1 |
| Portable air compressor | 3 | 3 | 3 |
| Pump hoist trucks | 2 | 2 | 2 |
| Coil tubing trucks | 2 | 2 | 2 |
| Logging trucks | 1 | 1 | 1 |
| Water trucks | 2 | 2 | 2 |

[a]Principal vehicles during construction would be the drilling contractors, while company support would largely occur during operations.

**Table 4.2. Estimated source terms for gaseous and particulate emissions from nominal 209-horsepower diesel drilling equipment[a]**

| Emission type | Emission rate |
|---|---|
| Sulfur oxides ($SO_x$) | 0.93 |
| Nitrous oxides ($NO_x$) | 11.01 |
| Hydrocarbons | 1.41 |
| Carbon monoxide | 9.20 |
| Particulates | 1.44 |
| Aldehydes | 0.20 |

[a]All values are reported in grams per horsepower-hour.
*Source*: EPA 1991.

Non-stationary sources of air pollutants would be diesel engines on the drill rigs and diesel-powered water trucks. Drilling would proceed through the mine units, with each drilling location requiring one to two days of work. Most other equipment would experience only sporadic use, and its impact on air quality would be negligible. Other mobile vehicles would be gasoline-powered onroad cars and trucks equipped with required emission control devices.

During well field construction, it is estimated that each project site would average 100 vehicle-hours per day annually (Pelizza 1996c). Based on the emission rates in Table 4.2, the annual total releases and average air concentrations at each site from well field construction activities would be as shown in Table 4.3. The estimated annual average air concentration is based on the average wind speed [13 km/hr (8 mph)], land use [24 ha (60 acres)] and a mixing layer height of 1 km (0.62 mile). These estimated releases are small fractions of the allowable increments for prevention of significant deterioration of air quality (see Section 3.1.6.2).

The potential for dust emissions from wind erosion would be minimized by promptly reclaiming disturbed soil and establishing vegetative cover on soil stockpiles. Most of the work associated with well field installation would take place with stationary equipment. Therefore, dust releases resulting from vehicle traffic in the well field should be small because of low traffic volume.

#### 4.1.1.2 Processing Emissions

Air quality impacts related to operations would be largely limited to airborne effluents generated from processing and fugitive dust generated by vehicle traffic on unpaved roads. Air pollution consisting of dust suspended by vehicle traffic associated with routine well field maintenance would be minimal. Additionally, material shipments from the Unit 1 and Church Rock sites to the central processing plant in Crownpoint would be conducted mostly on paved roads.

**Table 4.3. Estimated annual total releases and average air concentrations for gaseous and particulate emissions from well field activities**

| Emission type | Annual total (tonnes) | Annual average concentration (fg/m$^3$) |
|---|---|---|
| Sulfur dioxides ($SO_x$) | 7.1 | 0.18 |
| Nitrous oxides ($NO_x$) | 84.0 | 2.1 |
| Hydrocarbons | 10.8 | 0.27 |
| Carbon monoxide | 70.2 | 1.8 |
| Particulates | 11.0 | 0.28 |
| Aldehyde | 1.5 | 0.04 |

Air quality in the well fields and near the processing buildings would be affected by airborne effluents. Dissolved radon gas would be present in the processing solutions, and would escape into the atmosphere at several locations. First, radon would be vented in the well fields either from individual well vents or in the meter houses, or both. Also, the ion exchange system at each processing site would provide a potential escape pathway for radon. However, HRI proposes to operate the ion exchange systems using a pressurized down-flow design. Therefore, radon releases from the plants would occur only when individual ion exchange columns were disconnected from the pressurized recirculation system and opened to remove or elute the resins (see Section 2.1). Finally, yellowcake dryers and packaging areas could release airborne particulate emissions, including natural uranium and radon daughters, to the environment.

HRI modeled the radiological effects of these emissions upon the local population and surrounding area. The analysis was completed using the MILDOS-AREA computer code that was developed by NRC for predicting radiological doses from uranium recovery facilities (ANL 1989). The results of these analyses are described as radiological effects in Section 4.6. The estimated releases would result in very small fractions of the allowable dose limit for the general public.

Two sections of the standard transport routes between facilities would involve unpaved roads. A small section of Church Road and the access road to Unit 1 (Picnic Road) are currently unpaved, gravel roads. The additional vehicle traffic associated with the proposed project would cause adverse impacts from additional fugitive dust to residences and the churches in the immediate area of the road.

#### 4.1.1.3 Noise

In general, operations at ISL mining facilities do not create important sources of noise to offsite receptors except in two cases: construction/drilling in the well fields and truck traffic for the operation. No significant noise sources that would result in significant audible noises offsite would be in a well field for most of a well field's production and remediation lifetimes. In general, the only noise sources would be the necessary pumps and occasional truck traffic performing maintenance and inspections. Construction of the well fields and transportation of the slurry (or resins) and product would generally result in audible noises in and around residences or multi-use facilities (e.g., churches) in the immediate vicinity of the project site. Generated noise levels would likely be annoying, but would be either short in duration (construction) or intermittent (transportation). The following discussion details possible noise levels during short-duration construction or from transportation of slurry (or resins) and product.

Drill rigs, construction vehicles, heavy trucks, and other equipment used to construct and operate the well fields and production facilities would generate noise that would be audible above background levels of 50–60 decibels (dB) in the normal (A-scale) auditory frequency band [dB(A)] during the day. Noise resulting from the proposed project could occasionally be annoying to residents within 300 m (0.2 mile) of the noise sources. Noise levels (other than occasional instantaneous levels) resulting from the proposed project might reach or occasionally exceed 85 dB(A) at 16 m (50 ft) from the source. Because noise levels diminish by about 6 dB(A) for each doubling of distance from the source (Golden et al. 1979), nearby residents or users of multi-use facilities (e.g., churches) might experience outdoor noise levels of slightly greater than 70 dB(A) during periods when construction equipment operated in the general vicinity. Because well field construction would generally occur only during daytime hours, this noise would not be expected to cause exceedances of the 24-hr average sound-energy guideline of 70 dB(A) estimated by EPA (1978) to protect hearing with a margin of safety. However, outdoor noise levels at the nearest residences during the day would be expected to appreciably exceed 55 dB(A), the level given by EPA (1978) as protective against activity interference and annoyance with a margin of safety. Indoor noise levels typically range from 15 to 25 dB(A) lower than outdoor levels, depending on whether windows are open or closed. With windows open during construction hours, indoor noise levels could be substantially greater than the 45 dB(A) level given by EPA (1978) as protective against indoor interference and annoyance with a margin of safety. In summary, noise levels during well field construction and transportation of slurry and product are likely to be annoying to residences near the sources, but are not likely to be harmful.

## 4.1.2 Alternative 2 (Modified Action)

### 4.1.2.1 Alternative Sites for ISL Mining

One possible alternative to licensing the project as proposed by HRI is to limit the number of sites for ISL mining. Additional air and noise pollution in the local area could be avoided by not developing one or two of the three proposed sites. For example, developing only one of the satellite facilities would result in fewer vehicles using the unpaved section of road near the Crownpoint processing facility, reducing fugitive dust in that area. Using the Crownpoint site for yellowcake drying and packaging only (i.e., no wells at the Crownpoint site) would result in slightly smaller fugitive dust emissions than the proposed project, and would help avoid additional air and noise pollution because there would not be well field construction.

### 4.1.2.2 Alternative Sites for Yellowcake Drying and Packaging

Using an alternative site for yellowcake drying and packaging would help avoid additional fugitive dust emissions around the Crownpoint facility but would not result in a complete absence of additional dust generation. If the area around the Crownpoint main facility were mined but the dryer were elsewhere, for example, in south Texas, the Crownpoint facility (now effectively a satellite facility) would need to ship slurry to the new dryer location.

Placement of the dryer in the Unit 1 or Church Rock sites would result in increased fugitive dust emissions similar to those described for the Crownpoint site in Section 4.1.1.2.

### 4.1.3 Alternative 3 (The NRC Staff-recommended Action)

This section provides a summary of additional NRC staff requirements and recommendations based on its evaluation of the proposed action. The following list supplements the commitments already made by HRI in its license application. Subsequently, HRI has formally agreed to these conditions as expressed in its letter to NRC dated December 26, 1996 (see Appendix B). The staff believe that the previously identified impacts of this project can be mitigated through the measures discussed below.

If a license were issued for the proposed project, those items listed as requirements would be incorporated in the license either as separate license conditions or combined as one general license condition that references HRI's consolidated operations plan. For those items listed as NRC staff recommendations, BIA, BLM, and other cognizant regulatory agencies will be responsible for ensuring that HRI has complied with this guidance.

The proposed project would have only minor impacts in terms of air quality and noise (Section 4.1.1). However, to ensure that air quality impacts were minimized, if a license were issued for the proposed project NRC staff would require the following license conditions:

- Yellowcake drying operations shall be immediately suspended if any emission control equipment for the yellowcake drying or packaging areas is not operating within specifications for design performance.

- HRI shall, during all periods of yellowcake drying operations, ensure that the manufacturer-recommended vacuum pressure is maintained in the drying chamber. This shall be accomplished by continuously monitoring differential pressure and installing instrumentation which will signal an audible alarm if air pressure differential falls below the manufacturer's recommended levels.

In addition to these requirements, NRC staff recommends that HRI use dust suppression techniques to reduce fugitive dust emissions and associated impacts to residences and churches near the Crownpoint and Unit 1 sites during project shipments on unpaved roads.

### 4.1.4 Alternative 4 (No Action)

Under the no-action alternative, air quality in the project area would remain as described in Section 3.1.

# 4.2 GEOLOGY AND SOILS

## 4.2.1 Alternative 1 (The Proposed Action)

During construction of the proposed project, the principal impacts on soils would result from earth moving associated with constructing wastewater retention ponds and clearing drilling sites. During project operation and groundwater restoration activities, the principal impact on soils would be from ongoing drilling activities and land application of project wastewater. HRI has provided estimates of pond sizes and land application areas for three groundwater restoration approaches: (1) 100 percent groundwater sweep; (2) reverse osmosis treatment only; and (3) brine concentration. For the 100 percent groundwater sweep option, restoration water would be disposed of by land application (HRI 1993b). For the reverse osmosis option, HRI would depend on deep well disposal for reverse osmosis reject water. Therefore, under this option evaporation ponds would not be constructed and land application areas would not be required. For the brine concentration option, a 0.8-ha (2-acre) pond would be constructed at each project site.

Estimates of the amounts of land that would be disturbed during well field and plant construction are provided in the following sections. These estimates also include areas for the construction of ponds for the brine concentration approach, previously identified land application areas within the site boundaries, and land that has already been disturbed by previous construction activities. Therefore, the area estimates for construction impacts are anticipated to represent worst-case estimates.

### 4.2.1.1 Crownpoint

ISL mining activities would not result in the removal of rock matrix or structure, so unlike underground mining, they would not cause subsidence at the site from the collapse of overlying rock strata in the mine zone. The principal impacts on the geologic environment during project construction would result from earth moving associated with constructing wastewater retention ponds and clearing drilling sites. Most of the potential impacts of construction at the Crownpoint site have already occurred, because HRI purchased existing surface facilities at the site. However, the existing ponds may not be adequate and might need regrading and synthetic liners capable of retaining the wastewater. Including both previously and newly disturbed areas, construction at the Crownpoint site would likely involve about 258 ha (638 acres).

Topsoil would be preserved by adopting construction practices that prevent erosion. All areas where soil is temporarily scraped away would have the soil replaced and reseeded immediately after construction (HRI 1996f).

HRI has stated that the material in the Crownpoint site ponds presently consists of windblown sand, drill cuttings, and drill mud (bentonite) (HRI 1996o). Radionuclide analysis shows that the material contains very low concentrations of uranium, radium, thorium, and lead 210. HRI plans to dispose of this material in Section 12, 17N R13W, located northwest of the Crownpoint site. HRI acquired this land from Mobil Oil Corporation, which previously used the site for drill mud disposal. HRI plans to dispose of the existing pond material by disking (blending) it with the native soil and then reseeding the area. HRI has also identified the Section 12 property as a potential area for the off-site land application of project wastewater.

Additional impacts on soils could result from spills from processing equipment. Soil contamination could result from pipeline leaks and ruptures, retention pond liner failures, or transportation accidents resulting in yellowcake or ion exchange resin spills. If soil were contaminated by a spill, the soil would be removed and disposed of in retention ponds. Ultimately, this material would be disposed of with other 11e(2) by-product material at a licensed off-site disposal area in compliance with 10 CFR Part 20. All decontamination procedures would be confirmed with radiation surveys, and would be required to meet NRC's regulations addressing radioactive materials in soils in areas released for unrestricted use.

For the Crownpoint site, all of Section 12, 17N R13W, (Figure 4.1) would be available for irrigation/land application. Section 12 is located 1 mile north of the Crownpoint site boundary and approximately 1 mile northeast of the Unit 1 site boundary. Section 12 contains 259 ha (640 acres), but it is estimated that only 42 ha (104 acres) would be needed (HRI 1996a). However, since HRI states that all of Section 12 will be available for irrigation/land application, 259 ha (640 acres) is used in this analysis as a worst case estimate of environmental impact.

Before water would be disposed of using land application, radionuclide concentrations would be reduced to acceptable levels (Table 4.4). Radionuclide water quality would be monitored before water was disposed of by land application. Analyses submitted by HRI indicate that metal accumulation in the soils, including selenium, molybdenum, uranium, or radium-226, is not expected to be a problem at the land application site (HRI 1996a). Soil erosion estimates, based on a conservative use of the universal soil loss equation, show that soil losses would not contribute significantly to erosion. Soils at the land application site are presently subject to wind erosion; HRI's proposed irrigation and establishment of continuous ground cover would greatly reduce erosional losses due to wind. With irrigation applied at a rate of 0.2 in./hr, no runoff would be expected. HRI proposes to meet the following conditions (HRI 1996a):

1. No irrigation is to be carried out during a rainfall event.
2. If heavy rains are forecast, no irrigation is to be carried out in the preceding 12 hr.
3. No irrigation is to be allowed on saturated soils.
4. No irrigation is to be allowed on steep slopes or soils shallower than 72 in.
5. Close-order soil sampling of prospective irrigation plots will be conducted to exclude areas with existing soil conductivity problems prior to irrigation.

The salinity of the proposed irrigation water would be tolerable for the irrigation of pasture grasses. However, the salinity of the irrigation water would cause permeability problems with clay soils in the irrigation plots. Based on calculations provided by HRI, it does not appear likely that these problems would be sufficient to preclude irrigation, but monitoring of soil electrical conductivity would be required on a regular basis (HRI 1996a). In addition, if soil electrical conductivity should rise to

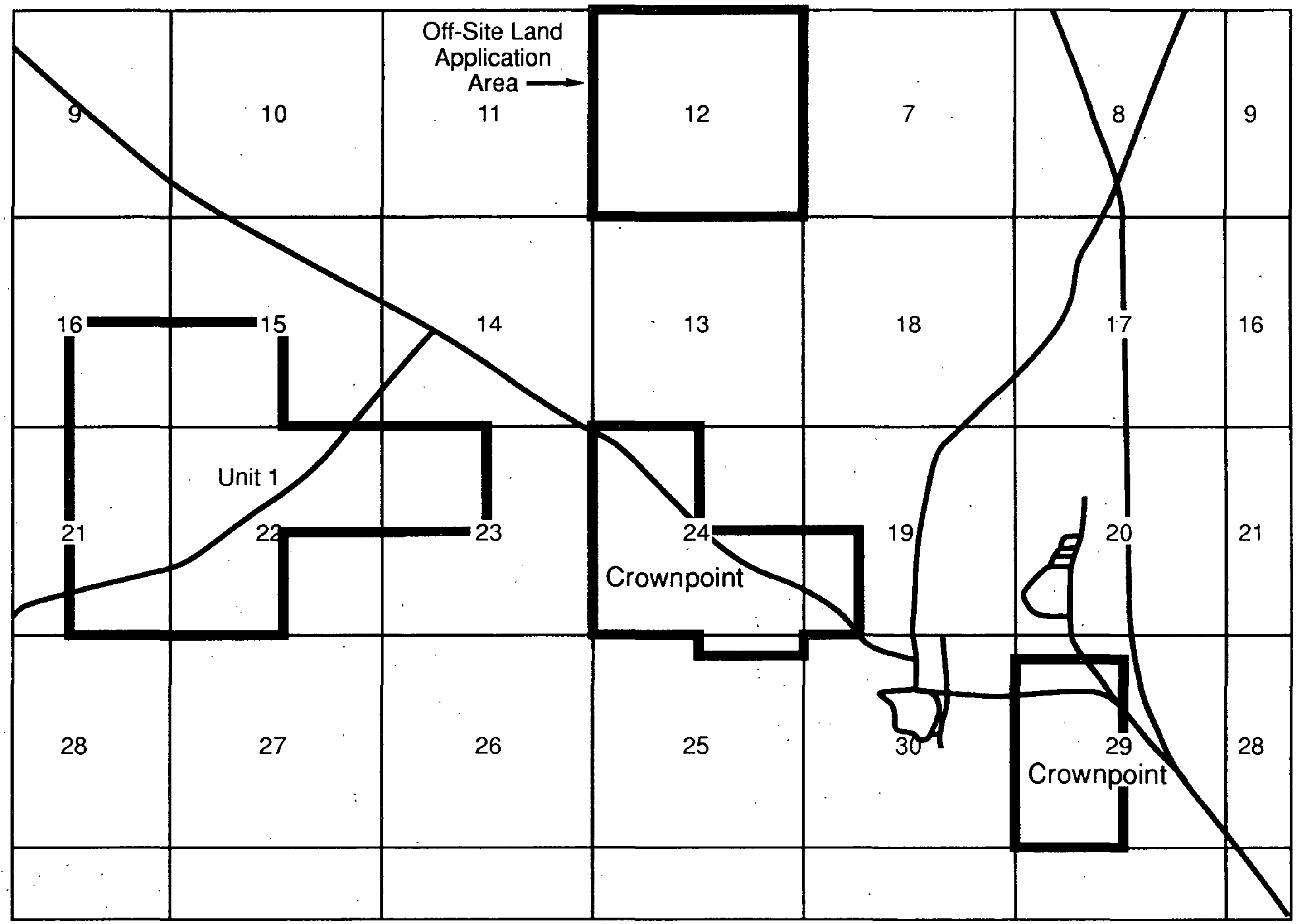


**Figure 4.1. The Section 12 off-site land application area for the Crownpoint and Unit 1 sites.**

**Table 4.4. Projected quality of water to be disposed of by land application (HRI 1996a)**

| Parameter | Concentration (mg/L) |
|---|---|
| Calcium | 56 |
| Magnesium | 4 |
| Sodium | 461 |
| Potassium | 39 |
| Carbonate | 26 |
| Bicarbonate | 566 |
| Sulfate | 260 |
| Chloride | 328 |
| Nitrate | 0.26 |
| Fluoride | 0.76 |
| Silica | 27 |
| Total dissolved solids | 1501 |
| Electric conductivity | 1522 ($\mu$mhos) |
| Alkalinity | 494 |
| pH | 8.5 (units) |
| Arsenic | 0.028 |
| Barium | 0.16 |
| Cadmium | 0.0013 |
| Copper | 0.01 |
| Iron | 0.07 |
| Lead | 0.0019 |
| Manganese | 0.76 |
| Mercury | 0.0 |
| Molybdenum | 0.01 |
| Nickel | 0.01 |
| Selenium | 0.013 |
| Silver | 0.01 |
| Uranium | 1.0 |
| Vanadium | 0.67 |
| Zinc | 0.05 |
| Boron | 0.14 |
| Ammonia | 0.11 |
| Radium-226 | 1.0 (pCi/L) |

*Source:* HRI 1996a.

70 percent of the maximum level tolerated by the planted crop, the irrigation area would be moved to another portion of the available land (HRI 1996a). HRI also proposes to maintain the soil sodium absorption ratio at 4 or below (HRI 1996a).

Total dissolved solids could present a problem for HRI's land application proposal. Total dissolved solids is a limiting condition for irrigation at 1500 mg/L (HRI 1996a), and the proposed irrigation water shows total dissolved solids at 1501 mg/L. HRI also reports that the sodium absorption ratio of the irrigation water is considered limiting at 15 (non-adjusted), while the sodium absorption ratio of the proposed irrigation water is 49.6 (adjusted). According to HRI, the existing total dissolved solid level and sodium absorption rate indicate that the proposed irrigation water would require close management and that soil sodium absorption ratios would require frequent monitoring (HRI 1996a). However, given HRI's proposed operating procedures, it is likely that soil impacts resulting from land application would be low.

At present, uranium is the only economically recoverable mineral resource at the Crownpoint site. NRC staff believe that the proposed project would not preclude recovering other minerals that might be discovered in economical quantities at the site in the future. Assuming that only 60 percent of the uranium ore reserves are recovered by the proposed project, an estimated 8.6 million kg (19 million lb) of uranium yellowcake would be produced from the Crownpoint site.

#### 4.2.1.2 Unit 1

Unlike at the Crownpoint site, water storage ponds would have to be constructed at the Unit 1 site to hold processing bleed and aquifer restoration water from the satellite ion exchange plant. Including both previously and newly disturbed areas, construction at the Unit 1 site would likely involve about 363 ha (896 acres).

For the Unit 1 site, all of Section 12, T17N R13W, (Figure 4.1) would be available for irrigation/land application. This is the same location proposed for the Crownpoint site, so the impacts of land application on soil resources should be the same as those described in Section 4.2.1.1.

At present, uranium is the only economically recoverable mineral resource at the Unit 1 site. NRC staff believe that the proposed project would not preclude recovering other minerals that might be discovered in economical quantities at the site in the future. Assuming that only 60 percent of the uranium ore reserves are recovered by the proposed project, an estimated 8.6 million kg (19 million lb) of uranium yellowcake would be produced from the Unit 1 site.

#### 4.2.1.3 Church Rock

ISL mining activities would not result in the removal of rock matrix or structure which could cause surface subsidence. Rather, subsidence at the Church Rock site would most likely result from the collapse of existing mine workings. If ISL mining were to contribute to working collapse, it would likely result from the varying water pressures and vibrations associated with an operating well field. NRC staff believe that any workings collapse that might occur during ISL mining would eventually occur whether or not ISL mining activities were ever conducted at the site. However, if depressions appeared at the land surface as a result of subsurface collapse, NRC staff would require HRI to return the land surface to its general contour as part of the project's surface reclamation activities.

Most of the potential impacts of construction at the Church Rock site have already occurred because HRI purchased existing surface facilities at the site. Including both previously and newly disturbed areas, construction at the Church Rock site would likely involve about 130 ha (324 acres).

Land application at the Church Rock site would probably take place on 32 ha (80 acres) in Section 17, T16N R16W (HRI 1993a; HRI 1996a). HRI has conducted land application soil studies for this parcel of land in Section 17 but is also considering other properties for land application (Figure 4.2) (HRI 1996c). These properties are

1. Flat mesa land consisting of 83 ha (206 acres) on patented Federal mining claims owned by HRI in Section 8, T16N R16W
2. Flat mesa land consisting of 109 ha (270 acres) on patented Federal mining claims owned by HRI in Section 12, T16N R17W
3. Pasture land consisting of 259 ha (640 acres) owned by the State of New Mexico in Section 16, T16N R16W

HRI has stated that of these three additional properties, the Section 16 parcel is the most preferable because it is the largest block of relatively flat property, it is close to the Crownpoint site, and it is at approximately the same elevation as the Crownpoint site (HRI 1996c). HRI has stated that the Section 16 parcel would be the largest parcel that would be considered for land application, and that the maximum affected area (land potentially removed from grazing) would be 259 ha (640 acres) (HRI 1996c).

HRI proposes to file an application with NRC at the time irrigation plans for the Church Rock site have been finalized. The application would contain information about the environmental conditions of the parcel selected for land application (HRI 1996c). For purposes of evaluating potential environmental impacts in this FEIS, NRC staff have assumed that land application could occur at any of the four potential sites, but that no more than 259 ha (640 acres) would be affected. Land application associated with the Church Rock site would have impacts similar to those described for the Crownpoint site in Section 4.2.1.1.

At present, uranium is the only economically recoverable mineral resource at the Church Rock site. NRC staff believe that the proposed project would not preclude recovering other minerals that might be discovered in economical quantities at the site in the future. Assuming that only 60 percent of the uranium ore reserves are recovered by the proposed project, an estimated 1.8 million kg (4 million lb) of uranium yellowcake would be produced from the Church Rock site.

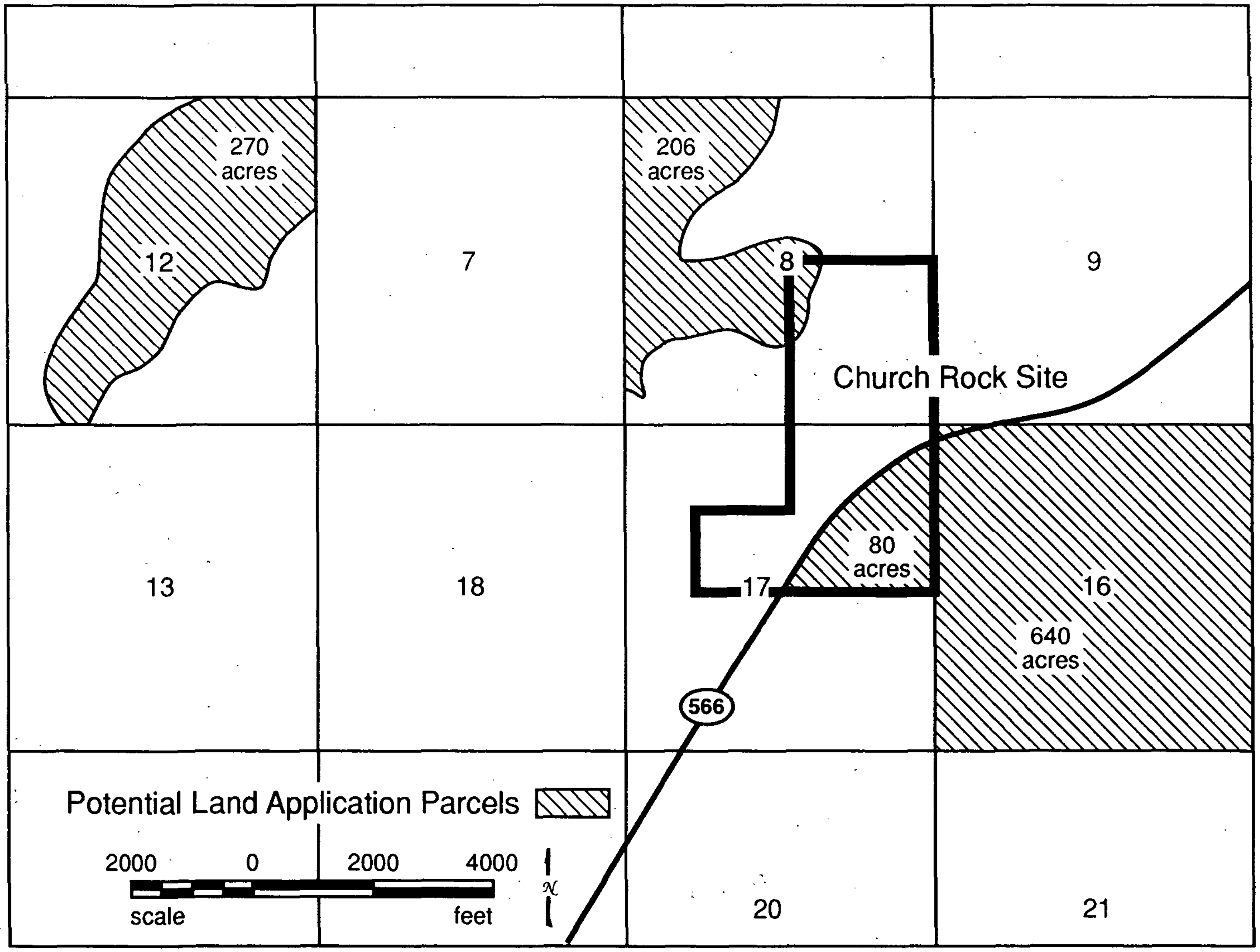


**Figure 4.2. Potential land application areas for the Church Rock site.**

## 4.2.2 Alternative 2 (Modified Action)

### 4.2.2.1 Alternative Sites for ISL Mining

The impacts of developing only one of the proposed project sites are described in Sections 4.2.1.1, 4.2.1.2, and 4.2.1.3 for the Crownpoint, Unit 1, and Church Rock sites, respectively.

Developing only the Church Rock and Unit 1 sites could involve the disturbance of up to 493 ha (1220 acres) for project plants, well fields, and production ponds. Land application would result in the disturbance of up to an additional 518 ha (1280 acres). It is projected that 10.4 million kg (23 million lb) of uranium yellowcake would be produced if these two sites were developed.

Developing only the Church Rock and Crownpoint sites could involve the disturbance of up to 389 ha (962 acres) for project plants, well fields, and production ponds. Land application would result in the disturbance of up to an additional 518 ha (1280 acres). It is projected that 10.4 million kg (23 million lb) of uranium yellowcake would be produced if these two sites were developed.

Developing only the Unit 1 and Crownpoint sites could involve the disturbance of up to 620 ha (1534 acres) for project plants, well fields, and production ponds. Land application would result in the disturbance of up to an additional 259 ha (640 acres). It is projected that 17.2 million kg (38 million lb) of uranium yellowcake would be produced if these two sites were developed.

### 4.2.2.2 Alternative Sites for Yellowcake Drying and Packaging

Impacts due to the construction of a dryer facility at either the Unit 1 or Church Rock site would be limited to a few acres. This land area would be cleared for construction of the dryer and the buildings used to store yellowcake and dried uranium.

There would be no significant impact on geologic and soil resources from using the existing drying and packaging facilities at HRI's Kingsville Dome site in Texas or at the Ambrosia Lake Uranium Mill north of Milan, New Mexico.

## 4.2.3 Alternative 3 (The NRC Staff-recommended Action)

This section provides a summary of additional NRC staff requirements and recommendations based on its evaluation of the proposed action. The following list supplements the commitments already made by HRI in its license application. Subsequently, HRI has formally agreed to these conditions as expressed in its letter to NRC dated December 26, 1996 (see Appendix B). The staff believe that the previously identified impacts of this project can be mitigated through the measures discussed below.

If a license is issued for the proposed project, those items listed as requirements would be incorporated in the license either as separate license conditions or combined as one general license condition that references HRI's consolidated operations plan. For those items listed as NRC staff recommendations, BIA, BLM, and other cognizant regulatory agencies will be responsible for ensuring that HRI has complied with this guidance.

The proposed project would not have major impacts on geology and soils in the region (Section 4.2.1). However, to ensure that potential impacts to soils are minimized, if a license were issued for the proposed project, NRC staff would require the following license conditions:

- HRI is prohibited from constructing wastewater retention ponds prior to NRC's review and approval of an embankment engineering design. The design shall contain all specifications related to embankment slope stability, liners, freeboard requirements, and leak detection systems. Any retention pond intended to retain degraded water above grade shall be designed in accordance with NRC Regulatory Guide 3.11, *Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills*. In addition, HRI shall demonstrate through detailed engineering analyses that the ponds and diversion channels around the ponds would be stable under a probable maximum flood condition, in accordance with NRC Staff Technical Position #WM-8201, *Hydrologic Design Criteria for Tailings Retention Systems*. Accordingly, HRI shall provide detailed analyses to document the adequacy of the system during an occurrence of the probable maximum flood.

- HRI shall, at all times, maintain sufficient reserve capacity in the retention pond system to enable transferring the contents of a pond to the other ponds. In the event of a leak and subsequent transfer of liquid, the freeboard requirements shall be suspended during the repair period.

- HRI shall submit a detailed site reclamation plan to the NRC for review and approval at least 12 months prior to planned final shutdown of mining operations. If depressions appear at the land surface due to subsurface collapse, HRI shall return the land surface to its general contour as part of the project's surface reclamation activities. Before release of an area to unrestricted use, HRI shall provide information to the NRC verifying that radionuclide concentrations meet applicable radiation standards. Currently, the soil cleanup criterion for natural uranium not in equilibrium with its daughters is 1.1 Bq/g (30 pCi/g), and for radium is 0.19 Bq/g (5 pCi/g) in the top 15 cm and 0.57 Bq/g (15 pCi/g) for other soils.

- HRI shall maintain an adequate financial surety to cover the costs of reclaiming disturbed areas. The amount of the surety shall be determined by the NRC based on cost estimates for completion of the approved reclamation plan by a third party in the event HRI defaults. The surety shall be reviewed annually by the NRC and adjusted to reflect expansions in operations, changes in engineering design, and inflation.

### 4.2.4 Alternative 4 (No Action)

There would be no impacts to geology or soils under the no-action alternative because no uranium would be produced. Conditions would remain as described in Section 3.2.

## 4.3 GROUNDWATER

The potential groundwater impacts of ISL mining are related to the consumption of groundwater (i.e., water is pumped from the aquifer but not returned to it) and short- and long-term changes to groundwater quality (i.e., the chemistry of the water). Perhaps the most significant environmental impact that can occur as a result of ISL mining is the degradation of water quality in the ore-bearing aquifer.

Local groundwater quality in the Westwater Canyon sandstone within the proposed mining units would deteriorate during HRI's proposed project. The Westwater Canyon aquifer is expected to be the only aquifer affected by the proposed mining operations under HRI's current submittals. Average background characteristics of groundwater in the Westwater Canyon aquifer are summarized in Table 4.5.

Well field water quality and hydraulic data are collected before mining operations begin. The water quality data are used to set the concentrations of parameters that will be used to determine whether the well field is being operated safely. Water quality data are also used to establish the water quality standards to which the aquifer will be restored after mining. From an environmental standpoint, the hydraulic data are used to (1) determine whether the well field can be operated safely, (2) confirm that monitor wells have been located correctly, (3) design aquifer restoration activities, and (4) predict post-restoration impacts.

During ISL mining operations, water quality impacts are usually of greater concern than water consumption impacts because water consumption during mining is relatively small. Water consumption becomes a significant impact during groundwater restoration activities. Contamination of groundwater from sodium-based alkaline lixiviant uranium leaching arises from (1) the addition of sodium bicarbonate and oxygen (lixiviant) to the groundwater, (2) the addition of chloride to the groundwater by the processing plant, and (3) the interaction of these chemicals with the mineral and chemical constituents of the aquifer being mined (most significantly uranium, potassium, sulfate, arsenic, selenium, molybdenum, and other trace metals) (Deutsch 1985). The result is that during mining, the concentration of most of the naturally occurring dissolved constituents will be appreciably higher than their concentrations in the original groundwater (Table 4.5).

Water quality impacts from ISL mining activities are related to the identification, control, and clean-up of excursions. Excursions are unanticipated releases of mining solutions that move beyond the "well field area." The "well field" is where production and injection wells have been completed and solution mining occurs. The "well field area" encompasses the well field and the larger area encircled by the perimeter monitor wells. During mining, mine solutions (groundwater altered by the injection of lixiviant) are not expected to move horizontally beyond the well field area. For the three proposed sites, the mine zone is the Westwater Canyon aquifer. Similarly, mine solutions are not expected to move vertically into aquifers above or below the mine zone. Where appropriate, wells would be placed in aquifers above and below the mine zone to monitor for vertical excursions.

**Table 4.5. Average background concentrations of principal chemical species in Westwater Canyon groundwater near the Church Rock and Crownpoint sites and estimated lixiviant water quality during proposed mining operations[a]**

| Chemical species | Church Rock background | Crownpoint background | Lixiviant |
|---|---|---|---|
| Calcium | 2.9 | 2.0 | 100–350 |
| Magnesium | 0.3 | 0.1 | 10–50 |
| Sodium | 125 | 110 | 500–1600 |
| Potassium | 2 | 3 | 0–500 |
| Carbonate | 20 | 27 | 0–500 |
| Bicarbonate | 255 | 195 | 800–1500 |
| Sulfate | 35 | 35 | 100–1200 |
| Chloride | 6 | 3 | 250–1800 |
| Nitrate | 0.02 | 0.04 | <0.01–2 |
| Fluoride | 0.3 | 0.3 | 0.05–1 |
| Silica | 15 | 17 | 25–50 |
| TDS | 360 | 320 | 1500–5500 |
| Uranium | 0.2 | 0.005 | 50–250 |
| Radium-226 | 10 | 0.7 | >100 |
| Conductivity | 540 | 415 | 2500–7500 |
| pH (standard units) | 8.8 | 9.0 | 7.0–6.9 |

[a]Values are in mg/L unless specified otherwise. Data are based on HRI's groundwater sampling and operating experience (HRI 1993a).

ISL monitoring programs are designed to ensure that any excursion is detected long before mining solutions can seriously degrade groundwater quality outside the well field area. Early detection of excursions by a monitor well is influenced by several factors, such as the thickness of the aquifer monitored, the distance between the monitor wells and the well field, the distance between adjacent monitor wells, how often monitor wells are sampled, the water quality parameters that are sampled, and the concentrations of parameters that are used to determine whether an excursion has occurred.

Since it is very expensive and time-consuming to sample for every water quality parameter that could be mobilized during ISL mining, a select group of parameters (known as "upper control limit" parameters) is chosen to provide early warning that more serious contaminants are moving toward the monitor wells. An excursion is deemed to have occurred when the concentrations of the upper control limit parameters in the water sampled exceed pre-determined concentrations calculated from baseline water quality data. These pre-determined concentrations are unique for each well field.

Horizontal excursions generally occur when well field injection rates and pumping rates are not correctly balanced. If injection rates exceed pumping rates, mining solutions can move out from the well field area. However, horizontal excursions are relatively easy to detect because the mine area is surrounded by monitor wells. When a horizontal excursion is detected, the maximum width of the excursion (the distance between monitor wells) and the direction in which the excursion is traveling (horizontally from the well field) are known. In addition, horizontal excursions are relatively easy to control because the wells located in the aquifer can pump the well field at an increased rate to pull back the contaminants and correct the excursion. If a well field operator takes prompt action after a horizontal excursion has been detected, the excursion should be easy to correct long before any serious water quality changes occur in the aquifer outside the well field area.

Vertical excursions occur when vertical pathways allow mining solutions to move up or down into overlying or underlying aquifers. Vertical pathways are caused by (1) thin or missing confining units (geologic material with very low permeabilities); (2) open faults, fractures, and exploration boreholes; (3) broken casing from mining wells; and (4) injection wells operating at excessive pressures. Vertical excursions tend to occur more frequently near injection wells where the hydraulic head (water level) exceeds the hydraulic head of any overlying or underlying aquifers. If there are no vertical pathways present, vertical excursions generally do not occur. Therefore, if a well field operator carefully characterizes, constructs, and tests the well field, there is a low likelihood of occurrence.

The potential risk of vertical excursions is reduced by detailed geologic characterization during well field development, hydrogeologic testing, careful well construction, close monitoring of injection pressures, and periodic mechanical integrity testing of installed wells. These measures make the likelihood of vertical excursions low. Consequently, vertical monitor wells are not drilled so as to encircle the well field in the aquifer above or below. Once a vertical excursion has been detected, the vertical pathways must first be located and sealed. Then additional wells must be drilled into the overlying or underlying aquifer to define the extent of the excursion and correct it. Thus, if a vertical excursion occurs, water quality in the overlying or underlying aquifer is likely to take much longer to correct than with a horizontal excursion.

During groundwater restoration, water consumption and water quality impacts can be significant. When restoration activities begin, water consumption increases dramatically. The amount of increase depends on the restoration techniques applied. Techniques that clean the aquifer by pumping contaminated water from the aquifer, removing the contaminants, and reinjecting the clean water into the aquifer consume the least amount of water.

Final restoration water quality standards are determined using baseline water quality data. Restoration standards are unique for each well field and usually consist of restoration on a parameter-by-parameter basis to the average baseline concentration for the well field or an appropriate State or Federal water quality standard. Therefore, after successful restoration, water quality in the aquifer will not be identical to that which existed prior to mining. However, if average baseline conditions are achieved, general water quality should be close to its original condition. If water use standards are achieved, water quality should be such that water use is preserved.

Post-restoration water quality stability monitoring is solely concerned with water quality impacts. This phase of the ISL mining process occurs after well field water quality has been successfully restored. Since the geochemical conditions just after restoration are not identical to pre-mining conditions, groundwater quality will be monitored for a specified period of time to ensure that aquifer water quality is not being degraded as a result of the remobilization of chemical constituents (HRI 1992b; HRI 1992d; HRI 1993a).

### 4.3.1 Alternative 1 (The Proposed Action)

The following text describes pre-mining, mining, and post-mining activities that are applicable to all three project sites. Activities that would be unique at each site are described in Sections 4.3.1.1, 4.3.1.2, and 4.3.1.3. Descriptions of potential impacts and mitigative measures proposed by HRI are also included. Section 4.3.3 describes NRC staff requirements and recommendations to mitigate potential groundwater impacts that were not proposed by HRI.

#### Pre-mining Activities

**Baseline Monitoring and Testing.** Groundwater would be monitored prior to, during, and after the proposed mining operations. Prior to lixiviant injection in a well field, data would be collected to determine baseline water quality and define aquifer properties. Water quality data would be collected to establish upper control limits and restoration criteria. Prior to lixiviant injection in each mining unit, HRI proposes that

1. Baseline water quality data would be established at (1) all mining unit perimeter monitor wells, (2) all upper and lower aquifer monitor wells, and (3) at least one production/injection well per acre in each well field.
2. Upper control limits and groundwater restoration criteria would be established (HRI 1996b).

Baseline water quality and water level data would be collected from the wells within the well field and completed in the Westwater Canyon aquifer at a density of one well per acre of well field (HRI 1996e). Baseline water quality and water level data would be collected from the first overlying aquifer at a density of one well per four acres of well field (HRI 1996b).

HRI would conduct additional pumping tests from production or injection wells to test the vertical confinement of a well field. HRI has identified a data gap for determining the flow direction in the Dakota Sandstone, but has committed to additional characterization or monitoring of the overlying aquifers at the three project sites before operations commence (HRI 1996b). HRI would characterize the groundwater flow direction in the overlying Dakota aquifers at the Church Rock, Unit 1, and Crownpoint properties before operations commence. HRI has committed to spacing monitor wells in the first overlying aquifer at a density of one well per four acres of field production area (HRI 1996b). There would be 11 shallow monitor wells at the Church Rock site, 24 at the Unit 1 site, and 40 at the Crownpoint site (HRI 1996b). The number of wells in the overlying aquifer would provide an adequate population of reference points to conduct contour analysis and determine flow direction, flow velocity, and water quality.

## Mining Activities

**Location of Monitor Wells.** Monitor wells completed in the Westwater Canyon Formation (mine zone) would encircle each well field at a distance of 140 m (400 ft) from the edge of the production or injection wells and 140 m (400 ft) between each monitor well (HRI 1992a; HRI 1993a; HRI 1992b). The angle formed by lines drawn from any production well to the two nearest monitor wells would not be greater than 75 degrees (HRI 1996h). Monitor wells would be located in the first overlying aquifer at a density of one well per 1.6 ha (4 acres) of well field (HRI 1996b). Deep monitor wells below the mining zone are completed within the boundaries of the well field at ISL uranium mining operations. Like production and injection wells, they are drilled through the zone of mining. Therefore, they have to be carefully completed so that they do not become pathways that could create a vertical excursion into the underlying aquifer.

HRI is concerned (HRI 1996a, Comment 63) that the primary risk to the Cow Springs aquifer would be deep drilling through the Recapture Shale, which, if not properly abandoned, could provide a conduit for fluid migration. No monitoring would be conducted in the underlying Cow Springs aquifer (HRI 1996a), which is reported to be a poor producer of water. At each of the three sites, the Cow Springs aquifer is separated from the Westwater Canyon aquifer by the Recapture Shale, which is estimated to be from 63 to 90 m (180 to 260 ft) thick [63 m (180 ft) at Church Rock and 90 m (260 ft) at Unit 1 and Crownpoint]. In view of the concern that the drilling of Cow Springs aquifer monitor wells could create vertical pathways for an excursion, and (1) the poor production rates of the Cow Springs aquifer, (2) limited Cow Springs aquifer groundwater use, (3) the large thickness of the Recapture Shale, and (4) the few boreholes that have penetrated the Recapture Shale within the site boundaries, the NRC staff concludes that the Cow Springs aquifer need not be monitored at any of the three sites.

**Operational Monitoring.** Samples from monitor wells would be collected every 2 weeks. Samples would be obtained either with submersible pumps mounted on a coil tubing unit which can be moved from well to well or with permanent in-place pumps in each well. An individual well would be pumped for at least 15 min until three consecutive samples taken at 5-min intervals had consistent conductivity measurements. Thereafter, a sample would be obtained and preserved for laboratory analysis (HRI 1992d).

**Upper Control Limits.** Upper control limits are intended to provide early warning that mining solutions are moving away from the well fields so that groundwater outside the monitor well ring is not significantly threatened. This is accomplished by choosing parameters that are strong indicators of the ISL mining process and that do not greatly attenuate because of geochemical reactions in the aquifers. If possible, the parameters chosen should be easy to analyze, allowing timely data reporting. The concentration of the chosen indicator parameters should be set high enough that false positives (false alarms due to natural fluctuations in water chemistry) are not a frequent problem, but not so high that significant groundwater quality degradation occurs by the time an excursion is identified.

Chloride is considered a strong indicator parameter for use as an upper control limit parameter because it is directly attributed to the ISL mining process, it is not readily attenuated by geochemical interactions within the aquifer, and it is found at levels significantly higher in the ISL mining leachate than in natural groundwater concentrations. Calcium, sodium, and bicarbonate are also projected to be found at significantly higher levels in ISL mining leachate than in natural groundwater concentrations. The transport of calcium and sodium would be affected by ion exchange reactions between the solution and the sediment (Deutsch 1985). For that reason, bicarbonate is preferable as an excursion indicator. The use of bicarbonate inside the mineralized zone may give false alarms because of induced oxidation around a monitor well (Staub 1986). Also, Deutsch (1985) and Staub (1986) note that there is a similar concern with the use of sulfate as an excursion indicator. However, this should only be a problem if upper control limit values are set too conservatively. Of these two parameters, bicarbonate would be the preferable choice because it is mostly a direct result of the injection of the sodium bicarbonate lixiviant and should reach a high concentration early in the mining of a well field.

Both Staub (1986) and Deutsch (1985) recommend the use of total dissolved solids (TDS) as an excursion indicator, whether the mining site has relatively high TDS groundwater quality, as is often found in Texas, or relatively low TDS groundwater quality, as is found in Wyoming and at the Church Rock, Unit 1, and Crownpoint sites. TDS has advantages as an upper control limit because it would be little affected by ion exchange reactions, it is considerably elevated in concentration by the leach solution, and it is a general indicator of the chemical species elevated in the groundwater by ISL mining. In this case, TDS would be measured as changes in specific conductivity. Conductivity is easily measured in the field and provides a good method to estimate the TDS concentration if, as is the case with ISL uranium mining, large amounts of organic matter are not present (Minear 1982; Clesceri 1990; Greenberg 1992).

In choosing the concentration for an upper control limit parameter, NRC staff guidance states that "*in order to account for the spatial and temporal variations in excursion indicator concentrations, upper control limits should be determined on a statistical basis. One such statistical technique is the student 'T' distribution*" (NRC 1981b). NRC staff guidance also recommends that in some cases a simple percentage increase over baseline values may be used (a 20 percent increase over the established baseline is suggested) (NRC 1981b). NRC staff have decided that it is acceptable to set baseline concentrations based on the mean plus a defined number of standard deviations. In areas of good water quality, NRC has found the mean plus 5 standard deviations to be acceptable. However, in aquifers with good water quality, chloride populations have been found to have such a narrow statistical distribution that the mean plus 5 standard deviations plus a defined concentration has been used.

For the proposed project, HRI would

1. Use chloride, alkalinity, and conductivity [corrected to a temperature of 25°C (77°F), as described in Cleseri (1990)] as upper control limit (UCL) parameters.
2. Set UCL concentrations for chloride, alkalinity, and conductivity for each well field by calculating the baseline mean and adding 5 standard deviations to sampled pre-mining mine area monitor well water quality data. Prior to calculating the baseline, mean outliers would be eliminated using a statistical method as described in the operating plan (HRI 1996b). Outlier elimination is acceptable to the NRC staff as long as it produces a regulatory conservative UCL.

HRI has provided an example of UCL value analysis based on data collected from the Unit 1 site (Mobil Operating Area #1) without removal of outliers. Calculated UCLs were

| | |
|---|---|
| Conductivity | 620 $\mu$mhos/L |
| Chloride | 56 mg/L |
| Bicarbonate | 252 mg/L |

HRI has proposed using uranium as an excursion indicator (HRI 1992d). However, one of the problems with using uranium as an indicator is that while it is mobilized by ISL mining, it is not considered an early indicator that solutions are moving away from the well field and therefore is not considered a suitable parameter for an upper control limit. However, even though HRI no longer plans to monitor uranium as an excursion indicator, HRI would continue to monitor and record values for uranium during biweekly monitor well sampling. This is because monitoring for uranium is required by HRI's New Mexico Environmental Departmental Discharge Plan.

In addition to uranium concentrations, water levels would also be collected every 2 weeks from each monitor well (HRI 1996m). All monitoring data would be retained on site for review by appropriate regulatory agencies (HRI 1996m).

**Excursions and Corrective Actions.** Identification and confirmation of excursions at the proposed project sites would involve the following steps:

1. An excursion would be deemed to have occurred if any two excursion indicators in any monitor well exceeded their respective UCLs or a single excursion indicator exceeded its UCL by 20 percent.
2. A verification sample would be taken within 24 hr after results of the first analyses were received.
3. If the second sample did not indicate that UCLs were exceeded, a third sample would be taken within 48 hr after the second set of sampling data was acquired.
4. If neither the second nor the third sample indicated that UCLs were exceeded, the first sample would be considered in error.
5. If the second or third sample contained indicators above UCLs, an excursion would be confirmed (HRI 1996a).

In the event of an excursion at any of the proposed project sites, the following corrective action programs would be applicable:

1. When excursion status was confirmed, corrective action would be required to return the water quality to the applicable UCL. During corrective action, sample frequency would be increased to weekly for the excursion indicators until the excursion was concluded.
2. An excursion would be deemed to have been corrected when all control parameters were reduced to their UCLs or below (HRI 1996a).

When an excursion was confirmed at any of the proposed project sites, the following procedures would be applicable:

1. In the event a lixiviant excursion were confirmed by groundwater monitoring, NRC would be alerted by telephone within 24 hr and by letter within 7 days from the time the excursion was confirmed.
2. A written report describing the excursion event, corrective actions taken, and the corrective action results would be submitted to NRC within 60 days of the excursion confirmation. If wells were still on excursion when the report was submitted, the report would also contain a schedule for submittal of future reports to the NRC describing the excursion event, corrective actions taken, and results obtained. In the case of a vertical excursion, the report would also contain a projected completion date when characterization of the extent of the vertical excursion would be completed.
3. In the event that an excursion were not corrected within 60 days of confirmation, HRI would terminate injection of lixiviant within the well field until aquifer cleanup was complete, or would provide an increase to the reclamation surety in an amount that was agreeable to NRC and which would cover the full cost of correcting and cleaning up the excursion. The surety increase would remain in force until the excursion was corrected. The written 60-day excursion report would state and justify which course of action would be followed (HRI 1996b; HRI 1996h).

If wells were still on excursion at the time the 60-day report was submitted to NRC and the surety option chosen, well field restoration surety would be adjusted upward. To calculate the increase in surety for horizontal excursions, it would be assumed that the entire thickness of the aquifer between the well field and the monitor wells on excursion had been contaminated with lixiviant. It would also be assumed that the width of the excursion was the distance between the monitor wells on excursion plus one monitor well spacing distance on either side of the excursion. When the excursion was corrected, the additional surety requirements resulting from the excursion would be removed.

To calculate the increase in surety for vertical excursions, an initial estimate of the area contaminated above background would be made. All estimates would assume that the entire thickness of the upper aquifer had been contaminated. As characterization of the extent of contamination proceeded, surety might be increased or decreased as appropriate. Once the extent of contamination had been determined, the area which had been contaminated above background would be the area used to calculate the increased level of surety. When the vertical excursion had been cleaned up, the additional surety requirements resulting from the excursion would be removed.

In calculating the increase in bonding for horizontal and vertical excursions, the same formula used to calculate the number of pore volumes required to restore a well field would be applied to the assumed areas of contamination. This approach is consistent with 10 CFR Part 40, Appendix A, Criteria 9. Increased surety provides assurance that cleanup would be accomplished in the event of licensee default and can be adjusted downward once cleanup is complete. In calculating the area impacted by an excursion and the volume of water required to effect restoration, a conservative estimate is taken to ensure that adequate funds are available to clean up the groundwater should the licensee fail to correct and clean up the excursion.

**Well Casing Integrity Testing.** If wells are not properly completed, lixiviant can flow through casing breaks and into overlying aquifers. Casing breaks can occur if the well is damaged during well construction activities. Casing breaks can also occur if water injection pressures exceed the strength of the well materials.

To inspect for casing leaks after a well had been completed and opened to the aquifer, a packer would be set above the well screen, and each well casing would be filled with water. At the surface, the well would then be pressurized up with either air or water to 862 kPa (125 psi) at the land surface, or 25 percent above the expected operating pressure, whichever is greater (HRI 1996a). A well would be considered to have passed the test if a pressure drop of less than 10 percent occurred over 1 hr (HRI 1992a; HRI 1992d; HRI 1992b). Operating pressure would vary with the depth of the well and would be less than formation fracture pressure. Ultimately, the pressure test performed after well completion determines the acceptability of placing the well in service.

Steel casing is much stronger than fiberglass casing, which in turn is much stronger than plastic (PVC) casing. Plastic casing would not be used at the Unit 1 or Crownpoint sites (HRI 1996a; HRI 1996b). Instead, HRI proposes to use one or more of the following casing techniques:

1. Single string of steel casing through the completion interval to be perforated.
2. Single string of fiberglass casing through the completion interval to be underreamed or perforated.
3. Dual size casing of either fiberglass or steel to accommodate large submersible pumps to pumping depth and smaller diameter casing through the completion interval (to be underreamed or perforated).
4. Dual size steel casing (as above), except that a crossover is to be made to fiberglass through the completion interval to facilitate underreaming.
5. Single string (or dual size as above) set to the top of completion interval. Below the casing, the hole would be drilled out (underreaming is optional) and screen set below the casing across the completion zone. A packer would be set inside the casing at the top of the screen. Gravel pack sand outside the screen would be optional (HRI 1996b).

Calculations by HRI and NRC staff were done to determine if the fiberglass casing could burst or collapse under well field operating pressures anticipated to occur at the Church Rock and Crownpoint sites (HRI 1996a; NRC 1996). Using projected maximum injection pressures, NRC staff calculated the following burst safety factors for fiberglass casing at the Crownpoint and Church Rock sites:

| | |
|---|---|
| Well head injection pressure | 2075 kPa (301 psi) |
| Depth to top of screen | 549 m (1800 ft) |
| Pressure at screen from full casing of water | 5371 kPa (779 psi) (9.8 kPa/m or 0.433 psi/ft) |
| Total pressure at top of screen | 7447 kPa (1,080 psi) |
| Burst pressure 4-inch fiberglass casing | 17,238 kPa (2,500 psi) |
| Safety factor | 131 percent |
| Burst pressure cement contribution | 9791 kPa (1420 psi) |
| Burst pressure with cement | 27,028 kPa (3920 psi) |
| Safety factor with cement | 262 percent |

This calculated safety factor (131 percent) should represent worst-case conditions because it was calculated using the deepest holes, the weakest fiberglass casing, projected maximum operating conditions; and it did not include the contribution by cement, which could raise the burst pressure by an additional 19,582 kPa to 23,098 kPa (2840 psi to 3350 psi). Using one half of the minimum cement strength of 19,582 kPa (2840 psi) in the calculation produces a safety factor of 262 percent.

NRC staff calculated collapse safety factors for fiberglass casing at the Crownpoint and Church Rock sites:

| | |
|---|---|
| Depth to static water level | 122 m (400 ft) |
| Depth to top of screen | 549 m (1800 ft) |
| Pressure outside an empty casing | 4178 kPa (606 psi) (9.8 kPa/m or 0.433 psi/ft) |
| Collapse pressure 4-in fiber glass casing | 2758 kPa (400 psi) |
| Safety factor | -51.5 percent |
| Collapse pressure with cement | 12,549kPa (1820 psi) |
| Safety factor with cement | 200 percent |

This calculated safety factor should represent worst-case conditions because it was calculated for the deepest holes, used the weakest fiberglass casing, placed the pump at the greatest depth (totally dewatering the casing), and did not include the contribution of cement, which could raise the burst pressure by an additional 19,582 kPa to 23,098 kPa (2840 psi to 3350 psi). As a result, the calculation shows that under these conditions, the casing would collapse. However, using one half of the minimum cement strength of 19,582 kPa (2840 psi) in the calculation produces a safety factor of 200 percent. Thus, there is little likelihood that fiberglass (and, therefore, steel) casing would burst or collapse under the well field operating pressures anticipated at the Church Rock, Unit 1, and Crownpoint sites.

**Well Field Injection Pressures.** The actual maximum injection pressures to be used in each of the mine areas would be determined when the operating wells were completed. The approximate values of allowable surface (well head) pressures for each area are 2075 kPa (301 psi) at the Crownpoint and Unit 1 sites and 807 kPa (117 psi) at the Church Rock site (HRI 1996a). HRI proposes that at the Crownpoint and Unit 1 sites maximum operating pressure would not exceed 2069 kPa (300 psi) (HRI 1996a). In calculating the maximum operating pressures, HRI based its decision on projected rupture pressures for the aquifer (i.e. the creation of vertical fractures). In calculating the rupture pressure, a conservative fracture gradient of 9.3 kPa/m (0.60 psi/ft) was used, as opposed to an expected fracture gradient of 14.4 to 16 kPa/m (0.64 to 0.70 psi/ft) (HRI 1996a). NRC staff calculated that this would result in land surface operating pressures at the Unit 1 and Crownpoint sites of 496 to 1234 kPa (72 psi to 179 psi) beneath expected rupture pressures, and at the Church Rock site of from 193 to 483 kPa (28 psi to 70 psi) beneath expected rupture pressures. This demonstrates that for fiberglass and steel casing, maximum injection pressures would be well below the burst pressures for the casing (HRI 1996a).

Plastic (PVC) casing would only be used at the Church Rock site (HRI 1996a). Using information submitted by HRI (HRI 1996a; HRI 1993a), NRC staff calculate the following numbers for the Church Rock site (NRC 1996):

| PVC casing diameters (inches) | Burst strength kPa (psi) | Deferential pressure[a] kPa (psi) |
|---|---|---|
| Four | 1207 (175) | 2896 (420) |
| Five | 1724 (250) | 2896 (420) |
| Six | 1724 (250) | 2896 (420) |

[a]Based on 214 m (700 ft) depth and 807 kPa (117 psi) maximum injection pressure.

This means that the maximum surface injection pressures at the Church Rock site would exceed the burst strength of the PVC casing. However, this equation does not take into account the strength of the cement sheath outside the casing. The cement would protect the casing by providing additional burst and collapse pressure resistance. HRI reports a compressive cement strength of 19,581 kPa and 23,098 kPa (2840 psi and 3350 psi) contributed by the cement. This additional burst and collapse pressure resistance would mean that at the Church Rock site, maximum projected injection pressure would not exceed the combined cemented casing burst and collapse pressure of wells using PVC casing. However, it does mean that maximum injection pressures could easily exceed a poorly cemented PVC-cased well. The BLM would require that wells be completed to meet the specific requirements described in Section 4.3.2.

**Well Field Operational Flow and Pressure Monitoring.** Flow rates on each injection and recovery well and injection manifold pressures on the entire system would be measured and recorded daily (HRI 1996b). During well field operations, injection pressures would not exceed the integrity test pressure at the well heads (injection pressure can be monitored for all wells with one measurement at the injection manifold) (HRI 1996b). No injection well would experience pressure significantly greater than that exhibited at the manifold.

**Retention Pond Leak Detection Monitoring.** HRI proposes to provide leak detection monitoring for all retention ponds. Because small amounts of condensation can accumulate in leak detection sumps, if water levels greater than 6 in. were detected, chemical assays for specific conductance and chloride would be used to confirm the source of the water. Elevated levels of these constituents would confirm a liner leak and would be reported to the NRC within 48 hr. Corrective actions would commence upon leak confirmation and would consist of transferring the solution to another pond so liner repairs could be made. All assay results would be reported in writing as soon as they were available.

To monitor for pond leaks, HRI would

1. Perform and document pond freeboard and checks of the leak detection system daily, including weekends and holidays (HRI 1996a).
2. Propose the level or volume of fluid that, when exceeded in the leak detection system standpipes, would be analyzed for selected chemical constituents.
3. Propose action levels for the selected chemical constituents which, when they were exceeded, would confirm that the pond is leaking. The selected chemical constituents should be easy to analyze and should be reflective of the ISL mining process. HRI would propose at least one additive parameter and at least one mobile ionic species. Likely additive parameters which reflect ISL solutions are alkalinity or specific conductance, while appropriate ionic species would include chloride, sodium, and sulfate (HRI 1996b).

In the event that evaporation pond standpipe water analyses indicate that a pond is leaking:

1. The NRC would be notified by telephone within 48 hr of verification.
2. Standpipe water quality samples would be analyzed for leak parameters once every 7 days during the leak period and once every 7 days for at least 14 days following repairs.
3. A written report would be filed with the NRC within 30 days of first notifying the NRC that a leak existed. This report would include analytical data and describe the mitigative action and the results of that action (HRI 1996b).

HRI would maintain a log of all significant solution spills (HRI 1996b). The NRC would be notified by telephone within 48 hr of any failure that might have a radiological impact on the environment. The notification would be followed, within 7 days, by submittal of a written report detailing the conditions leading to the failure or potential failure, corrective actions taken, and results achieved. This would be done in addition to the requirements of 10 CFR Part 20.

### Post-Mining Activities

**Groundwater Consumption.** Consumed water is the volume of water that is not returned to the aquifer. During mining, well field production bleed is estimated to be 152 Lpm (40 gpm). However, the amount of water consumed as a result of production bleed would also vary with the aquifer restoration method used, since it would be handled just like the water produced by restoration activities. Most groundwater consumption would occur during groundwater restoration.

**Groundwater Restoration.** At least 90 days prior to the termination of uranium recovery in a mining unit, HRI would submit to the NRC in the form of a license amendment a plan for groundwater restoration and post-restoration monitoring (HRI 1996b). HRI proposes to use three groundwater restoration alternatives at each project site: (1) 100 percent groundwater sweep (groundwater is pumped from the aquifer, but not returned to the aquifer), (2) reverse osmosis treatment with 3 parts product and 1 part reject, and (3) brine concentration and reverse osmosis reject with 99 parts product and 1 part reject. Under the 100 percent groundwater sweep option, wastewater would be disposed of by land application or surface water discharge. Under the reverse osmosis option, wastewater would be injected back into the well field, into an off-site well, or both. HRI would have to acquire an injection permit from the appropriate State or Federal agency before wastewater could be reinjected into aquifers outside the well field and mine zone. If surface water discharge were the chosen option, appropriate State or Federal permits would have to be obtained.

HRI proposes that groundwater restoration criteria be established on a parameter-by-parameter basis, with the primary goal of restoration to return all parameters to average pre-mining baseline conditions (HRI 1996g, HRI 1996k). In the event that water quality parameters cannot be returned to average pre-mining baseline levels, the secondary goal would be to return water quality to the maximum concentration limits as specified in EPA secondary and primary drinking water regulations (40 CFR Part 141 and § 143.3). The secondary restoration goal for barium and fluoride would be set to the State of New Mexico primary drinking water standard, which is lower than federal standards. A value of 300 pCi/mL (0.44 mg/L) would be used for uranium. This concentration was obtained from 10 CFR Part 20; it is suitable for unrestricted release of natural uranium to water and is below the State of New Mexico primary drinking water standard for uranium.

Under the conditions discussed above, HRI's secondary restoration goal would be equal to or below both State of New Mexico and EPA primary and secondary drinking water standards. Table 4.6 lists the primary and secondary restoration goals.

These restoration goals are consistent with the NRC Staff Technical Position Paper *Groundwater Monitoring at Uranium In Situ Solution Mines* (NRC 1981b). This document states that

> The following are recommended restoration targets.
>
> a. Restoration results in a return to baseline ground-water quality for all indicators in all affected groundwaters and in all restoration water quality monitor wells.
> b. Where the baseline concentration of a particular indicator is less than drinking water standards, the appropriate established State and Federal criteria may be used to establish maximum permissible values for restoration purposes (NRC 1981b).

HRI has stated that, consistent with relevant statutory and regulatory provisions and the provisions of other NRC ISL licenses, if it found that it were impracticable to restore to primary or secondary goals, it might request a license amendment that would allow some change in restoration requirements on a parameter-by-parameter basis (HRI 1996g).

If a groundwater parameter could not be restored to its secondary goal, HRI would have to make a demonstration to NRC that leaving the parameter at the higher concentration would not be a threat to public health and safety and that, on a parameter by parameter basis, water use would not be significantly degraded. This situation might possibly arise with respect to the TDS parameter at the proposed project. TDS is a measure of the total sum of all dissolved constituents, but it is most affected by the major constituents (sulfate, chloride, calcium, bicarbonate, carbonate, fluoride, sodium, and potassium). However, not all the major constituents have a secondary or primary drinking water

**Table 4.6. Primary and secondary restoration goals**

| Parameter | Primary goal (mg/L) | Secondary goal (mg/L)[a] |
|---|---|---|
| Alkalinity | Well field average | Well field average |
| Ammonium (as nitrate) | Well field average | 10.0 |
| Arsenic | Well field average | 0.05 |
| Barium | Well field average | 1.0[b] |
| Bicarbonate | Well field average | Well field average |
| Boron | Well field average | Well field average |
| Cadmium | Well field average | 0.01 |
| Calcium | Well field average | Well field average |
| Carbonate | Well field average | Well field average |
| Chloride | Well field average | 250.0 |
| Chromium | Well field average | 0.05 |
| Copper | Well field average | 1.0 |
| Fluoride | Well field average | 2.0[b] |
| Iron | Well field average | 0.3 |
| Lead | Well field average | 0.05 |
| Magnesium | Well field average | Well field average |
| Manganese | Well field average | 0.05 |
| Mercury | Well field average | 0.002 |
| Molybdenum | Well field average | Well field average |
| Nickel | Well field average | 0.1 |
| Nitrate | Well field average | 10.0 |
| Potassium | Well field average | Well field average |
| pH[a] | Well field average | 6.5–8.5 |
| Radium-226[c] | Well field average | 5.0 |
| Selenium | Well field average | 0.05 |
| Silver | Well field average | Well field average |
| Sodium | Well field average | Well field average |
| Sulfate | Well field average | 250.0 |
| Total dissolved solids | Well field average | 500.0 |
| Uranium | Well field average | 0.44[d] |
| Vanadium | Well field average | Well field average |
| Zinc | Well field average | 5.0 |

[a]Numeric values are 40 CFR Part 141 or § 143.3 unless otherwise noted.
[b]State of New Mexico Standards.
[c]pCi/L.
[d]10 CFR Part 20, Appendix B, Table 2.

standard (for example bicarbonate, carbonate, calcium, magnesium, potassium). Consequently, it is possible that after groundwater restoration, the TDS secondary goal might be achieved, but the secondary goal for individual major ions that contribute to TDS might not be achieved. If such a situation occurred, HRI would have to make a demonstration to NRC that leaving a parameter at higher than secondary goal concentrations would not be a threat to public health and safety and that water use would not be significantly degraded. For groundwater with TDS concentrations less than the secondary goal, NRC staff have assumed that worst-case groundwater restoration would return water quality to the secondary goal, even though it cannot be achieved without leaving some of the major parameters at higher than background concentrations (i.e., between primary and secondary goal concentrations).

If groundwater restoration is successful, ISL uranium mining is not expected to affect the color of the groundwater. Dissolved organic matter is a common cause of discoloration in groundwater. A few uranium ISL mines have been known to cause discoloration in groundwater (Ford 1996a). In these instances, organic matter was dissolved in the groundwater by the oxidizing conditions created in the aquifer and/or induced microbiological activity. However, the dissolved organic matter caused fouling problems with the resin used to extract the uranium from solution. As a result, ISL uranium mining usually takes place only in aquifers with little organic matter. Conversations with HRI staff in a public meeting on June 19, 1996, and with representatives of the Wyoming mining industry (Ford 1996c) and State of Wyoming mine regulators (Ford 1996b) confirm that groundwater color is rarely changed by ISL uranium mining.

HRI states that restoration to average baseline or State of New Mexico drinking water standards is possible in 4 pore volumes or less. Table 4.7 contains a comparison of applicable State of New Mexico and EPA drinking water standards. A pore volume is an indirect measure of the volume of water that must be pumped or processed to restore the groundwater. It represents the water that fills the void space inside a certain volume of rock or sediment. Restoration costs are closely linked to the amount of water that must be processed to effect restoration. The pore volume parameter is used to represent how many times the contaminated volume of water in the rock must be displaced or processed to restore groundwater quality. It provides a means of comparing the level of effort required to restore groundwater regardless of the scale of the test. In general, the more pore volumes of water it takes to restore groundwater quality, the more money it will cost to achieve restoration. In evaluating the number of pore volumes required to effect groundwater restoration, the NRC staff referenced data submitted by the applicant including HRI 1992b, HRI 1993a, HRI 1993b, and HRI 1993d.

The success of a groundwater restoration demonstration is determined by (1) success in returning the pre-mining water quality to acceptable conditions, (2) the stability of post-restoration water quality (i.e., did the water quality stay restored?), and (3) the amount of effort required to do the restoration. With the exception of a few core scale demonstrations, HRI has relied on demonstrations that were conducted at other project locations.

In conducting the review for this FEIS, NRC staff have significant concerns about using a small number of small-scale core tests to represent site-scale groundwater restoration demonstration. In

**Table 4.7. Comparison of State of New Mexico and U.S. Environmental Protection Agency/Navajo Nation Environmental Protection Agency (EPA/NNEPA) water quality standards**

| Parameter | New Mexico standards (mg/L) | EPA/NNEPA standards (mg/L) |
|---|---|---|
| **Parameters with primary standards** | | |
| Arsenic | 0.1 | 0.05 |
| Barium | 1.0 | 2.0 |
| Cadmium | 0.01 | 0.01 |
| Chromium | 0.05 | 0.05 |
| Fluoride | 1.6 | 4.0 |
| Lead | 0.05 | 0.05 |
| Mercury | 0.002 | 0.002 |
| Nickel | — | 0.1 |
| Nitrate | 10.0 | 10.0 |
| Radium-226[a] | 30.0 | 5.0 |
| Selenium | 0.05 | 0.05 |
| Uranium | 5.0 | — |
| **Parameters with secondary standards** | | |
| Sulfate | 600.0 | 250.0 |
| Chloride | 250.0 | 250.0 |
| Copper | 1.0 | 1.0 |
| Iron | 1.0 | 0.3 |
| Manganese | 0.2 | 0.05 |
| Total dissolved solids | 1,000.0 | 500.0 |
| pH[b] | 6–9 | 6.5–8.5 |
| **Parameters with irrigation standards** | | |
| Boron | 0.75 | — |
| Molybdenum | 1.0 | — |

[a]pCi/L.
[b]Units.

HRI's case, 2.4 m (7 ft) of core are being used to demonstrate the restoration potential of approximately 70 m (200 ft) of aquifer over an area of about 7.8 $km^2$ (3 $miles^2$), with one site located about 52 km (20 miles) away. Although this does not provide representative demonstration NRC staff also recognize that core restoration tests can provide useful insight into which water quality parameters are expected to be mobilized and which parameters may be problems for restoration.

Three rock core restoration studies were conducted on rock samples from the ore zone in the proposed mining areas. These were the Church Rock slow leach study, the Church Rock fast leach study, and the Crownpoint study. The samples were collected as cores from exploratory bore holes penetrating the Westwater Canyon sandstone. Groundwater from the ore zones was used to render laboratory conditions as representative as possible. The water samples were fortified in the laboratory with sodium bicarbonate and hydrogen peroxide to simulate ISL mining lixiviant. Samples were prepared by crushing the rock and then compacting the material into leaching columns. During the leaching phase, lixiviant was circulated through the material, simulating lixiviant recirculation in a mine unit. One of the tests of the Church Rock core was run at a rapid flow rate, while the other was run slowly to more closely imitate large-scale well field processing. Restoration was simulated by flushing the ore with baseline water, diluted 20 percent with distilled water, to simulate water treated by reverse osmosis.

"Before" and "after" water quality data from the Church Rock core restoration #1 (slow leach) study are shown in Table 4.8, which shows the restored values after 20 pore volumes are circulated through the core. As explained above, Church Rock core restoration study #2 (fast leach) was run at faster flow velocities than would normally be expected in the field. Water quality data from this test are also reported in Table 4.8, which shows the restored values after 16 pore volumes were circulated through the core. Tables 4.9 and 4.10 show the number of pore volumes required for these tests to reach baseline or relevant federal standards.

Water quality data from the Crownpoint core restoration study are reported in Tables 4.9, 4.10, and 4.11, which show the restored values after 28 pore volumes were circulated through the core.

In addition to the core leach studies, HRI submitted a single-well pilot solution mine test, conducted in the Westwater Canyon aquifer near the Church Rock site in June 1980 by United Nuclear Corporation and Teton Exploration Company. Groundwater samples were collected before, during, and after the test to provide baseline water quality data, to monitor uranium recovery, and to evaluate aquifer restoration. Data from this test are reported in Tables 4.9, 4.10, and 4.12, which show the restored values after 3 pore volumes had been pumped from the aquifer. The Teton test was a larger-scale test than HRI's core restoration studies. However, the test may not represent restoration of a full-scale well field because (1) considerable dilution from uncontaminated groundwater occurs during the clean-up phase; (2) one pore volume (at most) was leached, which is much less than in a commercial operation; (3) there was a relatively short contact time between the rock and lixiviant (5 days); and (4) fresh lixiviant was not continuously injected into the formation as would occur in an operating ISL mine.

**Table 4.8. Results from two core leach tests conducted with ore samples from the Church Rock site**

| | Slow leach test | | | Fast leach test | |
|---|---|---|---|---|---|
| | Leach water | Pregnant lixiviant | Restored[a] | Pregnant lixiviant | Restored[b] |
| Ammonia | 0.11 | 0.14 | 0.06 | 0.12 | 0.15 |
| Bicarbonate | 244 | 612 | 199 | 573 | 240 |
| Calcium | 4.9 | 28 | 3.7 | 14 | 3.9 |
| Chloride | 4 | 505 | 3.5 | 232 | 4.4 |
| Fluoride | 0.30 | 0.55 | 0.19 | 0.47 | 0.29 |
| Iron | 0.02 | 0.01 | 10.00 | 0.01 | 0.02 |
| Nitrate | 0.34 | 0.14 | 0.08 | 0.06 | 0.12 |
| Sodium | 98 | 515 | 110 | 341 | 93 |
| Sulfate | 18 | 8 | 87 | 4 | 18 |
| TDS | 289 | 1520 | 427 | 970 | 283 |
| Arsenic | 0.003 | 0.295 | 0.025 | 0.084 | 0.055 |
| Barium | 0.08 | 0.51 | 0.25 | 0.59 | 0.19 |
| Boron | 0.08 | 0.16 | 0.12 | 0.14 | 0.09 |
| Cadmium | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Chromium | <0.01 | <0.01 | <0.01 | 0.03 | 0.01 |
| Copper | 0.03 | <0.01 | 0.001 | <0.01 | <0.01 |
| Lead | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Manganese | <0.01 | <0.01 | 0.10 | <0.01 | <0.01 |
| Mercury | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Molybdenum | <0.02 | 0.02 | 0.01 | <0.01 | <0.01 |
| Nickel | <0.01 | 0.01 | <0.01 | <0.01 | <0.01 |
| Selenium | <0.001 | 0.001 | 0.001 | <0.001 | <0.001 |
| Silver | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Zinc | 0.03 | <0.01 | 0.02 | <0.01 | <0.01 |
| Radium (pCi/L) | 1.0 | 1010.0 | 1000.0 | 665.0 | 231.0 |
| Uranium | 0.04 | 19.20 | 5.08 | 40.90 | 10.60 |

*Source*: HRI 1988; HRI 1993a.
[a]Water quality after 20 pore volumes.
[b]Water quality after 16 pore volumes.

**Table 4.9. Pore volumes to achieve baseline values by restoration studies[a]**

| Parameter | Mobil Section 9 pilot (pilot plant) | Teton test (single hole) | Church Rock: Core slow leach (laboratory) | Church Rock: Core fast leach (laboratory) | Crownpoint core laboratory |
|---|---|---|---|---|---|
| Arsenic | >16.7 | <3 | >20 | >16 | >28 |
| Barium | >16.7 | <3 | | | |
| Bicarbonate | 9.7 | >3 | >20 | 12 | 17 |
| Boron | | >3 | >20 | >16 | >28 |
| Cadmium | 6 | <3 | | | |
| Calcium | >16.7 | >3 | 3.5 | 3 | 5 |
| Chloride | >16.7 | <3 | 13.3 | >16 | >28 |
| Chromium | 12 | <3 | | | |
| Conductivity | | >3 | 14.0 | 9 | 15 |
| Copper | 1.8 | <3 | | | |
| Fluoride | <1 | <3 | | | |
| Iron | <1 | <3 | >20 | | |
| Lead | <1 | <3 | | | |
| Magnesium | 16 | <3 | | | |
| Manganese | 16 | <3 | >20 | | |
| Mercury | >16.7 | <3 | | | |
| Molybdenum | >16.7 | <3 | | | >28 |
| Nickel | 1.8 | <3 | | | |
| Nitrate | <1 | >3 | | | <3 |
| Potassium | | <3 | | | |
| Radium-226 | >16.7 | >3 | >20 | >16 | >28 |
| Selenium | 5 | >3 | | | |
| Sodium | >16.7 | >3 | >20 | | |
| Sulfate | >16.7 | <3 | >20 | 9 | 4 |
| Total | >16.7 | <3 | >20 | | |
| Uranium | >16.7 | >3 | >20 | >16 | >28 |
| Vanadium | | <3 | | | |
| Zinc | 7 | <3 | | | |

[a]Pore volumes only reported for measured data.

**Table 4.10. Pore volumes to achieve relevant Federal standards by restoration studies [a,b]**

| Parameter | Mobil Section 9 pilot (pilot plant) | Teton test (single hole) | Church Rock: Core slow leach (laboratory) | Church Rock: Core fast leach (laboratory) | Crownpoint core (laboratory) |
|---|---|---|---|---|---|
| Arsenic | >16.7 | <3 | | >16 | |
| Barium | <1 | <3 | | | |
| Cadmium | <1 | <3 | | | |
| Chloride | 3.9 | <3 | 2.09 | <1 | <1 |
| Chromium | <1 | <3 | | | |
| Copper | <1 | <3 | | | |
| Fluoride | <1 | <3 | | | |
| Iron | <1 | <3 | | | |
| Lead | <1 | <3 | | | |
| Manganese | 9.7 | <3 | >20 | | |
| Mercury | <1 | <3 | | | |
| Nickel | <1 | <3 | | | |
| Nitrate | <1 | <3 | | | <3 |
| Radium-226 | >16.7 | >3 | >20 | >16 | >28 |
| Selenium | 5 | >3 | | | |
| Sulfate | 9.7 | <3 | <1 | <1 | <1 |
| TDS | 9.7 | <3 | 2.8 | | |
| Uranium | 12 | >3 | >20 | >16 | >28 |
| Zinc | <1 | <3 | | | |

[a]Pore volumes only reported for measured data.
[b]Compliance with EPA primary and secondary drinking water standards and the NRC standard of 0.44 mg/L uranium.

**Table 4.11. Results from the core leach test conducted with ore from the Crownpoint site**

| | Leach water | Pregnant lixiviant | Restored[a] |
|---|---|---|---|
| Ammonia | <0.01 | 0.29 | 0.03 |
| Bicarbonate | 233 | 1543 | 229 |
| Calcium | 1.4 | 9.6 | 2.4 |
| Chloride | 2.8 | 123 | 2.6 |
| Fluoride | 0.40 | 0.45 | 0.29 |
| Iron | 0.50 | 0.01 | 0.01 |
| Nitrate | 0.06 | 0.97 | <0.01 |
| Sodium | 114 | 739 | 102 |
| Sulfate | 44 | 71 | 24 |
| TDS | 339 | 1950 | 293 |
| Arsenic | <0.001 | 0.077 | 0.003 |
| Barium | 0.04 | 0.18 | 0.06 |
| Boron | 0.07 | 0.08 | 0.05 |
| Cadmium | <0.0001 | <0.0001 | <0.0001 |
| Chromium | <0.01 | 0.01 | <0.01 |
| Copper | <0.01 | <0.01 | <0.01 |
| Lead | <0.001 | 0.01 | <0.001 |
| Manganese | <0.01 | <0.01 | <.01 |
| Mercury | <0.0001 | <0.0001 | <0.0001 |
| Molybdenum | <0.01 | 0.02 | <0.01 |
| Nickel | <0.01 | <0.01 | <0.01 |
| Selenium | 0.001 | 0.078 | 0.010 |
| Silver | <0.01 | <0.01 | <0.01 |
| Zinc | 0.02 | <0.01 | <0.01 |
| Radium (pCi/L) | 0.9 | 433.0 | 57.0 |
| Uranium | 0.05 | 7.28 | 0.72 |

*Source*: HRI 1992b.
[a]Water quality after 28 pore volumes.

**Table 4.12. Teton single-hole pilot study**

| Parameter | Baseline (mg/L) | Restored[a] (mg/L) |
|---|---|---|
| Arsenic | 0.017 | 0.032 |
| Barium | 0.16 | 0.07 |
| Bicarbonate | 277.0 | 313.0 |
| Boron | 0.04 | 0.12 |
| Cadmium | <0.01 | <0.01 |
| Calcium | 0.6 | 1.1 |
| Carbonate | 41.0 | 56.0 |
| Chloride | 27.0 | 6.0 |
| Chromium | <0.05 | <0.05 |
| Copper | <0.05 | <0.05 |
| Fluoride | 0.35 | 0.30 |
| Iron | 10.9 | 0.67 |
| Lead | <0.05 | <0.05 |
| Magnesium | 0.0 | 0.0 |
| Manganese | 0.08 | <0.05 |
| Mercury | <0.001 | <0.001 |
| Molybdenum | <0.05 | <0.05 |
| Nickel | <0.05 | <0.05 |
| Nitrate | 0.74 | 1.34 |
| Potassium | 2.5 | 2.2 |
| Radium-226[b] | 3.9 | 8.5 |
| Selenium | <0.005 | 0.72 |
| Sodium | 134.0 | 148.0 |
| Sulfate | 37.0 | 37.0 |
| TDS | 442.0 | 426.0 |
| Uranium | 0.12 | 2.7 |
| Vanadium | <0.05 | 0.1 |
| Zinc | 0.06 | 0.01 |

[a]Water quality after 3 pore volumes.
[b]pCi/L

HRI also submitted data from another pilot project conducted by Mobil Oil Company in 1979 and 1980 in conjunction with the Tennessee Valley Authority in Section 9, T17N R12W. The test, known as the Section 9 pilot project, was conducted approximately 1.5 km (1 mile) north of the Unit 1 site. Mobil used four five-spot injection well patterns to conduct the test, injecting and recirculating lixiviant for 11 months. The test only removed approximately 15 percent of the ore's uranium content. Therefore, uranium was still highly concentrated in the groundwater when restoration was begun. Additionally, chloride levels became highly elevated in the groundwater (Table 4.13).

Data from the Mobil Section 9 pilot are reported in Tables 4.9, 4.10, and 4.13 which show restored water quality values after 16.7 pore volumes had been pumped from the aquifer. The Mobil Section 9 pilot had difficulties in restoring molybdenum concentrations. However, HRI states that its core results indicate that molybdenum would not be present in the Unit 1 or Crownpoint sites (HRI 1996a). The assertion that molybdenum concentrations are low in the Unit 1 or Crownpoint sites is supported by independent U.S. Geological Survey data (Leventhal 1990).

After 16.7 pore volumes in the Mobil Section 9 pilot, radium had not been restored to the EPA drinking water quality standard of 5 pCi/L. HRI anticipates that the restored value for radium at the Church Rock, Crownpoint, and Unit 1 sites would be baseline values (HRI 1996a). This is because HRI believes that average pre-mining well field radium concentrations would exceed the U.S. EPA and State of New Mexico drinking water standard for radium (HRI 1996a).

HRI's beliefs are supported by radium concentration values gathered from sampling groundwater in the Westwater Canyon aquifer at the Unit 1 and Crownpoint sites. For the Unit 1 site, a maximum radium-226 value of 200 pCi/L and an average value of 10.3 pCi/L is reported (HRI 1996b). Both of these values exceed the EPA maximum concentration limit for radium (HRI 1993b). At the Crownpoint site, a minimum radium concentration of 0.1 pCi/L and a maximum value of 806 pCi/L is reported. Using data from Crownpoint site wells CP-2, CP-3, CP-5, CP-6, CP-7, and CP-8, an average value of 65 pCi/L is calculated (HRI 1992b). This exceeds the U.S. EPA and State of New Mexico drinking water standards.

HRI has provided restoration demonstration data for Wyoming and New Mexico from its Texas production-scale facilities (HRI 1996a). The NRC regulates ISL mining in Wyoming and New Mexico. Previously, the NRC has approved the restoration of several test patterns used to explore the feasibility of ISL mining or demonstrate the feasibility of production-scale restoration. However, NRC has not yet approved the successful restoration of a production-scale well field at any of its licensed sites.

The State of Texas has approved groundwater restoration of production-scale ISL facilities. However, NRC staff observe that the Texas restoration demonstrations were conducted in groundwater of lower water quality than that on the New Mexico properties. TDS in the Texas properties ranged from 880 ppm to 2170 ppm and averaged 1652 ppm. This means that restoration of the Texas sites was not restored to the same level of water use as anticipated at the Church Rock, Crownpoint, and Unit 1 sites in the Westwater Canyon aquifer. Therefore, NRC staff does not consider the Texas data as representative for demonstrating restoration at the New Mexico sites.

**Table 4.13. Concentration of selected chemical constituents in groundwater at the Mobil Pilot Project[a]**

| | Baseline | Pregnant lixiviant | Restored[b] | Restoration standard |
|---|---|---|---|---|
| Ammonia | 0.47 | | | |
| Bicarbonate | 228 | 1005 | 225 | |
| Calcium | 5.8 | 320 | 46 | |
| Chloride | 20.3 | 1800 | 54.5 | 250 |
| Fluoride | 0.39 | 0.3 | <0.5 | 1.6 |
| Iron | 0.67 | 0.02 | 0.146 | 5.5 |
| Nitrate | 0.09 | 0.17 | 0.556 | 10.0 |
| Sodium | 114 | 1600 | 141 | |
| Sulfate | 38 | 1176 | 47.6 | 600 |
| TDS | 357 | 5500 | 356 | 1000 |
| Aluminum | 0.02 | | 0.808 | 5.0 |
| Arsenic | 0.004 | 0.054 | 0.14 | 0.1 |
| Barium | 0.1 | 0.1 | 0.277 | 1.0 |
| Boron | 0.1 | 0.2 | 0.238 | 0.75 |
| Cadmium | 0.006 | 0.01 | 0.006 | 0.036 |
| Chromium | 0.007 | 0.02 | 0.005 | 0.074 |
| Cobalt | <0.05 | | 0.021 | 0.05 |
| Cyanide | 0.088 | | <0.005 | 0.780 |
| Copper | 0.010 | 0.04 | 0.008 | 1.0 |
| Lead | 0.003 | 0.005 | 0.016 | 0.063 |
| Manganese | 0.050 | 5.85 | 0.035 | 0.456 |
| Mercury | 0.00024 | 0 | 0.0003 | 0.002 |
| Molybdenum | 0.172 | 62 | 1.118 | 1.0 |
| Nickel | 0.02 | 0.09 | 0.022 | 0.2 |
| Selenium | 0.01 | 4.6 | 0.006 | 0.05 |
| Silver | <0.01 | | <0.005 | 0.05 |
| Zinc | 0.01 | 0.39 | 0.039 | 10.0 |
| Radium (pCi/L) | <14.1 | 150 | 59.9 | 97.2 |
| Uranium | 0.010 | 145 | 0.319 | 5.0 |

[a]Concentrations in mg/L unless noted. Data from Mobil (1980b), Mobil Mining and Minerals Company (1986), and Mobil Alternative Energy Inc. (1986).
[b]Water quality after 16.7 pore volumes.

A study sponsored by the NRC (Deutsch 1983) was conducted to investigate the ability of natural geochemical processes to restore water quality after ISL mining activities in an aquifer. Tests were conducted to simulate lixiviant migrating down-gradient from a mined area into the area of an aquifer where reducing conditions occur naturally. The study indicated that major ion concentrations elevated during ISL mining, such as sodium, chloride, and sulfate, are affected very little when the lixiviant migrates into the undisturbed reduced zone. As a result, concentrations tend to remain at the level to which the water was restored for some distance from the area of former mining. Conversely, redox-(oxidation/reduction) sensitive ions such as uranium, arsenic, selenium, and molybdenum precipitate from solution if the restored water moves into a reducing zone. Therefore, after restoration activities, if groundwater moves into a reducing area, concentrations of these ions should rapidly decrease in the groundwater.

This study also indicated that water quality in aquifers containing uranium deposits may be highly variable. Consequently, the NRC staff considers that groundwater restoration criteria for specific mining projects should be set taking into account site-specific conditions and spatial variation. Restoration criteria should be based on a statistical analysis of groundwater chemistry data from a large set of wells sampled over a period of time.

In order to address concerns with the lack of a site-specific representative groundwater restoration demonstration, HRI proposes to complete a concurrent restoration demonstration at each of the three proposed project sites within 18 months of the date on which mining commences (HRI 1996b). The demonstration would include

1. An isolated restoration demonstration pattern, completed in a mine unit, constructed to the same basic configuration as the proposed production well field pattern, and operated under the same conditions as the proposed mining procedures.
2. Leaching of the pattern would be run for at least 3 months under commercial activity conditions using leaching agency concentrations equal to or greater than those expected to be required for production.
3. After the leaching phase, a complete chemical description of the produced fluid would be obtained and a demonstration of a restoration would be initiated.
4. Sample analysis of fluids would be completed at least every week during the restoration demonstration to allow observation of the concentration of various restoration parameters. Progress reports would be submitted to NRC every 6 months after the demonstration was initiated.
5. Restoration would continue until the groundwater was restored to levels consistent with baseline.
6. With each progress report, the operator would calculate and submit the volume of groundwater affected. Factors to be considered would include aerial extent, formation thickness, and porosity. Upon the completion of the restoration demonstration, HRI would submit the data, analysis, and conclusions in a final report.
7. Authorization for expansion of mining into additional mine units would be contingent upon the results of the restoration demonstration within the 18-month period (HRI 1996b).

The restoration tests conducted to date have shown that some parameters can be restored to average pre-mining well field concentrations and that all the parameters can eventually be restored to water use standards. Therefore, NRC staff conclude that achieving the restoration standards listed in Table 4.6 would require significantly more than 4 pore volumes, as proposed by HRI.

Depending on the parameter and the test chosen, the pore volumes required to achieve the lower water quality of the secondary restoration goal or background ranged from less than 1 pore volume to greater than 28 pore volumes. However, plots of TDS concentrations and specific conductivity values (an indirect measure of TDS) show little improvement with continued pumping after 8 to 10 pore volumes. The Mobil Section 9 pilot is the largest restoration demonstration conducted in the project area to date. During groundwater restoration activities in the Mobil demonstration, TDS concentrations were close to the secondary restoration goal of 500 mg/L after 6.9 and 9.7 pore volumes. On the basis of the data submitted by HRI, the staff conclude that practical production-scale groundwater restoration activities would at most require a 9 pore volume restoration effort. Accordingly the staff have calculated groundwater impacts assuming the use of 9 pour volumes for groundwater restoration. Furthermore, surety should be maintained at this level until the number of pore volumes required to restore the groundwater quality of a production-scale well field has been demonstrated by HRI.

After groundwater restoration activities were completed, post-restoration groundwater quality monitoring would be required of HRI. The objective of this water quality monitoring would be to determine whether groundwater quality had been restored. This monitoring would continue until it had been confirmed that groundwater quality had been successfully restored. Sealing of production and injection wells would not occur until the NRC and other appropriate regulatory agencies agreed that groundwater quality had been restored.

### 4.3.1.1 Crownpoint

**Groundwater Impacts of Land Application.** Groundwater contamination is not expected to occur in the Section 12 land application area because radionuclide concentrations (radium, uranium, and thorium) in the restoration water would be reduced to levels that could be released to surface water bodies and because the water table (groundwater) is at least 104 m (300 ft) below the surface. Groundwater impacts from the Crownpoint facility alone would be less than the combined effect of disposing of restoration water from both the Crownpoint and Unit 1 sites.

**Groundwater Impacts of ISL Mining.** Several potential groundwater impacts associated with ISL mining were identified for the Crownpoint site. The potentially significant impacts are

1. water quality impacts during mining,
2. water quality impacts after successful restoration, and
3. water consumption impacts during restoration.

Water quality impacts during mining are related to potential contamination from unanticipated releases of mining fluids, which are referred to as excursions. Groundwater consumption is minimal during the mining phase and is not considered a significant impact. Concerns pertaining to water quality impacts during the mining phase are discussed in the following paragraphs. Potential impacts associated with the restoration phase and post-restoration phase are discussed under the Groundwater Restoration heading of this section.

For the purpose of this environmental impact assessment, NRC staff assume that the flow direction in the Dakota Sandstone beneath the Unit 1 and Crownpoint sites is toward the town of Crownpoint. This assumption is based on the conservative view that the greatest potential for impact from the proposed project would be at the location of greatest groundwater use and human population. The closeness of the Crownpoint site to the town's water supply wells indicates that a potential excursion could ultimately travel to the supply wells, since pumping supply wells causes groundwater flow under the Crownpoint site to converge at the wells.

For the Crownpoint site, NRC staff have concluded that the influence of active pumping from the town water supply wells might make it more difficult to prevent excursions than at other sites that do not have to compensate for the pumping influences of local wells. However, HRI's proposed well spacing is such that it is unlikely that a contaminant plume from a horizontal excursion would go undetected over the period of time that mining occurred in a well field. Therefore, there should be adequate time for corrective action if an excursion occurred.

To prevent horizontal excursions during mining, HRI proposes to maintain a continuous (pumping) bleed at the Crownpoint site until the well fields have been declared fully restored to the required permit/regulatory limits (HRI 1996a and HRI 1996c). This is designed to prevent the movement of water from the well fields. Further, HRI proposes to maintain emergency generator capacity capable of maintaining a 190 Lpm (50 gpm) bleed from the mine zone throughout the mining and restoration life of the mine (HRI 1996b).

HRI conducted a groundwater flow modeling study for the Crownpoint site to show that solution mining could be conducted under the influence of the town of Crownpoint wells without the threat of horizontal excursions. In the model (Reed 1993), HRI simulated well field operations during summer pumping by the town of Crownpoint (as opposed to less pumping during the winter months). The modeled groundwater flow paths were contained within the well field areas. This model assumed a constant flow field. However, Crownpoint site well CP-8 is located 1.6 km (1 mile) from the nearest Crownpoint water supply well, NTUA-1. Data provided by HRI (HRI 1996a) show that water levels in well CP-8 could change by 7 m (20 ft) or more during a year.

In addition, information provided by HRI (1992b; 1996a) shows water level changes on the order of 1.7 m (5 ft) occurring over a period of 5 to 6 days. Apparently, groundwater gradients could be altered over the Crownpoint property in short periods of time by water supply well withdrawals. Also, groundwater flow modeling conducted by HRI indicates that changes in the pumping rate of well NTUA-1 from 95 to 379 Lpm (25 to 100 gpm) could result in respective water level drawdowns of 1.4 to 5.8 m (4.1 and 16.6 ft) at a distance of 522 m (1500 ft). This, in turn, produced modeled steady state velocities of 1.3 and 5.2 m (3.7 and 14.8 ft) per year (HRI 1996n). Therefore, while local groundwater flow direction and velocity may be continuously changing because of events that cannot be controlled by HRI (i.e, individual wells being turned on and off), the effects of those changes on groundwater velocity should be very small. As a result, well field solutions should be kept in the well field with sufficient over-pumping of groundwater.

Vertical excursions are less likely than horizontal excursions at the Crownpoint site. Water level data indicate that the Dakota Sandstone is confined from the Westwater Canyon in Section 24 at the Crownpoint site. The difference in water levels between the Westwater Canyon and the Dakota Sandstone ranges from 28 to 35 m (80 to 100 ft) (HRI 1996a). In addition, leakage between the two aquifers is not indicated, since there is not a corresponding reaction in Dakota Sandstone water levels to water level changes in the Westwater Canyon that would suggest leakage. These observations are supported by a plot of Westwater Canyon (well CP-8) and Dakota Sandstone (well CP-10) water level data collected from January 1992 through March 1996 (HRI 1996a). Data collected on October 4, 1979, in Section 28, T17N R12W 1.6 km (1 mile) east of the town of Crownpoint) showed a difference of 49 m (140 ft) in water levels between the Dakota Sandstone and the Westwater Canyon.

HRI has exploration drill hole survey locations for every exploration hole at the Crownpoint site (HRI 1996a). Drilling at the site began in the late 1960s and early 1970s. Therefore, all plugging at the site was in compliance with the New Mexico State Engineers Regulation NMSA Section 69-3-6, which was promulgated in 1968. HRI has all the plugging records available for the Crownpoint site (HRI 1996a). Knowing the surveyed locations of old exploration boreholes means that the holes would be easy to locate if they need to be plugged for suspected leaks. Having the completion records for these holes increases the confidence that the holes were sealed correctly and should not leak during ISL mining activities.

Mine shafts have been excavated from the surface into the Westwater Canyon aquifer at the Crownpoint site. The mine shafts are lined with steel and grouted to the surface. However, they were never opened up to the Westwater unit. Therefore, they do not present an avenue for interformation transfer of groundwater.

No significant displacement in the Westwater sands within the mining boundary (HRI 1996a) was identified by HRI after a detailed geologic evaluation of the Crownpoint site. HRI reports that there is no indication that a reported fault in Section 19 intersects the Westwater Canyon sands within the area to be mined. Available data indicate that none of the faults mapped in the vicinity of the Crownpoint site have a displacement that would significantly reduce the sand thickness and hydraulic continuity of the Westwater sands (HRI 1996a). The overlying confining unit consists of weakly indurated clay and shale, so that there is little potential for faults to act as vertical pathways (i.e., the faults are less likely to be open) for groundwater migration to an overlying sand.

Given the projected thickness and rock type of the overlying confining units, there should be little likelihood that faults in the Crownpoint area would act as vertical pathways for groundwater migration from the mining zone to an overlying aquifer. However, the potential for faults to act as vertical pathways is not non-existent. This is because stratigraphic observations cannot detect a fault if it has minor stratigraphic displacement or determine if the fault is open to groundwater flow. Therefore, HRI would conduct pre-mining tests to confirm aquifer confinement.

HRI has stated that after a mine area has been identified, monitor wells (both overlying and in the production zone) and baseline mining wells would be installed (HRI 1996b). A hydrologic test would then be designed and conducted by pumping a single well relatively central to the proposed mining area. This well would be pumped at a constant flow rate so that the pressure drawdown (cone-of-depression) caused by water production would stress the formation and any potential hydraulic boundaries or barriers, such as the overlying confining clays and possible non-sealing faults.

If the proposed mine area is sufficiently small, then the stress induced by pumping from a single well would test potential barriers. However, if it is determined that the observed maximum water level drawdowns across the proposed mine area are inadequate to test for confinement, a second pump test would be conducted (HRI 1996b). This test would involve producing multiple wells concurrently across the area, and observing the composite effect of the resulting pressure drawdown on the various monitor wells.

Plots of the water levels versus time of pumping would be made for the overlying monitor wells and evaluated for pressure responses to pumping from the mine zone. Maximum drawdowns would be tabulated for each of the production zone monitor wells to ensure that adequate response was achieved for those wells (HRI 1996b). A Mine Unit Hydrologic Test Document would be assembled and submitted to the New Mexico Environmental Department for review. In accordance with NRC requirements, the Mine Unit Hydrologic Test Document would be reviewed by an HRI Safety and Environmental Review Panel to ensure that the results of the hydrologic testing and the planned mining activities are consistent with technical requirements and do not conflict with any requirement stated in the NRC license (HRI 1996b). After appropriate review of the Mine Unit Hydrologic Test Document and subsequent authorization by the New Mexico Environmental Department and HRI's Safety and Environmental Review Panel, injection of lixiviant would begin in the new mining unit (there would be no field recirculation prior to adding oxygen). Water levels would be taken on all monitor wells prior to each routine, bi-weekly water sampling and reviewed for unusual water level changes denoting any hydraulic connection with the mining zone.

In the event of a vertical excursion, HRI proposes to proceed immediately to determine the cause of the leakage and reverse the trend (HRI 1996a). Should a vertical excursion occur, identifying and correcting the excursion is likely to be a much longer process than identifying and correcting horizontal excursions.

The risk of a vertical excursion should be low, given the Crownpoint site geology, the previous borehole sealing procedures, and HRI's planned well integrity testing program. However, NRC staff also consider that upper monitor wells may not detect an excursion if a strong groundwater gradient is present because the wells do not encircle the well field area, but are commonly located in the center of well fields. Should an excursion occur down–groundwater gradient of the Dakota Sandstone aquifer monitor wells, the excursion may move undetected toward the town water supply wells. This is important, because three of the town of Crownpoint's water wells (BIA-5, BIA-3, and BIA-6) are completed in the Dakota Sandstone as well as the Westwater Canyon Member. Pumping from the town wells could cause groundwater in the Dakota Sandstone underneath the Crownpoint site to flow toward the town water supply wells. In addition, well BIA-5 is also completed in the Cow Springs aquifer.

This means that should a vertical excursion take place in the Dakota Sandstone or the Cow Springs aquifer, contamination could move toward the Crownpoint water supply wells. The risk of vertical excursion in the Dakota Sandstone is greater than in the Cow Springs aquifer, because injection and production wells will be completed through the Dakota Sandstone and the explosion holes that have already been drilled in the Dakota Sandstone.

**Groundwater Monitoring.** At the Crownpoint site, the Brushy Basin member does not contain any aquifers and consists entirely of shale (HRI 1996a). Above the Dakota Sandstone is 209–244 m (600–700 ft) of Mancos Shale. From there to the surface, siltstone and shale units interbedded with a number of sands form the Mesa Verde Group, the lowermost being the Gallup Sandstone. HRI proposes to monitor only the Dakota Sandstone with monitor wells spaced at a density of one per 1.6 ha (4 acres) (HRI 1996b). HRI does not propose to place monitor wells at the Crownpoint site in saturated sands of the Mesa Verde Group because

1. These sands are separated from the production zone by the Dakota, which would be monitored.
2. The massive Mancos shale which separates the Dakota from the Mesa Verde group makes interformational transfer impossible.
3. Mechanical integrity well testing would ensure that well casing does not leak into shallow sands of the Mesa Verde group.
4. The saturated sands of the Mesa Verde group are not substantial aquifers.

However, while HRI does not propose to place monitor wells in the deepest saturated sands of the Mesa Verde Group, if a vertical excursion is confirmed in the Dakota Sandstone at the Unit 1 or Crownpoint sites, HRI would construct one or more exploration wells into the Mesa Verde (Gallup Sandstone) at the location where the excursion was identified (HRI 1996b).

NRC staff agree with HRI's determination that routine monitoring is warranted in the Dakota Sandstone, but that routine monitoring of the shallower Mesa Verde Group is not necessary. NRC staff find this approach acceptable because of the hydrologic separation between these two aquifers and the thick, laterally extensive Mancos shale separating the two systems, and because the aquifers above the Dakota Sandstone at the Crownpoint site are not large producers of groundwater. The potential for a vertical excursion into the overlying aquifers is primarily through inadvertent leakage from installed wells. Mechanical integrity tests of injection and pumping wells provide an additional measure of safety to prevent vertical migration of injected fluids.

As previously described in Section 4.3.1, no monitoring would be conducted in the underlying Cow Springs aquifer (HRI 1996a) because of the thickness of the Recapture Shale separating the two aquifers. HRI concludes that the primary risk to any underlying water bearing sand would be deep drilling through the Recapture Shale, which, if not properly abandoned, could provide a conduit for fluid migration. Near the Crownpoint site, three drill holes have been identified that penetrate the total thickness of the Recapture Shale (HRI 1996a). These are drill holes 24-156C (located at the Crownpoint site), 28-132 [located 1.6 km (1 mile) east of the town of Crownpoint], and 16-224 [located 3.2 km (2 miles) west of the town of Crownpoint]. Most of the drill holes in the area only penetrated the upper 1.7 to 14 m (5 to 40 ft) of Recapture Shale. Town of Crownpoint well BIA-5 is completed into the Dakota Sandstone aquifer, the Westwater Canyon aquifer, and the Cow Springs aquifer (HRI 1992b). In addition, a local well (Mobil Monument Windmill) located 1.3 km (0.5 mile) east of the Crownpoint site in Section 28 (T17N R12W) appears to be completed into the Cow Springs aquifer (HRI 1992b).

**Groundwater Restoration.** The primary groundwater restoration impact concern relates to potential water quality impacts after successful restoration of uranium depleted mining units. Groundwater impacts from excursions during restoration are unlikely and are not considered a significant impact. HRI proposes that worst case groundwater restoration targets be the higher of average pre-mining groundwater quality background data or maximum permissible values. HRI proposes that maximum permissible values be the lower of either State of New Mexico (NMWQCC 3-103.A and 3-103b) or EPA (40 CFR § 141 and 143.3) primary and secondary standards. For uranium, 300 pCi/mL (0.44 mg/L) would be used. This concentration was obtained from Table 2, Appendix B of 10 CFR Part 20 and is suitable for unrestricted release of natural uranium to water.

Pumping by the town of Crownpoint controls the direction of groundwater flow in the Westwater Canyon aquifer underneath both the Crownpoint and Unit 1 sites. This means that groundwater in the Westwater Canyon aquifer beneath both properties is moving toward the town of Crownpoint wells where it would be pumped into the town water supply system. Therefore, if ISL uranium mining takes place at either the Unit 1 or Crownpoint site and the town continues to pump from its existing water supply wells as it has in the past, water which has gone through the ISL mining and restoration process would eventually reach the town of Crownpoint water supply system after many years.

NRC staff evaluated three alternatives for the Unit 1 and Crownpoint sites to determine whether groundwater degraded by ISL mining activities, after successful restoration at the Unit 1 and the Crownpoint sites, could threaten the town of Crownpoint water supply.

1. No restoration of the groundwater after mining
2. Restoration to secondary restoration goal
3. Restoration to primary restoration goal

Table 4.14 contains a projected list of water quality concentrations in a well field at the end of mining, but prior to restoration activities in either the Unit 1 or Crownpoint sites. This situation represents the alternative of no groundwater restoration after mining. Table 4.14 shows that radium-226, selenium, uranium, sulfate, chloride, manganese, total dissolved solids, and molybdenum greatly exceed both State of New Mexico and EPA/NNEPA drinking water standards. Therefore, without restoration, water quality would be degraded to the point that the groundwater at the sites could not be used as a source of drinking water without treatment.

The second alternative to be examined is groundwater restoration to secondary restoration goals. For those parameters with pre-mining baseline values below the EPA water quality standard, successful restoration would be in compliance with EPA water quality standards in the well fields and at the town water supply wells. Health impacts analyses have been conducted for the EPA primary and secondary standards and, therefore, the impact of restoring groundwater quality to these concentrations should

**Table 4.14. Comparison of proposed restoration standards dated 9-19-96 to State and Federal Standards**

| Parameter | No restoration | Secondary goal alternative (mg/L) | Primary goal alternative (mg/L) |
|---|---|---|---|
| | **Parameters with primary standards** | | |
| Arsenic | 0.054 | 0.05 | 0.0 |
| Barium | 0.1 | 2.0 | 0.05 |
| Cadmium | 0.01 | 0.01 | 0.0 |
| Chromium | 0.02 | 0.05 | 0.0 |
| Fluoride | 0.3 | 4.0 | 0.35 |
| Lead | 0.005 | 0.05 | 0.0 |
| Mercury | 0.0 | 0.002 | 0.0 |
| Nickel | 0.09 | 0.1 | 0.0 |
| Nitrate | 0.17 | 10.0 | 0.05 |
| Radium-226[a] | 150.0 | 5.0 | 65.85 |
| Selenium | 4.6 | 0.05 | 0.0 |
| | **Parameters with secondary standards** | | |
| Sulfate | 1,176.0 | 250.0 | 54.9 |
| Chloride | 317.0 | 250.0 | 10.9 |
| Copper | 0.04 | 1.0 | 0.0 |
| Iron | 0.02 | 0.3 | 0.0 |
| Manganese | 5.85 | 0.05 | 0.0 |
| TDS | 5,500.0 | 500.0 | 367.8 |
| pH[b] | 7.2 | 6.5–8.5 | 9.0 |
| | **Parameters without EPA standards** | | |
| Boron | 0.2 | BL[c] | 0.06 |
| Molybdenum | 62.0 | BL | 0.0 |
| Ammonia | 1.07 | BL | 0.03 |
| Calcium | 320.0 | BL | 2.68 |
| Magnesium | 21.6 | BL | 0.44 |
| Sodium | 1,600.0 | BL | 120.3 |
| Potassium | 7.0 | BL | 10.58 |
| Carbonate | 0.0 | BL | 26.42 |
| Bicarbonate | 1,005.0 | BL | 201.22 |
| Uranium | 33.5 | 0.44[d] | 1.8 |
| Vanadium | 0.48 | BL | 0.0 |

[a]pCi/L.
[b]Units.
[c] BL = pre-mining baseline well field average. Same as average baseline alternative.
[d]from NRC Appendix B 10 CFR Part 20.

preserve the water use of the aquifer. The restoration of uranium to 0.44 mg/L should not be a threat to public health. This concentration was derived from the concentration of 300 pCi/mL listed in Appendix B of 10 CFR Part 20, which identifies a concentration of 300 pCi/mL (0.44 mg/L) for unrestricted release of natural uranium to water.

The third alternative assumes that groundwater quality would be returned to the primary restoration goal of pre-mining well field baseline averages. Table 4.14 contains average water quality concentrations for the Crownpoint site. With the exception of radium, all of these concentrations are below EPA primary and secondary standards. Therefore, restoring groundwater quality to these concentrations should preserve the water use of the aquifer.

However, the average baseline for radium at the Crownpoint site is calculated to be 65.85 pCi/L. This concentration exceeds both State (30 pCi/L) and Federal standards (5 pCi/L). At the town of Crownpoint wells, radium-226 baseline values range from 0.18 to 0.2 pCi/L (HRI 1995b). Therefore, NRC staff conducted a modeling analysis to determine if restoring radium to a concentration of 65 pCi/L in the well fields could impact the town of Crownpoint wells.

The amount of dilution from groundwater flow (advection) and well head dilution was modeled. As a first step, NRC staff reviewed the modeling results submitted by HRI (Reed 1993). The HRI model calculated that it would take 35.6 years for groundwater to flow from the boundary of the Crownpoint site in Section 29 (east of town) to well BIA-6, 90.4 years from the boundary of the Crownpoint property in Section 19 (west of town) to well NTUA-1, and 1657.5 years from the easternmost Unit 1 site boundary in Section 14 to the town wells.

NRC staff consider that calculated groundwater flow times of 35.6 and 90.4 years are time periods within which it is quite likely that the town of Crownpoint could still be using water from the Westwater Canyon aquifer in the present area of the town wells.

Dilution is possible at the well head if uncontaminated water flows into the well from other directions. In this case, the uncontaminated water would dilute (reduce the concentration) contaminates in the groundwater. An analysis of the groundwater flow pathways for the Crownpoint site indicates that well NTUA-1 would receive only contaminated water and can take no dilution credit. However, well BIA-6 may pull up to half of its water from an uncontaminated source. If mining only occurred at the Unit 1 property, well NTUA-1 might pull about 60 percent of its water from an uncontaminated source and BIA-6 might pull as much as 70 percent of its water from an uncontaminated source. The NRC staff analysis used baseline water quality to dilute the predicted post-restoration concentration by the amount estimated at the well head. Well head dilution was calculated for three scenarios: (1) radium-226 movement from the boundary of the Crownpoint property in Section 19 (west of town) to well NTUA-1, (2) radium-226 movement from the boundary of the Crownpoint site in Section 29 (east of town) to well BIA-6, and (3) radium-226 movement from the easternmost Unit 1 site boundary in Section 14 to well NTUA-1. The analysis showed that the combined effect of both the Unit 1 and Crownpoint sites on modeled well head concentrations were no worse than the modeled concentrations at well NTUA-1 from the Crownpoint site alone.

Since no dilution was allowed in modeling the movement of radium from the Crownpoint site to well NTUA-1, modeled radium concentrations remained at 65.85 pCi/L. The model of radium-226 movement from the Crownpoint site to well BIA-6 allowed some dilution at the well head, which resulted in predicted concentrations of 33 pCi/L. For the Unit 1 site alone, modeled well head dilution effects were similar to the analysis for the Crownpoint site and well BIA-6 and resulted in radium-226 concentrations of 31 mg/L. Modeled concentrations of radium for all three scenarios of water movement to the town of Crownpoint well exceeded both State of New Mexico and EPA/NNEPA drinking water standards.

The preceding analysis assumes that dissolved constituents in the groundwater do not chemically react with solid material in the aquifer. For many water quality parameters this is unrealistically conservative. To investigate the role that geochemical interactions may have on modeled concentrations of radium-226 at the well head, the geochemical process of adsorption was investigated. One of the common methods used to model geochemical absorption is through the use of the distribution coefficient commonly known as $K_d$ (Freeze 1979). The $K_d$ approach attempts to predict the partitioning of solutes between the liquid and solid phases in a porous medium. A $K_d$ reflective of reducing conditions was conservatively chosen for radium because radium is more mobile under reducing conditions. Current groundwater flow modeling indicates that groundwater from the Crownpoint or Unit 1 site could flow through either the reduced or oxidized side of the roll front, or both. Radium $K_d$s for oxidizing environments fall in the range of 500 mL/g (Sheppard 1990; Allard 1979; Krishnaswami 1982; Serene 1982; Meijer 1995; Wescott 1995; Barney 1984). For reducing conditions in sandstone with low organic matter, Barney (1984) determined a radium-226 $K_d$ of 55 mL/g. It was this lower $K_d$ that was used to model the retardation of radium-226.

The modeled scenario of radium movement from the Crownpoint site to well NTUA-1 produced a travel time of 41,505 years. For the scenario of contaminant movement from the Crownpoint site to well BIA-6, radium had a travel time of 16,481 years. For the scenario of contaminant movement from the Unit 1 site to well NTUA-1, radium had a travel time of 758,535 years. Calculated travel times of these lengths indicate that for reasonable circumstances radium is immobile and would not reach the town wells in sufficient concentrations to exceed either State of New Mexico or EPA drinking water standards.

Uranium concentrations in the groundwater beneath the Crownpoint site average 0.001 mg/L, and at the town of Crownpoint wells range from 0.0006 mg/L to 0.003 mg/L (HRI 1995b). These concentrations are well below both the NRC concentrations for uranium contained in 10 CFR Part 20 and the EPA proposed maximum concentration limit for uranium. However, the calculated average concentration for uranium may be a function of the placement of the current wells relative to the ore body. At the Church Rock site, an average uranium concentration of 1.8 mg/L is calculated. When wells are located within the ore body it is possible that some well fields may have average uranium baseline values and, therefore, primary groundwater restoration goals that exceed 0.44 mg/L. NRC staff conducted the same modeling exercise for uranium that was conducted for radium to evaluate the potential for post-restoration uranium concentrations to migrate to the town of Crownpoint wells.

Uranium is least susceptible to chemical adsorption in oxidizing, high-bicarbonate environments, which are the conditions produced by ISL uranium mining. Therefore, after ISL mining, the uranium was conservatively assigned a $K_d$ of zero in these transport calculations, since dissolved uranium should be in uranium's most mobile form for oxidizing environments. Since uranium could take either reducing or oxidizing pathways to the town water supply wells, for modeling purposes it was conservatively assumed that oxidizing conditions existed all the way to the town wells. Therefore, for the scenario of uranium movement from the boundary of the Crownpoint site in Section 19 (west of town) to well NTUA-1, uranium concentrations at the well head would be above the 0.44 mg/L. For the other two scenarios, a post-restoration uranium concentration that exceeded 0.93 mg/L at the Unit 1 and Crownpoint sites would exceed a concentration of 0.44 mg/L at the town wells. However, the Unit 1 site calculation assumes that uranium would move entirely through oxidized rock.

The assumption that uranium would not encounter reducing conditions or other absorption mechanisms while traveling from the Unit 1 site to the town of Crownpoint is unrealistically conservative, given the modeled groundwater flow paths from the Unit 1 site into the reduced side of the ore body, the 3.2-km (2-mile) distance to the town wells, and the average travel time of 1657 years. In reality, it is reasonably certain that uranium concentrations should be significantly reduced in concentration before water from the Unit 1 site reaches the Crownpoint wells.

In summary, post–groundwater restoration impacts were determined to be acceptable by the NRC staff, provided the water quality at the well field met either the primary (baseline) or secondary restoration goal. Post–groundwater restoration impacts at the town of Crownpoint wells were judged to be acceptable if the water quality at the town wells did not exceed EPA's primary and secondary drinking water standards and the NRC standard of 0.44 mg/L for uranium. However, conservative analysis by the NRC staff suggests there is a potential risk that restoration of groundwater to the primary goal at the Crownpoint site may result in uranium concentrations at the town's drinking water wells that exceed the NRC standard of 0.44 mg/L, but still fall within the New Mexico Drinking Water Standard of 5 mg/L. The staff would require HRI to relocate the town of Crownpoint drinking wells to an alternate location with acceptable groundwater quality and quantity, prior to mining at the Crownpoint site, to ensure a continued source of high-quality water to the town of Crownpoint. This requirement is included as a mitigative measure in Section 4.3.3.

The second groundwater restoration impact concern relates to consumptive use during restoration. HRI modeled drawdown effects due to mining and restoration activities from the combined effect of the Crownpoint and Unit 1 sites (HRI 1996b). The model was developed to simulate a mine plan that used the maximum amount of groundwater removed for the 21-year period. Model runs were long enough so that drawdown effects were changing very slowly with time. Therefore, HRI believes that the model runs for the Crownpoint and Unit 1 sites represent the practical maximum drawdown effects that would occur.

The cumulative drawdown at the end of 21 years of mining at both Unit 1 and Crownpoint is projected as 17 m (55 ft) on well NTUA-1 or 15 to 17 m (49 to 55 ft) for the area of the town wells. The maximum projected drawdown from the two sites is anticipated to occur after 17 years, and would produce a drawdown effect of 24 m (80 ft) on well NTUA-1 or 21 to 24 m (70 to 80 ft) for the area of the town wells.

HRI observes that an adequate water column (HRI 1996e) exists in the Crownpoint area to ensure that the well yields of the town of Crownpoint wells would not be affected with even the worst case drawdown (i.e., if the current water column were 457 m (1500 ft), then 433 m (1420 ft) would still be available). HRI concludes that the submersible pumps in the town wells would not need to be lowered as a result of the projected drop in well water levels. However, if additional pipe were needed to lower a submersible pump in a town well, HRI estimates a one-time cost of $5000 for this work. This cost is conservative, because the additional pipe would normally be added during routine well servicing at the nominal cost of the pipe.

A drop in fluid levels could also result in increased pumping costs. HRI generated worst-case calculations (HRI 1996i) based on the well projected to be most affected by a drop in water level during groundwater restoration activities at the Unit 1 and Crownpoint sites. Based on the projected impact at this well, HRI provided calculations to show the increased pumping costs from the lower projected water levels at town of Crownpoint wells BIA-3, BIA-5, BIA-6, NTUA-1, and NTUA-2. The additional annual cost due to groundwater restoration activities at the Crownpoint site was calculated to be $3023. The additional annual cost due to groundwater restoration activities at the Unit 1 site was calculated to be $1443. Therefore, the additional annual cost due to groundwater restoration activities at the Crownpoint and Unit 1 sites was calculated to be $4466.

Based on these calculations, NRC staff conclude that water level drawdowns caused by restoration activities at the Crownpoint and Unit 1 sites could result in a one-time cost of $5000 per well for a total of $25,000. Worst-case pumping costs during groundwater restoration activities could range from $1443 per year to $4466 per year. Groundwater restoration activities at the Crownpoint site could result in a one-time cost of $25,000 and a pumping cost of $3023 per year. Groundwater restoration activities at the Unit 1 and Crownpoint sites could result in a one time cost of $25,000 and a pumping cost of $4466 per year.

### 4.3.1.2 Unit 1

**Groundwater Impacts of Land Application.** Groundwater contamination is not expected to occur in the Section 12 land application area because radionuclide concentrations (radium, uranium, and thorium) in the restoration water would be reduced to levels that could be released to surface water bodies and because the water table (groundwater) is at least 104 m (300 ft) below the surface. Groundwater impacts from the Unit 1 facility alone would be less than the combined effect of disposing of restoration water from both the Crownpoint and Unit 1 sites.

**Groundwater Impacts of ISL Mining.** As with the Crownpoint site, several potential groundwater impacts associated with ISL mining were identified for the Unit 1 site. The potentially significant impacts are

1. water quality impacts during mining

2. water quality impacts after successful restoration
3. water consumption impacts during restoration

Water quality impacts during mining are related to potential contamination from excursions. Groundwater consumption is minimal during the mining phase and is not considered a significant impact. Concerns pertaining to water quality impact during the mining phase are discussed in the following paragraphs. Potential water quality impacts associated with successful restoration at the Unit 1 site were considered in conjunction with the Crownpoint site Groundwater Restoration evaluation in Section 4.3.1.1. Water consumption impacts associated with the restoration phase were also considered in conjunction with the Crownpoint Groundwater Restoration evaluation in Section 4.3.1.1.

For the purpose of this environmental impact assessment, NRC staff have assumed that the flow direction in the Dakota Sandstone beneath the Unit 1 site is toward the town of Crownpoint. This assumption is based on the conservative view that the greatest potential for impact from the proposed project would be at the location of greatest groundwater use and human population.

As at the Crownpoint site, the potential to detect horizontal excursions at the Unit 1 site should be high. However, the potential for horizontal excursions from causes beyond HRI's control should be less at the Unit 1 site because Unit 1 is located farther [3.2 km (2 miles)] from the town of Crownpoint water wells. There should be little effect from variations in pumping rates on water levels at the Unit 1 site. The occurrence of horizontal excursions should be low with a properly balanced well field.

HRI has submitted data from the Unit 1 site collected in 1982, showing a difference of 66.86 m (192.13 ft) in water levels between the Dakota Sandstone and the Westwater Canyon. Mobil conducted a pump test of 24 hr duration in August 1982, in the Westwater Canyon aquifer in Sections 16 and 15, T17N R12W. Two wells were completed into the overlying Dakota Sandstone and showed no drawdown response during the pump test. Further analysis showed that leakage through the overlying Brushy Basin shale was not measurable (Prickett 1983; HRI 1996b). These data indicate that in the northeast corner of the Unit 1 site, the Westwater Canyon aquifer is not hydraulically connected to the Dakota Sandstone aquifer.

For the Unit 1 site, HRI purchased Mobil Oil Company's records which, to the best of HRI's knowledge, contain all plugging reports (HRI 1996a). Drilling at the Unit 1 site began in the early 1970s; therefore, all plugging at the site was in compliance with the New Mexico State Engineers Regulation NMSA, Section 69-3-6. Knowing the surveyed locations of old exploration boreholes means that the holes would be easy to locate and plugged should one be suspected of leaking. Having the completion records for these holes increases the confidence that the holes were sealed correctly and should not leak during ISL mining activities.

Given the projected thickness and rock type of the overlying confining units, there should be little likelihood that any faults in the Unit 1 site would act as vertical pathways for groundwater migration from the mining zone to an overlying aquifer. The overlying confining unit consists of weakly indurated clay and shale, so that there is little potential for faults to act as vertical pathways (i.e., the faults are less likely to be open) for groundwater migration to an overlying sand. However, the potential for faults to act as vertical pathways is not non-existent. This is because stratigraphic observations cannot detect a fault if it has minor stratigraphic displacement or determine if the fault is open to groundwater flow. Therefore, HRI would conduct pre-mining tests to confirm aquifer confinement. Pre-mining tests for confinement at the Unit 1 site would be the same as those described for the Crownpoint site.

The potential for vertical excursions at the Unit 1 site is very low because of the thick aquitards over and under the production zone, the quality of the plugged exploration holes, and the proposed integrity testing that would be applied to all wells (HRI 1996a). HRI proposes to monitor water levels and water quality in the overlying aquifer to detect leakage. In addition to the construction of Dakota Sandstone monitor wells above the mine zone, HRI proposes to drill three to five monitor wells in the overlying Dakota Sandstone aquifer between the well fields and the town of Crownpoint water supply wells (HRI 1996k). Further, in the event of a vertical excursion, HRI proposes to proceed immediately to determine the cause of the leakage and reverse the trend (HRI 1996a).

The risk of a vertical excursion occurring should be low given the site geology, the previous borehole sealing procedures, and HRI's planned well integrity testing program. Three of the town of Crownpoint's water wells (BIA-5, BIA-3, and BIA-6) and a local well (Mobil Monument Windmill) located 0.8 km (0.5 mile) east of the Crownpoint site in Section 28 (T17N R12W) are completed in the Dakota Sandstone. However, these wells are 3.2 km (2 miles) from the Unit 1 boundary and should not produce a strong hydraulic gradient at that distance. This means that the advective and dispersive forces from a potential point of leakage into the upper aquifer would not be strongly influenced by the local groundwater gradient. This in turn would allow the plume to widen and increase the likelihood of detecting a potential for vertical excursion. HRI determined a travel time of 1657 years for water to flow from the Unit 1 site at the town of Crownpoint in the Westwater Canyon aquifer. All five of the town's water supply wells influence Westwater Canyon gradients, while only three of the wells influence gradients and travel times in the Dakota aquifer. Therefore, the flow of groundwater in the Dakota Sandstone aquifer toward the town of Crownpoint should take much longer than the modeled flow in the Westwater Canyon. Therefore, a potential vertical excursion to the Dakota Sandstone aquifer should not adversely affect the town of Crownpoint water supply.

**Groundwater Monitoring.** At the Unit 1 site, the Brushy Basin member does not contain any aquifers and consists entirely of shale (HRI 1996a). Above the Dakota Sandstone is 209–244 m (600–700 ft) of Mancos Shale. Thereafter to the surface, a number of sands form the Mesa Verde Group, the lowermost being the Gallup Sandstone. HRI proposes to monitor only the Dakota Sandstone with monitor wells spaced at a density of one per four acres (HRI 1996b). In addition, at the Unit 1 site only, HRI proposes to drill three to five monitor wells in the overlying Dakota Sandstone aquifer between the well fields and the town of Crownpoint water supply wells (HRI 1996k).

However, while HRI only proposes to place monitor wells in the deepest saturated sands of the Mesa Verde Group, if a vertical excursion is confirmed in the Dakota Sandstone at the Unit 1 site, HRI would construct one or more exploration wells into the Mesa Verde (Gallup Sandstone) at the location where the excursion was identified (HRI 1996b).

NRC staff agree with HRI's determination that routine monitoring is warranted in the Dakota Sandstone, but that routine monitoring of the shallower Mesa Verde Group is not necessary. NRC staff find this approach acceptable because of the thick, laterally extensive Mancos shale separating the two systems and because the aquifers above the Dakota Sandstone at the Unit 1 site are relatively poor producers of groundwater. Therefore, the potential likelihood of a vertical excursion into the overlying aquifers is primarily through inadvertent leakage from installed wells. Mechanical integrity tests of injection and pumping wells provide an additional measure of safety to prevent vertical migration of injected fluids from wells.

As previously described in Section 4.3.1, no monitoring would be conducted in the underlying Cow Springs aquifer (HRI 1996a) because of the thickness of the Recapture Shale separating the two aquifers at each of the sites. A large number of holes were drilled into the Recapture Shale at each of the three sites; however, most of these holes only penetrated the upper 1.5 m to 12 m (5 to 40 ft). None of the holes penetrated the entire thickness of the Recapture Shale (HRI 1996b). One well is known to have penetrated the entire thickness of the Recapture Shale at the Unit 1 site. Mobil well TWW-1 was drilled to 1010 m (2903 ft) in Section 16, but has since been plugged (BLM 1996). After reviewing the materials submitted in the license application, NRC staff have not found any instances where the Recapture Shale is absent beneath the site. There should be little risk of a vertical excursion into the Cow Springs aquifer because of the thickness of the Recapture Shale and the low potential that drill holes within the site boundary have penetrated the unit.

In the unlikely event that a vertical excursion should enter the Cow Springs aquifer, the impact to the town of Crownpoint's water supply would not be significant. The nearest wells completed in the Cow Springs aquifer are town of Crownpoint well BIA-5 and a local well (Mobil Monument Windmill) located 0.8 km (0.5 mile) east of the Crownpoint site in Section 28 (T17N R12W). Five large public water supply wells influence water flow in the Westwater Canyon aquifer. HRI modeled that it would take 1657 years for the water to flow from the Unit 1 site to the town of Crownpoint in the Westwater Canyon aquifer. Pumping by the windmill east of town and by well BIA-5 should have only a small influence on the rate of Cow Springs groundwater movement beneath the Unit 1 site. Therefore, should a vertical excursion occur in the Cow Springs aquifer, it would be small in size and any flow of groundwater toward the town of Crownpoint should take much longer than the rate of groundwater flow in the Westwater Canyon aquifer.

**Groundwater Restoration.** Potential impacts due to decreases in water levels at the town of Crownpoint wells from groundwater restoration activities at the Unit 1 site are described above in the Groundwater Restoration evaluation for the Crownpoint site in Section 4.3.1.1. Restoration activities at the Unit 1 site could result in a one-time cost of $25,000 and a pumping cost of $1443/year.

#### 4.3.1.3 Church Rock

**Groundwater Impacts of Land Application.** HRI's potential land application areas for the Church Rock site (Sections 17 and 16) are located on top of the Mancos shale. Therefore, land application should pose no threat to groundwater quality in the underlying aquifers. The two areas, which are located above the Church Rock site on flat mesa land, should pose no threat to any regional aquifers and could, at most, influence small perched water bodies that might form within the mesa.

**Groundwater Impacts of ISL Mining.** Underground mine workings completed into the Westwater Canyon aquifer exist in the southern end of the Church Rock site. HRI plans to conduct ISL mining operations in the area of these workings, most of which are believed to be intact and not collapsed (HRI 1996a). Contrary to this opinion, NRC staff consider it likely that many of the workings have collapsed, because the type of underground mining employed at the site would have caused some of the workings to collapse while the mine was in operation (HRI 1996a). HRI has reviewed the mine workings mapped by the previous operator and concluded that no workings extend beyond the boundaries of the planned well fields (HRI 1996a; HRI 1996b).

The potential to detect horizontal excursions at the Church Rock site should be high. Monitor wells would encircle the well field and the mine workings to detect horizontal excursions should they ever occur. In addition, monitor wells would be located by treating production mine workings as if they were injection or production wells (HRI 1996k). Therefore, monitor wells would encircle each well field at a distance of 139 m (400 ft) from the edge of the production and injection wells and mine workings. The wells would be spaced 139 m (400 ft) apart (HRI 1992a; HRI 1993a; HRI 1992b). The angle formed by lines drawn from any production or injection well or mine working to the two nearest monitor wells would not be greater than 75 degrees (HRI 1996h; HRI 1996k). This means that the detection of horizontal excursions would not be degraded by the presence of the mine workings.

The potential for horizontal excursions should be low with a properly balanced well field. HRI provided aquifer modeling results that demonstrate that the project could be conducted while controlling lixiviant migration (HRI 1996b). The model used site data on the hydraulic characteristics of the Westwater sandstone and HRI's projected operational data. The model results indicate that a cone of depression would be formed during the project. A groundwater divide would develop between each mine unit and locations down-gradient during the production and restoration phases of the project. Therefore, groundwater and lixiviant migration would be controlled by forcing water to flow into the well fields.

However, HRI's model did not include the mine workings in its design. Since it cannot be guaranteed that the mine workings do not extend beyond the injection and production wells of the well field, the workings may form preferential pathways for lixiviant movement away from the well field. Therefore, the potential for horizontal excursions could be increased in areas of existing mine workings. Regardless, HRI's proposed monitoring program should detect any horizontal excursions and, thus, HRI would be required to correct excursions if they occurred.

In January 1988, HRI conducted a pump test in the Westwater Canyon at the northern end of the Church Rock site (HRI 1993a). Observation wells were completed into the Brushy Basin "B" sand and the Dakota Sandstone aquifers in addition to wells in the Westwater Canyon aquifer. Communication between the Westwater Canyon aquifer and the overlying aquifers was not detected during a 72-hr pump test of the Westwater Canyon aquifer. These data indicate that the Westwater Canyon aquifer is not hydraulically connected to either of the overlying aquifers in the area of the pump test.

HRI possesses the exploration drill hole survey locations for all exploration holes drilled at the Church Rock site (HRI 1996a). The Church Rock site was drilled before 1968 New Mexico State engineer plugging requirements were promulgated. The holes were plugged with old drill mud and geologic materials that collapsed into some holes. The confining units at the Church Rock site contain clays and shales, and the plugging of boreholes from clays squeezing the boreholes shut was a consistent problem at the Church Rock site (HRI 1996a). However, should any boreholes be open, pre-mining hydrologic testing will be used to identify and locate them; and during mining, overlying monitor wells will be used to identify and locate vertical excursions should they occur.

HRI does not propose to drill any wells through old mine workings. However, should HRI determine that it is economically feasible to extract reserves under the workings, HRI would drill and complete wells through the workings or directionally drill and complete wells from the workings. If wells are drilled and completed through the workings, HRI would use two strings of casing through the mine workings, one casing string inside the other. Surface casing would first be installed and would extend into the sand/clay below any workings that the bore-hole intersects. This surface casing would be of sufficient strength that it would support at least 150 percent of the expected maximum pressures that might be placed on it, either burst or collapse pressures. As with a normal well installation, this surface casing would be grouted to the surface, except across any open mine workings. Drilling would then continue until final depth is reached. The well casing normally used in well completions would then be installed inside the surface casing and grouted to the surface. There would be two strings of casing with two grout barriers throughout the well completion. The mine workings [approximately 3 m (9 ft) in height] would have two casing strings and one grout barrier.

Given the projected thickness and rock type of the overlying confining units, there should be little likelihood that any faults in the Church Rock site would act as vertical pathways for groundwater migration from the mining zone to an overlying aquifer. HRI has not discovered any faults within the Church Rock site (HRI 1993a). The overlying confining unit consists of weakly indurated clay and shale, so that there is little potential for faults to act as vertical pathways (i.e., the faults are less likely to be open) for groundwater migration to an overlying sand. However, the potential for faults to act as vertical pathways is not non-existent. This is because stratigraphic observations cannot detect a fault if it has minor stratigraphic displacement or determine if the fault is open to groundwater flow. Therefore, HRI would conduct pre-mining tests to confirm aquifer confinement. Pre-mining tests for confinement at the Church Rock site would be the same as those described for the Crownpoint site.

The risk of a vertical excursion occurring outside the area of former mining activities should be low given the thick aquitards over and under the production zone, the planned well integrity testing program, and the potential for old boreholes to squeeze shut. HRI proposes to monitor water levels and water quality in the overlying aquifer to detect leaks. Further, in the event of a vertical excursion, HRI proposes to proceed immediately to determine the cause of the leakage and reverse the trend (HRI 1996a). The potential for an upper aquifer excursion to go undetected should be small, as discussed for the Unit 1 site in Section 4.3.1.2.

ISL mining could increase the potential for old mine workings to collapse. Workings with walls near an injection well would experience an increase in pressure; those that were near a production well would experience a decrease in pressure. Thus, the workings as a whole might experience a range of varying pressures as mining proceeded through a well field. Vertical pathways for groundwater flow could be caused by the collapsing workings. If a collapse occurred during mining, vertical pathways could be created as the overlying rock layers collapsed into the workings or the collapse caused well casings to break. However, it should be possible to mine in the Westwater Canyon aquifer and not create a vertical excursion. This can be accomplished by sealing off the shafts or structuring well field pressures so that in the area around the shafts they are less than overlying aquifer pressures. However, HRI has not specifically demonstrated how this would be accomplished. Nevertheless, as discussed later under Groundwater Monitoring, HRI's commitment to perform monitoring near the old mine workings should provide adequate detection of potential excursions associated with the old mine shafts.

The Cow Springs aquifer is separated from the Westwater Canyon aquifer at each of the three sites by the Recapture Shale, which is estimated to be about 55 m (180 ft) thick at the Church Rock site. Because of the thickness of the Recapture Shale and the low potential that drill holes in the site boundary have penetrated the Recapture Shale, there should be little risk of a vertical excursion into the Cow Springs aquifer.

HRI modeled drawdown effects for the Church Rock site. The model was developed to simulate a mine plan that used the maximum amount of groundwater removed for the 21-year period. Model runs were long enough so that drawdown effects were changing very slowly with time. Therefore, HRI believes that the model runs for the Church Rock site represent the practical maximum drawdown effects that would occur. This model produced a decline in water levels at the most downgradient monitor well (MW-20) that ranged from approximately 4.2 to 12 m (12 to 34 ft) during the mining and restoration phases of the project (Reed 1993).

**Groundwater Monitoring.** At the Church Rock site, HRI proposes to monitor the Brushy Basin "B" sand as well as the Dakota Sandstone aquifer (HRI 1996a; HRI 1996b). Above the Dakota Sandstone, there are no additional aquifers because the Mancos Shale continues to the surface. Upper monitor wells completed in the Brushy Basin "B" sand would be located with, at a minimum, one well per 1.6 ha (4 acres) of production area (HRI 1993a). In addition, monitor wells would be placed within 14 m (40 ft) of any likely openings of the existing mine workings into either the overlying Dakota Sand or the Brush Basin "B" Sand. These wells would be placed downgradient from the suspected open section in the direction of groundwater movement to ensure that any excursion would be detected (HRI 1996k). HRI would develop a standard operating procedure to address monitoring at the Church Rock site in the vicinity of the existing mine workings (HRI 1996k). Upper monitor wells completed in the Dakota sandstone aquifer would be located with, at a minimum, one well per 3.2 ha (8 acres) of production area (HRI 1993a). This monitoring plan should provide adequate detection of potential vertical excursions.

As previously described, no monitoring would be conducted in the underlying Cow Springs aquifer (HRI 1996a). The Cow Springs aquifer is separated from the Westwater Canyon aquifer at each of the three project sites by the Recapture Shale, which is estimated to be about 55 m (180 ft) thick at the Church Rock site. There should be little risk of a vertical excursion into the Cow Springs aquifer because of the thickness of the Recapture Shale and the low potential that drill holes within the Church Rock site boundary have penetrated the Recapture Shale.

**Groundwater Restoration.** HRI does not believe the existing mine workings would present a significant problem for groundwater restoration. HRI has presented data on TDS to support its opinion that water quality in the existing mine workings has been previously contaminated by conventional underground mining and, unlike native groundwater, does not meet primary drinking water standards for TDS (HRI 1996b). HRI concludes that if the mine workings are affected chemically by ISL mining, they should require less restoration effort than the native sandstone leached in other areas (HRI 1996b). This is because with a poor background water quality, restoration to background or a water quality standard would be easier.

In addition, HRI estimates that the mine workings contain 2.9 million $ft^3$ or 22 million gal of water, and that it would take only one pore volume to clean the groundwater in the workings (i.e. one displacement of the water contained in the workings) (HRI 1996b). HRI bases this opinion on the observation that lixiviant interactions with the rock matrix in the mined sandstone should require additional flushing during restoration, as compared to the empty mine workings. HRI has also presented calculations (HRI 1996b) which show that a one pore volume restoration estimate for the workings is not materially greater than the amount of water that would have to be pumped through the rock to restore the groundwater if the workings were not there. HRI also proposes that an adequate surety would be provided for any projected increased groundwater restoration costs (HRI 1996b).

The existence of preferential flow paths and the water contained in the workings may create some unique restoration problems. For example, preferential pathways may mean less water flow through the matrix, inhibiting cleanup of the matrix. In addition, water in the workings may become contaminated. Since wells would not be directly monitoring the water quality in the workings, it is possible that contaminated water may be left behind in the workings. Restoring the workings to a lower water quality than the water quality of the surrounding aquifer may make it difficult to restore the water in the surrounding aquifer (i.e., water of lower quality would be constantly pulled from the workings).

If HRI proposes to restore water in the workings to a different quality from water in the surrounding rock, HRI would be required to adequately characterize the pre-mining quality of the shafts. For purposes of impact analysis and surety calculation, it is assumed that water quality in the workings would be the same as the rest of the aquifer.

An active uranium ore body is one where reducing conditions exist on one side of the ore body and oxidizing conditions exist on the other side. Current research (Deutsch 1985; Deutsch 1983) indicates that for active ore bodies, the redox-sensitive ions (such as uranium) which have been mobilized by uranium solution mining would rapidly be adsorbed and removed from groundwater when they encounter reducing conditions in the rock. So if the post-mining groundwater flow direction is from the oxidized side of the ore body to the reduced side, these ions should be rapidly attenuated after solution mining activities.

However, as recognized by HRI (1996a), the dewatering effects of the old mine workings have subjected the Westwater Canyon Member to oxidizing conditions. The implication is that for some distance around the old Church Rock mine working (i.e., into areas that were not mined by the underground operation), dewatering may have significantly diminished or eliminated reducing conditions in the aquifer. Therefore, uranium may move a longer distance than would normally be predicted before it encounters reducing conditions in the aquifer.

## 4.3.2 Alternative 2 (Modified Action)

As described in Section 2.2, this section contains the staff's evaluations of various reasonable alternatives to the proposed action.

### 4.3.2.1 Alternative Sites for ISL Mining

**The Church Rock Site Only.** For the Church Rock site only alternative, the volume of water restored to average background or less than Federal primary and secondary drinking water standards is estimated to be 1.0 million $m^3$ (780 acre-ft). For 4 and 9 pore volume restoration efforts, the water consumed over the life of the project is estimated to be

**Water consumed**

| | 4 pore volumes | | 9 pore volumes | |
|---|---|---|---|---|
| Restoration alternatives | Million $m^3$ | Acre-feet | Million $m^3$ | Acre-feet |
| Groundwater sweep | 3.4 | 2792 | 7.7 | 6282 |
| Reverse osmosis | 0.9 | 698 | 2.0 | 1571 |
| Brine concentration | 0.009 | 7 | 0.02 | 16 |

**The Unit 1 Site Only.** For the Unit 1 site only alternative, the volume of water restored to average background or less than Federal primary and secondary drinking water standards is estimated to be 0.8 million $m^3$ (644 acre-ft). For 4 and 9 pore volume restoration efforts, the water consumed over the life of the project is estimated to be

**Water consumed**

| | 4 pore volumes | | 9 pore volumes | |
|---|---|---|---|---|
| Restoration alternatives | Million $m^3$ | Acre-feet | Million $m^3$ | Acre-feet |
| Groundwater sweep | 4.5 | 3674 | 10.1 | 8267 |
| Reverse osmosis | 1.1 | 919 | 2.5 | 2068 |
| Brine concentration | 0.008 | 7 | 0.02 | 16 |

During groundwater restoration activities, the town of Crownpoint would experience increased pumping costs at the existing water supply well locations and might experience increased pumping costs at any future well locations.

**The Crownpoint Site Only.** For the Crownpoint site only alternative, the volume of water restored to average background or less than Federal primary and secondary drinking water standards is estimated to be 1.5 million $m^3$ (1247 acre-ft). For 4 and 9 pore volume restoration efforts, the water consumed over the life of the project is estimated to be

**Water consumed**

| | 4 pore volumes | | 9 pore volumes | |
|---|---|---|---|---|
| **Restoration alternatives** | **Million $m^3$** | **Acre-feet** | **Million $m^3$** | **Acre-feet** |
| Groundwater sweep | 5.0 | 4059 | 11.3 | 7733 |
| Reverse osmosis | 1.3 | 1015 | 3.0 | 1934 |
| Brine concentration | 0.013 | 10 | 0.03 | 17 |

Conservative analysis by the NRC staff suggests there is a potential risk that restoration of groundwater to the primary goal at the Crownpoint site might result in uranium concentrations at the town's drinking water wells that exceed the NRC standard of 0.44 mg/L, but still fall within the New Mexico Drinking Water Standard of 5 mg/L. The staff would require HRI to relocate the town of Crownpoint drinking wells to an alternate location with acceptable groundwater quality and quantity, prior to mining at the Crownpoint site, to ensure a continued source of high-quality water to the town of Crownpoint. This requirement is included as mitigative measure in Section 4.3.3. During groundwater restoration activities, the town of Crownpoint would experience increased pumping costs at the existing water supply well locations and might experience increased pumping costs at any future well locations.

**The Church Rock and Unit 1 Sites Only.** For the Church Rock and Unit 1 sites only alternative, the volume of water restored to average background or less than Federal primary and secondary drinking water standards is estimated to be 1.8 million $m^3$ (1424 acre-ft). For 4 and 9 pore volume restoration efforts, the water consumed over the life of the project at both sites is estimated to be

**Water consumed**

| | 4 pore volumes | | 9 pore volumes | |
|---|---|---|---|---|
| **Restoration alternatives** | **Million $m^3$** | **Acre-feet** | **Million $m^3$** | **Acre-feet** |
| Groundwater sweep | 7.9 | 6466 | 17.8 | 14,549 |
| Reverse osmosis | 2.0 | 1617 | 4.5 | 3638 |
| Brine concentration | 0.02 | 14 | 0.045 | 32 |

During groundwater restoration activities at the Unit 1 site, the town of Crownpoint would experience increased pumping costs at the existing water supply well locations and might experience increased pumping costs at any future well locations.

**The Unit 1 and Crownpoint Sites Only.** For the Unit 1 and Crownpoint sites only alternative, the volume of water restored to average background or less than Federal primary and secondary drinking water standards is estimated to be 2.3 million $m^3$ (1891 acre-ft). For 4 and 9 pore volume restoration efforts, the water consumed over the life of the project at both sites is estimated to be

**Water consumed**

| | 4 pore volumes | | 9 pore volumes | |
|---|---|---|---|---|
| **Restoration alternatives** | **Million $m^3$** | **Acre-feet** | **Million $m^3$** | **Acre-feet** |
| Groundwater sweep | 9.5 | 7733 | 21.4 | 17,400 |
| Reverse osmosis | 2.4 | 1934 | 5.4 | 4352 |
| Brine concentration | 0.021 | 17 | 0.05 | 38 |

Conservative analysis by the NRC staff suggests there is a potential risk that restoration of groundwater to the primary goal at the Crownpoint site might result in uranium concentrations at the town's drinking water wells that exceed the NRC standard of 0.44 mg/L, but still fall within the New Mexico Drinking Water Standard of 5 mg/L. The staff would require HRI to relocate the town of Crownpoint drinking wells to an alternate location with acceptable groundwater quality and quantity, prior to mining at the Crownpoint site, to ensure a continued source of high-quality water to the town of Crownpoint. This requirement is included as mitigative measure in Section 4.3.3. During groundwater restoration activities, the town of Crownpoint would experience increased pumping costs at the existing water supply well locations.

#### 4.3.2.2 Alternative Sites for Yellowcake Drying and Packaging

Impacts to groundwater quantity and quality would be the same regardless of the alternative site selected for yellowcake drying and packaging.

### 4.3.3 Alternative 3 (The NRC Staff-recommended Action)

This section provides a summary of additional NRC staff requirements and recommendations based on its evaluation of the proposed action. The following list supplements the commitments already made by HRI in its license application. Subsequently, HRI has formally agreed to these conditions as expressed in its letter to NRC dated December 26, 1996 (see Appendix B). The staff believe that the previously identified impacts of this project can be mitigated through the measures discussed below.

If a license were issued for the proposed project, those items listed as requirements would be incorporated in the license either as separate license conditions or combined as one general license condition that references HRI's consolidated operations plan. For those items listed as NRC staff recommendations, BIA, BLM, and other cognizant regulatory agencies will be responsible for ensuring that HRI has complied with this guidance.

- HRI would be required to perform well integrity tests on each injection and production well before the wells are utilized and on wells that have been serviced with equipment or procedures that could damage well casing. Additionally, each well has to be retested at least once each 5 years it is in use.

- HRI would be required to return to the process circuit, maintain in wastewater retention ponds, or discharge as approved all liquid effluents from process buildings and other process waste streams, with the exception of sanitary wastes. HRI would have to demonstrate that any disposal method selected meets NRC's release limits for radionuclides (10 CFR Part 20) as well as standards from any other required permits. All changes to the liquid effluent disposal plan would have to be approved by license amendment.

- HRI anticipates using production flow rates of 9500 to 11,500 Lpm (2500 to 3000 gpm) at each ion exchange plant. HRI would be required not to exceed a maximum flow rate of 15,000 Lpm (4000 gpm).

- HRI would be required to establish an effluent and environmental monitoring program at each processing site in accordance with Table 4.4-1 of the submittal dated March 16, 1993. All effluent releases would be subject to release limits specified in 10 CFR Part 20. HRI is prohibited from injecting lixiviant prior to NRC's review and approval of a specific environmental monitoring plan. The plan shall indicate sampling methods and equipment, analytical procedures, and lower limits of detection. Additionally, the plan shall indicate proposed environmental monitoring locations, and provide the rationale for their selection.

- HRI would be required to establish baseline water quality data at the following points: (1) all mining zone perimeter monitor wells, (2) one monitor well per 1.6 ha (4 acres) of the mining unit in the first overlying aquifer, (3) one monitor well per 3.2 ha (8 acres) of mining unit in each higher aquifer, and (4) one production/injection well per 1.6 ha (4 acres) in each well field. Baseline groundwater quality data shall be established by gathering three independent samples from each well.

- HRI's proposal not to monitor the Cow Springs aquifer is based on the belief that vertical excursions to the aquifer would not occur. Prior to the injection of lixiviant at any of the three project sites, HRI would be required to collect sufficient water quality data to generally characterize the water quality of the Cow Springs aquifer beneath the project sites, and would conduct sufficient hydrologic confinement tests to determine if the Cow Springs aquifer beneath the sites is hydraulically confined from the Westwater Canyon aquifer.

- Site-specific tests conducted by HRI have not demonstrated that the proposed groundwater restoration standards can be achieved at a production scale. Therefore, prior to the injection of lixiviant at either the Unit 1 or Crownpoint site, HRI would be required to conduct an acceptable restoration demonstration at the Church Rock site. The demonstration would be conducted at a large enough scale to determine the number of pore volumes that would be required to restore a production-scale well field. Based on a review of the data submitted by HRI, surety (bonding) for groundwater restoration of the initial well fields shall be based on 9 pore-volumes. Surety shall be maintained at this level until HRI can demonstrate the number of pore volumes required to restore a production-scale well field.

- Prior to the injection of lixiviant at any of the three project sites, HRI would be required to conduct a Westwater Canyon aquifer step-rate injection (fracture) test within project site boundaries but outside future well field areas. Since the Unit 1 and Crownpoint sites are in reasonably close proximity to each other, only one test at either site shall be required prior to the injection of lixiviant at either site.

- Prior to the injection of lixiviant at the Crownpoint site, HRI would be required to replace town of Crownpoint water supply wells NTUA-1, NTUA-2, BIA-3, BIA-5, and BIA-6. The wells, pumps, pipelines, and any other necessary changes to the existing water supply system shall be completed so the system can continue to provide the same quantity of water. The new wells shall be located so that the water quality at each individual well head would not exceed EPA primary and secondary drinking water standards and a concentration of 0.44 mg/L uranium as a result of future ISL mining activities at the Unit 1 and Crownpoint sites. HRI shall coordinate with the appropriate agencies and regulatory authorities, including the BIA, the Navajo Nation Department of Water Development and Water Resources and the NNEPA, and the NTUA, to determine the appropriate placement of the new wells. Further, the existing wells shall be abandoned and sealed so that they cannot become future pathways for the vertical movement of contaminants.

- In the event of a vertical excursion, HRI would be required to explore any significant aquifer above the Dakota sandstone aquifer for vertical excursions, as opposed to just the deepest saturated sand of the Mesa Verde Group. The specific aquifers to be monitored in the event of a vertical excursion shall be identified in HRI's 60-day excursion report.

- Prior to conducting mining operations beyond the first well field, HRI would be required to develop an NRC-approved groundwater restoration plan for the entire project. At a minimum, this plan would include a proposed restoration schedule, and a general description or methodology of restoration and post-restoration groundwater monitoring for the entire project.

- During groundwater restoration activities at production-scale well fields at either the Unit 1 or Crownpoint site, HRI would be required to reimburse the town operators of the Crownpoint water supply wells for increased pumping and well work-over costs. This reimbursement requirement would not apply to restoration demonstrations of small-scale well fields.

- HRI would be required to maintain an adequate financial surety to cover the costs of groundwater restoration. The amount of the surety shall be determined by the NRC based on cost estimates for completing the approved restoration plan by a third party in the event HRI defaults. The surety shall be reviewed annually by the NRC and adjusted to reflect expansions in operations, changes in engineering design, and inflation.

HRI would be required to complete wells to meet the following specifications:

1. Minimum design factors for tension (1.6 dry or 1.8 buoyant), collapse (1.125), and burst (1.0) that are incorporated into casing design.
2. Casing collars shall have a minimum clearance of 10.7239 mm (0.4222 in.) on all sides in the hole/casing annulus.
3. All waiting on cement times shall be adequate to achieve a minimum of 3500 kPa (500 psi) compressive strength at the casing shoe prior to drill out.
4. All casing shall be new or reconditioned and tested used casing that meets or exceeds API standards for new casing.
5. Casing shall be cemented back to the surface (150 percent calculated volume needed).
6. Casing shall have centralizers on every fourth joint [about every 42 to 52 m (120 to 150 ft)] of casing starting with the shoe joint and up to the bottom of the collar.
7. Top plugs shall be used to reduce contamination of cement by displacement fluid. A bottom plug, or other acceptable technique, shall be utilized to help isolate the cement from contamination by the mud fluid being displaced ahead of the cement slurry.
8. All casing strings shall be pressure tested to 1.5kPa (0.22 psi) per meter (foot) of casing string length or 10,500 kPa (1500 psi), whichever is greater, but not to exceed 70 percent of the minimum internal yield (measured on surface usually using water and the rig pump). If pressure declines more than 10 percent in 30 min, corrective action shall be taken.

### 4.3.4 Alternative 4 (No Action)

Under the no-action alternative, there would be no impacts to groundwater quantity or quality. Groundwater quantity and quality would remain as described in Section 3.3.

## 4.4 SURFACE WATER

### 4.4.1 Alternative 1 (The Proposed Action)

#### 4.4.1.1 Crownpoint

All drainage channels near and at the Crownpoint site are ephemeral washes, which only contain water during infrequent periods of precipitation or snow melt. The facility would not discharge to drainage channels as a result of well field or plant operation. During periods of rainfall, well field construction and reclamation activities at the site might contribute a small amount of sediment to on-site drainage channels. After reclamation, the surface would be vegetated and contoured to prevent adverse effects to surface water quality. Any effect on water quality during infrequent periods of runoff would be expected to be small and temporary. Land application sites would be operated to minimize the potential for off-site runoff. Precautions taken would include these:

1. No irrigation during a rainfall event
2. If heavy rains are forecast, no irrigation during the preceding 12 hr
3. No irrigation on saturated soils
4. No irrigation on steep slopes or soils shallower than 72 in.

In general, HRI has committed (HRI 1996b) to follow the guidance suggested in NRC Staff Technical Position *Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites*. However, HRI has not provided detailed information regarding specific and unique details of the diversion channels or the project impoundment system. HRI has provided general information regarding the preliminary design layout of the facility and the potential for flooding of the site (HRI 1996e). Detailed information of this type is needed before NRC staff can judge the acceptability of the final design. Environmental impacts of any such design would be evaluated as part of the detailed design review. Therefore, the impacts are expected to be minimized in that existing staff guidance would address this issue.

Based on a review of the preliminary information provided by HRI (HRI 1996e), NRC staff believe that there are no unique design problems associated with the implementation and completion of the hydraulic design features of the Crownpoint site. NRC staff have visited the site area and have considerable experience in reviewing diversion channel and hydraulic designs. Based on that knowledge, NRC staff believe that an acceptable engineering design can be provided and contaminated material would not be released to drainage channels in the area as the result of impoundment failure. When that design is provided, NRC staff will evaluate its acceptability. Accordingly, a condition requiring submittal of revised hydraulic design information and review/approval by the NRC would be incorporated into the license.

#### 4.4.1.2 Unit 1

Projected surface water impacts for the Unit 1 site are nearly identical to the impacts described for the Crownpoint site (Section 4.4.1.1).

#### 4.4.1.3 Church Rock

All drainage channels near and at the Church Rock site are ephemeral washes, which only contain water during infrequent periods of precipitation or snow melt. Projected impacts for the Church Rock site are nearly identical to the impacts described for the Crownpoint site (Section 4.4.1.1). The facility would not discharge to drainage channels as a result of well field or plant operation. However, the facility might discharge restoration water into surface water streams (HRI 1996o). This discharge might occur if groundwater sweep is chosen as a groundwater restoration option and enough water rights cannot be obtained to dispose of the water by land application. Should surface water discharge be implemented, HRI would have to obtain any appropriate State or Federal permits.

Any effect on water quality during infrequent periods of runoff is expected to be small and temporary. Land application sites would be operated to minimize the potential for off-site runoff, as described for the Crownpoint site (Section 4.4.1.1).

In general, HRI has committed (HRI 1996b) to follow the guidance suggested in NRC Staff Technical Position *Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites*. However, HRI has not provided detailed information regarding specific and unique details of the diversion channels or the project impoundment system. HRI has provided general information regarding the preliminary design layout of the facility and the potential for flooding of the site (HRI 1996e). Detailed information of this type is needed before NRC staff can judge the acceptability of the final design. Environmental impacts of any such design would be evaluated as part of the detailed design review. Therefore, the impacts are expected to be minimized in that existing staff guidance would address this issue.

Based on a review of the preliminary information provided by HRI (HRI 1996e), NRC staff believe that there are no unique design problems associated with the implementation and completion of the hydraulic design features of the Church Rock site. NRC staff have visited the site area and have considerable experience in reviewing diversion channel and hydraulic designs. Based on that knowledge, NRC staff believe that an acceptable engineering design can be provided and contaminated material would not be released to drainage channels in the area as the result of impoundment failure. When that design is provided, NRC staff will evaluate its acceptability. Accordingly, a condition requiring submittal of revised hydraulic design information and review/approval by the NRC would be incorporated into the license.

### 4.4.2 Alternative 2 (Modified Action)

#### 4.4.2.1 Alternative Sites for ISL Mining

Impacts for each of the alternative sites should be less than the impacts of the proposed project, which are predicted to be of little significance. The alternatives considered are

1. The Church Rock site only
2. The Unit 1 site only
3. The Crownpoint site only
4. The Church Rock and Unit 1 sites only
5. The Church Rock and Crownpoint sites only
6. The Unit 1 and Crownpoint sites only

#### 4.4.2.2 Alternative Sites for Yellowcake Drying and Packaging

Construction, operation, and decommissioning of a processing facility at either the Church Rock or Unit 1 site should have little effect on the quality or quantity of surface water.

Use of HRI's existing ISL facility at Kingsville, Texas, or the Ambrosia Lake Uranium mill, located north of Milan, New Mexico, should have no impact on the quality or quantity of surface water at either of the two sites.

### 4.4.3 Alternative 3 (The NRC Staff-recommended Action)

This section provides a summary of additional NRC staff requirements and recommendations based on its evaluation of the proposed action. The following list supplements the commitments already made by HRI in its license application. Subsequently, HRI has formally agreed to these conditions as expressed in its letter to NRC dated December 26, 1996 (see Appendix B). The staff believe that the previously identified impacts of this project can be mitigated through the measures discussed below.

If a license were issued for the proposed project, those items listed as requirements would be incorporated in the license either as separate license conditions or combined as one general license condition that references HRI's consolidated operations plan. For those items listed as NRC staff recommendations, BIA, BLM, and other cognizant regulatory agencies will be responsible for ensuring that HRI has complied with this guidance.

The proposed project would have only minor impacts on surface water (Section 4.4.1). However, to ensure that impacts to surface water are minimized, if a license is issued for the proposed project NRC staff would require the following license conditions:

- HRI is prohibited from constructing wastewater retention ponds prior to NRC's review and approval of an embankment engineering design. The design shall contain all specifications related to embankment slope stability, liners, freeboard requirements, and leak detection systems. Any retention pond intended to retain degraded water above grade shall be designed in accordance with NRC Regulatory Guide 3.11, *Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills*. In addition, HRI shall demonstrate through detailed engineering analyses that the ponds and diversion channels around the ponds would be stable under a probable maximum flood condition, in accordance with NRC Staff Technical Position #WM-8201, *Hydrologic Design Criteria for Tailings Retention Systems*. Accordingly, HRI shall provide for NRC review detailed analyses to document the adequacy of the system during an occurrence of the probable maximum flood.

### 4.4.4 Alternative 4 (No Action)

The no-action alternative would result in no impacts to either surface water quality or quantity in the project area. Surface water quality and quantity would remain as described in Section 3.4.

# 4.5 TRANSPORTATION RISK

## 4.5.1 Alternative 1 (The Proposed Action)

Materials transportation to and from the three project sites can be classified into four categories: (1) shipments of refined yellowcake from the Crownpoint processing facility to a uranium conversion facility in Illinois, (2) shipments of yellowcake slurry or resin from the Unit 1 and Church Rock satellite facilities to the Crownpoint processing facility, (3) shipments of process chemicals from suppliers to the three sites, and (4) shipments of 11e(2) by-product material for disposal at an NRC-licensed facility in Utah. NRC staff have conceptualized and analyzed a transportation accident in each of these four categories and the results are given in the following subsections.

### 4.5.1.1 Shipments of Refined Yellowcake from Crownpoint to Illinois

Yellowcake shipments made from the proposed project would not differ from those made from a conventional mill. NRC evaluated transportation accidents associated with yellowcake shipments from conventional mills and published the results in a generic environmental impact statement (NRC 1980b). The following analysis is based on that earlier study.

Refined yellowcake would be packed in 55-gallon, 18-gauge drums holding an average of 430 kg (950 lb) and classified by the U.S. Department of Transportation as Type A packaging (49 CFR Part 171–189 and 10 CFR Part 71). Yellowcake would be shipped by truck approximately 2400 km (1500 miles) to a conversion plant in Illinois, which would process the yellowcake in the first step of manufacturing reactor fuel. An average truck shipment contains approximately 40 drums, or 17 metric tons (19 tons) of yellowcake. Based on the projected maximum annual yellowcake production for the proposed project of 1360 metric tons (3 million lb), approximately 80 shipments of 40 drums each would be required annually when each of the three sites is producing at full capacity.

The average probability of a truck accident is 4.0E-7/km (6.4E-7/miles) on interstate highways in rural areas, 1.4E-6/km (2.2E-6/miles) on interstate highways in urban areas, and 1.4E-6/km (2.2E-6/miles) on two-lane roads typical of those in the vicinity of the proposed project (Harwood and Russell 1990). Truck accident statistics for the Crownpoint vicinity are presented in Section 3.4. The route to the conversion facility in Illinois is approximately 1920 km (1193 miles) on rural interstate highways and 480 km (1298 miles) on urban highways. Based on these statistics, the projected number of shipments per year, and the shipping distance, the likelihood of a truck from the proposed project being involved in any accident during a 1-year period is approximately 1 chance in 10 on the interstate portion and 5 chances in 1000 on New Mexico 371 and Navajo 9. Given a heavy truck accident, the probability of an injury is 0.21 and the probability of a fatality is 0.01 on the interstate portion (DOT 1995). The probability of an injury or fatality from an accident involving a truck carrying yellowcake on New Mexico 371 and Navajo 9 is about 1 chance in 1000 (0.001) during a 1-year period.

In a generalized accident-risk evaluation, NRC classified accidents into eight categories, depending on the combined stresses of impact, puncture, crush, and fire. On the basis of this classification scheme, conditional accident probability was developed for eight severity levels. These fractional probabilities of occurrence for truck accidents are given in column 2 of Table 4.15.

To assess the risk of a transportation accident, the fraction of radioactive material released when an accident of a given severity occurs must be known. For this analysis, two accident models are considered. Model I is hypothetical; complete loss of drum contents is assumed for all but the lowest accident severity category. Model II is based on actual tests; partial loss of drum contents is assumed. The yellowcake packages are Type A drums containing low specific activity (LSA) material. The fractional releases to the environment for each model are shown in columns 3 and 4 of Table 4.15.

Considering the fractional occurrence and the release fractions (loss) for Models I and II, the quantity of yellowcake released from the containers in the event of a truck accident is estimated to be 7700 kg (17,000 lb) for Model I and 520 kg (1140 lb) for Model II.

The previously stated probabilities of an accident can now be further defined: the probability of an accident producing a Model I release (upper bound) is 0.05 per year on the interstate system and 0.002 per year on New Mexico 371 and Navajo 9. The Model II accident probabilities (more realistic) are 0.004 per year on the interstate system and 0.0002 per year on New Mexico 371 and Navajo 9.

Most yellowcake released from the container would be deposited directly on the ground in the immediate vicinity of the accident. However, some fraction of the released material would be dispersed to the atmosphere. Using expressions for material dispersal to the environment (Battelle Northwest Laboratories 1975), the following empirical expression was derived for release from the container:

$$F = 0.001 + 4.6E\text{-}4\ (1\text{-}e^{-0.15ut})\ u^{1.78}$$

where

| | | |
|---|---|---|
| F | = | the fractional airborne release, |
| u | = | the wind speed at 15.2 m (50 ft) expressed in m/s, |
| t | = | the duration of the release, in hours. |

In this expression, the first term represents the initial "puff" that is immediately airborne when the container fails in an accident. Assuming the wind speed is 5 m/s (10 mph) and the time available for release is 24 hours, the estimated environmental release fraction would be 9E-3. A recent summary of data by DOE (1994) shows this value to be conservative by a factor of nearly 6. For insoluble uranium, all particles in the respirable size range, and a typical population density of 61 persons/km$^2$ (160 persons/ miles$^2$) of the eastern United States, the 50-year dose commitments to the lungs of the general public would be about 2 man-Sv (200 man-rem) and 0.14 man-Sv (14 man-rem) for Models I and II, respectively. These values estimate the doses integrated over a 50-year time period following exposure. Population density for the eastern United States was used because yellowcake shipments would be sent to Illinois. Integrated dose estimates for more sparsely populated areas would be lower.

In an accident that occurred in September 1977 (NRC 1980b), a commercial carrier hauling 50 drums of uranium concentrate overturned and spilled an estimated 3200 kg (7000 lb) of yellowcake on the ground and in the truck trailer. Within 3 hr, the material was covered with plastic sheeting to prevent

**Table 4.15. Fractional probabilities of occurrence and corresponding package release fractions for each of the release models for low specific activity (LSA) and Type A containers involved in truck accidents**

| Accident severity category | Fractional occurrence of accident | Release fractions | |
|---|---|---|---|
| | | Model I | Model II |
| I | 0.55 | | 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 |

*Source:* Nuclear Regulatory Commission 1977. *Final Environmental Report on the Transportation of Radioactive Materials by Air and Other Modes* (NUREG-0170).

further release to the atmosphere. Using the formula given earlier for the 3-hour duration of release, an estimated 24 kg (53 lb) of $U_3O_8$ were released to the atmosphere. The consequence for the area in which the accident actually occurred, where the population density is about 1.0 person/km$^2$ (2.5 persons/miles$^2$), is estimated to be 0.012 man-Sv (1.2 man-rem).

Inhaling yellowcake dust might produce some health effects due to the chemical toxicity of uranium. In the case of the September 1977 accident, 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 chemically toxic levels of uranium intake did not occur.

#### 4.5.1.2 Shipments of Uranium Slurry from the Satellite Processing Facilities to the Main Processing Facility

HRI's proposal to operate the Church Rock and Unit 1 facilities involves transporting yellowcake slurry or resins from the satellite processing facilities to the Crownpoint facility for processing, drying, and packaging. The slurry would be transported by truck from the satellite plants in specially designed 9900-L (2600-gal) stainless steel tanks with walls that are 0.65 cm (0.25 in.) thick. Such tanker trucks would withstand the impact of most collisions. The truck accident rate per trip is 9.2E-5 from Church

Rock and 6.6E-6 from Unit 1 (Section 3.4). The projected maximum annual yellowcake yield from both the Church Rock and Unit 1 facilities is 454 metric tons (1 million lb), and approximately 100 tank truck shipments per year would be the maximum required from each satellite site. Based on accident statistics and the projected number of annual shipments, the likelihood of a tank truck from the Church Rock site being involved in an accident during a 1-year period is 0.009. The likelihood of a fatality or injury from a uranium tank truck accident during a 1-year period is 0.002.

In the most severe conditions, an accident would result in a rupture of the tank and release of only a portion of the slurry. During such an accident, slurry would pour onto the ground and thicken as water in the slurry soaked into the ground. Eventually, some slurry would dry, and yellowcake could be released to the atmosphere near the spill, depending on the time required to clean up the material.

The effects of accidents involving wet yellowcake would be considerably less than those involving yellowcake dust as described in Section 4.5.1.1 because the material would be incapable of becoming airborne as dry dust. To prevent the spread of contamination, HRI would be responsible for cleaning up the slurry as rapidly as possible. Oversight would be provided on-site by an NRC inspector through NRC's regional office and by the Incident Response Center and would be coordinated with State and local emergency assistance teams.

Sufficient statistical data are not available for a quantitative analysis of the consequences of such an accident. However, the consequences would likely be considerably lower than those estimated for the shipment of dry concentrate.

#### 4.5.1.3 Shipments of Chemicals to the Processing Facilities

Truck shipments of process chemicals, including small quantities of analytical reagents, to the Crownpoint facility and the satellite plants could result in local environmental impacts if the trucks are involved in an accident. Processing chemicals required at the project sites are exhibited in Table 4.16. All uranium recovery sites, including mills and solution mines, require similar processing chemicals. The potential for shipping accidents is similar at all sites as well.

**Table 4.16. Bulk chemicals required at the project processing sites**

| Shipped as dry bulk solids | Shipped as liquids and gases |
|---|---|
| Salt (NaCl) | Hydrochloric acid (HCl) |
| Sodium bicarbonate ($NaHCO_3$) | Hydrogen peroxide ($H_2O_2$) |
| Sodium carbonate ($Na_2CO_3$) | Carbon dioxide ($CO_2$) |
| Sodium hydroxide (NaOH) | Oxygen ($O_2$) |
| | Diesel oil |
| | Bottled gases |
| | Liquified petroleum gas (LPG) |

#### 4.5.1.4 Shipments of 11e(2) By-product Material for Disposal in Utah

HRI would dispose of all 11e(2) by-product material generated by the project at an off-site, NRC-licensed disposal facility (HRI 1996b). Currently, HRI is contracted with Energy Fuels Nuclear to use their disposal facility in Blanding, Utah (HRI 1996b). HRI has not provided information concerning the amount of 11e(2) by-product material that would be generated by the project, the number of truck shipments that would be required to transport the material to the disposal facility, or the specific route that would be used to transport the material from the project area to Blanding, Utah. However, the risk associated with each shipment of 11e(2) by-product material from the project to Utah would be less than that associated with each shipment of yellowcake from the project to Illinois (Section 4.5.1.1). This decreased risk is primarily due to the relative proximity of the disposal facility in Utah [approximately 404 km (250 miles) from Crownpoint, assuming transportation via Highway 666 north from New Mexico into Utah and Highway 191 south to Blanding] compared to the conversion facility in Illinois [approximately 2400 km (1500 miles)].

### 4.5.2 Alternative 2 (Modified Action)

Several alternative sites could be selected for yellowcake drying and packaging. Use of either the Church Rock or the Unit 1 facilities would not appreciably change the potential impacts discussed for transporting processed yellowcake from the Crownpoint facility. The use of the Ambrosia Lake facility near Milan, New Mexico, would slightly increase the risk associated with transporting uranium slurry, which is small compared to that for yellowcake, and slightly decrease the risk of transporting yellowcake since Milan is about 50 miles closer to the yellowcake conversion plant in Illinois. The use of HRI's Kingsville, Texas, facility would significantly increase the risk of transporting uranium slurry and slightly increase the risk of transporting yellowcake.

### 4.5.3 Alternative 3 (The NRC Staff-recommended Action)

This section provides a summary of additional NRC staff requirements and recommendations based on its evaluation of the proposed action. The following list supplements the commitments already made by HRI in its license application. Subsequently, HRI has formally agreed to these conditions as expressed in its letter to NRC dated December 26, 1996 (see Appendix B). The staff believe that the previously identified impacts of this project can be mitigated through the measures discussed below.

If a license is issued for the proposed project, those items listed as requirements would be incorporated in the license either as separate license conditions or combined as one general license condition that references HRI's consolidated operations plan. For those items listed as NRC staff recommendations, BIA, BLM, and other cognizant regulatory agencies will be responsible for ensuring that HRI has complied with this guidance.

The transportation risk associated with shipments to and from the proposed project would be relatively small (Section 4.5.1). However, to further minimize transportation risk, if a license is issued for the proposed project, NRC staff would require the following license condition:

- Yellowcake and 11e(2) by-product waste material, other than samples for research, shall not be transferred from the site without specific prior approval of the NRC in the form of a license amendment. HRI shall maintain permanent record of all transfers made under the provisions of this condition. Transfers of samples for research shall comply with provisions of 10 CFR § 40.22.

In addition to this license condition, NRC staff recommends the following measures to help minimize transportation risk:

- all delivery trucks used to transport project materials (uranium slurry, yellowcake, and process chemicals) should carry the appropriate certifications of safety inspections; and

- all delivery truck drivers should hold appropriate licenses.

### 4.5.4 Alternative 4 (No Action)

There would be no transportation risk associated with the no-action alternative.

## 4.6 HEALTH PHYSICS AND RADIOLOGICAL IMPACTS

This section describes an analysis of estimated incremental radiological impacts to the environment and the population that would be contributed from the proposed project. The primary radiological impact to the environment in the vicinity of the project results from naturally occurring cosmic and terrestrial radiation and naturally occurring radon-222 and its daughters. The average whole-body dose rate to the population in this part of New Mexico includes a dose of 1.5 mSv/year (150 mrem/year) from local natural background radiation and 0.75 mSv/year (75 mrem/year) from medical procedures, based on national average. Therefore, total background is estimated to be about 2.25 mSv/year (225 mrem/year). Dose estimates and airborne concentrations of radionuclides from the proposed project do not include natural background and are incremental values.

This analysis examines three types of potential exposures to members of the public. During project operations, releases could occur in the form of air releases of particulate and gases. Additionally, HRI would have to dispose of waste materials from the ISL process. After operations, HRI would have to reclaim well fields and facility grounds to allow unrestricted release in the future.

### 4.6.1 Alternative 1 (The Proposed Action)

Analysis of potential air releases is primarily based on estimated releases of radioactive materials, determined by HRI, using an NRC radiological dose assessment code known as MILDOS-AREA (ANL 1989). HRI ran separate MILDOS-AREA simulations for operations in the Crownpoint and Church Rock areas. The Crownpoint area includes operations at both Unit 1 and Crownpoint facilities. The operations at each of the facilities are similar except that final drying and packaging of natural uranium would take place only at the Crownpoint facility. Detailed analyses of the estimated radiological impacts of the proposed operations to nearby individuals and the entire population within 80 km (50 miles) of each facility have been performed.

With HRI's proposed action, there would be no radioactive waste material released into surface waters. Although some contaminated water leaked from retention ponds could affect the groundwater system, no significant contribution to dose by water pathways is anticipated. As a control, HRI would perform environmental monitoring to provide early detection of any seepage from retention ponds that might occur and to take appropriate mitigating measures. Solid and sludge waste material would be sent to a licensed disposal site for burial. Wastewater would be disposed of primarily in evaporation ponds after the volume had been reduced by either reverse osmosis or brine concentration. During restoration, land application might be used, due to the much higher volume of wastewater created.

Radiological effects during project construction would include natural background plus remnant radiation stemming from previous mining and milling activities near the Church Rock site. As each well in the mine units is drilled through the Westwater Canyon sandstone, drill cuttings containing uranium ore would be entrained into the drilling mud. The relative volume of uranium in the drilling mud would be minute, and there would be no significant radiological impact to the area. Ore cuttings would be entrained in the wet drilling mud, and would be contained in the mud pits. HRI would allow the pits to dry for a time, and then backfill them with clean soil when the drilling site is reclaimed. In addition, HRI would be required to verify that well fields have been properly reclaimed and meet appropriate requirements before releasing the well field back to unrestricted use.

#### 4.6.1.1 Crownpoint and Unit 1

**Air Releases**

**Source Term.** Operations in the immediate vicinity of the town of Crownpoint would occur at both the Crownpoint and Unit 1 sites, each of which would be brought into production on different schedules. Table 4.17 shows the planned schedule of operations at the two facilities. Analysis of radiological effluents was done for the fourth time step, in which the operations are at a maximum at both sites.

**Table 4.17. Crownpoint and Unit 1 timeline**

| Year | Actions |
|---|---|
| 1998–1999 | Unit 1—Production flow only<br>Crownpoint—Drying only |
| 2000–2001 | Unit 1—Production flow and limited restoration<br>Crownpoint—Production flow only |
| 2002–2014 | Full production flow and restoration flow |
| 2015–2018 | Restoration flow only |

HRI has determined that the project would have controlled releases from three areas (source terms) within each operation. The source terms are: (1) the resin transfer/process circuit, (2) the process circuit pressure vents, and (3) land application releases. Typical ISL uranium mines have additional source terms, but HRI has proposed various modifications to its operations to remove radon source term locations. Engineering modifications were made to the production and restoration bleed stream to eliminate radon dispersion into the environment from wastewater. In both situations, process bleed and restoration stream waters would be circulated through vented tanks. The off-gas would be captured, compressed, and injected into the lixiviant injection system for reintroduction into the ore zone. The off-gas from the bleed streams would largely consist of carbon dioxide, but would also contain virtually all radon gas dissolved in the lixiviant when it is pumped to the surface.

The release from the resin transfer/process circuit assumes that each ion exchange column would contain 1.323 $m^3$ (3500 gal) of process water and would be vented three times a day. This value is conservative because each column would actually contain a large volume of resin, and less water. It is further assumed that the water contains a dissolved radon concentration of 4.9 $MBq/m^3$ (133,000 pCi/L) with a very conservative 100 percent radon evolution rate. This results in a calculated radon release of 68 GBq (1.83 Ci) per year.

The process circuit pressure vents situated on trunk lines would discharge for 2 s every 5 min. With a carrying capacity of 0.25 $m^3/s$ (4000 gpm) for each trunk line and 20 total vents, the radon released by this system would be approximately 110 GBq/year (2.96 Ci/year). This value is conservative because it assumes that all trunk lines are functioning continuously at the maximum proposed flow rate.

Restoration water would not be open to venting until it arrives at the land application area in Section 12. The source term for modeling was based on equal volumes of water from each of the facilities being disposed of at the land application area. All of the releases are assumed to happen in the center of Section 12. Based on a dissolved radon concentration of 4.9 $MBq/m^3$ (133,000 pCi/L) and a flow rate of 0.019 $m^3/s$ (300 gpm), the source term from each facility would be 2.9 TBq (79.35 Ci), or a total of 5.8 TBq (159 Ci), per year. It assumes 100 percent evolution of radon-222 and a high flow rate for restoration water.

Traditionally, open hearth dryers at uranium recovery facilities are a primary source of airborne particulates. The vacuum dryer proposed by HRI is a state-of-the-art, zero-release unit that would result in very minimal particulate emissions from the drying and packaging areas. The proposed drying system would have no vent stack. Additionally, because the ISL production circuit is a wet process, no routine radiological particulate emissions source terms are predicted from other portions of the process circuit. The vacuum dryer is more fully described in Section 2.1.2.1. HRI performed a separate MILDOS-Area calculation of emissions from the drying and packaging areas (HRI 1994). The modeled source term for the dryer at the main process facility was based on data gathered for U-238 at an ISL facility using a similar vacuum dryer in Texas. Using an assumption that the measured value of the lixiviant ratio between Ra-226 and U-238 was constant, the source terms resulted in the following values: U-238, 9.0 kBq/yr (0.243 $\mu$Ci/yr); Th-230, Ra-226, Pb-210, each 58 Bq/yr (1.56 nCi/yr).

**Population Distribution.** Population census data for 1980, updated to 1990 by projections and field verified, were used in the MILDOS-Area program. Population data for input into the program were determined for persons living within 5 km and 80 km (3 and 50 mi) of the Crownpoint site. HRI determined that approximately 3,600 persons live within 5 km of the Crownpoint process building, and that 76,000 persons live within the 80 km radius. Residences found within lease areas, the nearest residence downwind, and total populations were used in each modeling run to determine compliance with regulatory dose restrictions.

**Meteorological Parameters.** Weather data used in the MILDOS-Area simulations were obtained from U.S. Department of Commerce records maintained for Gallup, New Mexico. Gallup is located about 16 km (10 mi) southwest of the Church Rock site, and 56 km (35 mi) from Crownpoint. Gallup is the nearest active weather station maintaining the complete weather information necessary to run the MILDOS program. More information on meteorology can be found in Section 3.1.1.

**Individual Receptor Locations.** HRI modeled 38 separate receptors for the Crownpoint operational area. The Crownpoint receptors are actual residences or multi-use locations (e.g., churches) near the main processing facility or in the Unit 1 lease area (Figure 4.3). These receptors include nearest residences, nearest downwind residences, population concentrations, and hypothetical facility and well field boundary receptors. HRI would be required to implement a comprehensive environmental monitoring program to determine the annual doses to individuals in unrestricted areas.

**Exposure Pathways.** Potential environmental exposure pathways by which persons could be exposed to radioactive air effluents are presented schematically in Figure 4.4. Estimated dose commitments to humans are based on the proposed facility design and actual characteristics of the site environment. NRC's analysis considers both radioactive particulates and gaseous releases to the atmosphere.

Environmental exposure pathways of concern for airborne effluents from the project include inhaling radioactive materials in the air, particularly radon and its daughters. To a much lesser degree, external exposure would occur from radioactive materials in the air or deposited on ground surfaces, and possibly ingesting contaminated food products (vegetables, milk, and meat) raised locally.

**Regulatory Limits on Exposure for Individuals.** Permissible dosage limits found in 10 CFR Part 20 for individual members of the public are 1 mSv (100 mrem) total effective dose equivalent (TEDE), and 0.02 mSv/hr (2 mrem/hr) from any external sources. Compliance with the annual dose limit to the public (10 CFR § 20.1301) can be shown by calculating the dose to the individual at greatest risk (nearest residence) or compliance with annual concentration levels (10 CFR Part 20, Appendix B) at the site boundary. Two EPA standards apply to this operation. EPA's established average annual dose limits, found in 40 CFR Part 190, *Environmental Radiation Protection Standards for Nuclear Power Operations*, are 0.25 mSv (25 mrem) whole body, 0.75 mSv (75 mrem) to the thyroid, and 0.25 mSv (25 mrem) to any other organ for a member of the public. The other EPA standard, found in (currently suspended) 40 CFR Part 61, Subpart I, *National Emissions Standard for Hazardous Air Pollutants*, is a 0.1 mSv (10 mrem) TEDE limit. The EPA standards exclude radon and its daughters.

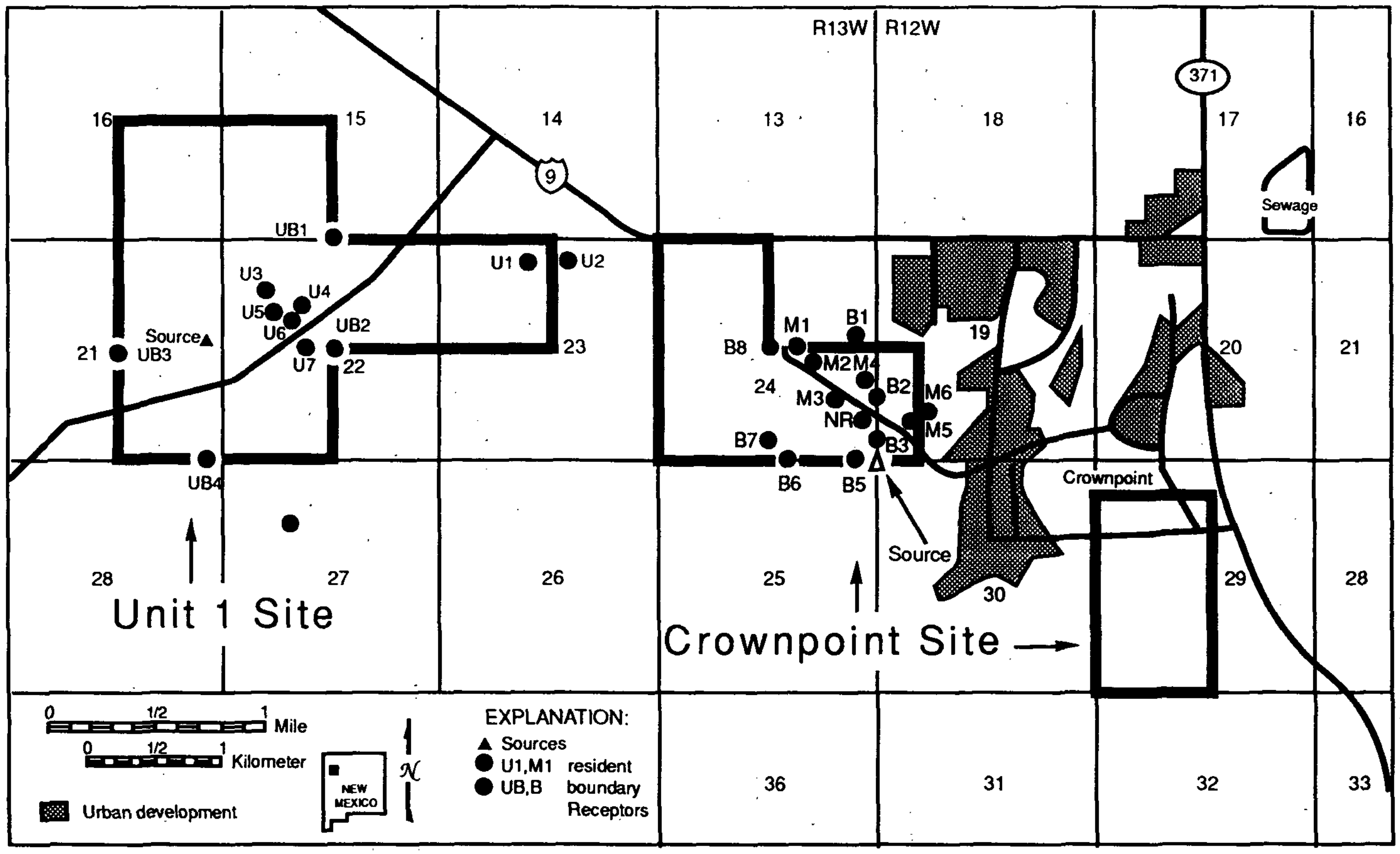


**Figure 4.3. Residences and boundary receptors in the Crownpoint and Unit 1 areas.**

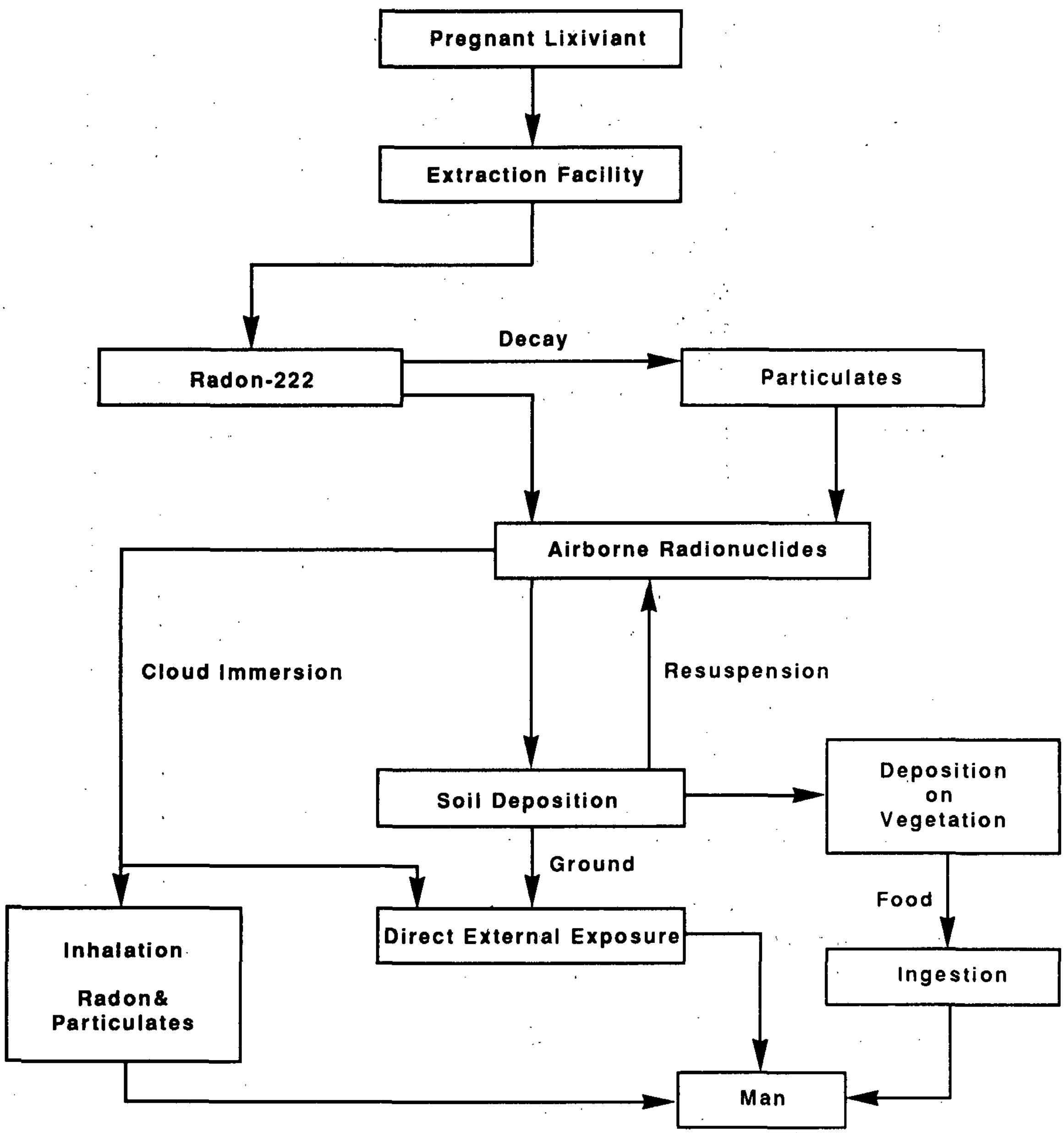


**Figure 4.4.** Potential exposure pathways for radon-222 and its daughters, escaping the uranium recovery process and wastewater treatment facilities.

**Estimated Doses at Modeled Receptors.** The dose assessment presented here considers doses to infants, which are slightly more sensitive than other age categories. All modeled total annual dose commitments predicted at nearest residences are below the TEDE limits found in NRC regulations. Releases from the Unit 1 site consist only of radon and, thus, are excluded from the evaluation of 40 CFR Part 61, Subpart I and 40 CFR Part 190. Particulate releases from the main processing facility at Crownpoint would be minimal and well below the EPA standards. The estimated dose commitments during periods of simultaneous operations at both Crownpoint and Unit 1 with maximum releases are shown in Table 4.18. The dose estimates include dose commitment due to radon and its daughters.

**Table 4.18. Estimated TEDE doses from air effluent releases from the Crownpoint Project facilities to various receptor locations**

| Crownpoint | | Unit 1 | | Church Rock | |
|---|---|---|---|---|---|
| Receptor | TEDE[a] | Receptor | TEDE | Receptor | TEDE |
| MX1 | 0.21 | U1RX1 | 0.29 | CRR 1 | 0.017 |
| MX2 | 0.27 | U1RX2 | 0.29 | CRR 2 | 0.019 |
| MX3 | 0.35 | U1RX3 | 0.27 | CRR 3 | 0.024 |
| MX4 | 0.46 | U1RX4 | 0.27 | CRR 4[b] | 0.25 |
| MX5 | 0.28 | U1RX5[b] | 0.28 | CRR 5 | 0.055 |
| MX6 | 0.23 | U1RX6 | 0.28 | CRR 6 | 0.033 |
| MX7 | 0.14 | U1RX7 | 0.26 | CRR 7 | 0.017 |
| NR | 0.76 | | | CRR 8 | 0.011 |
| School | 0.07 | | | CRR 9 | 0.012 |

[a]In mrem/year; for mSv/year, divide by 100.
[b]Nearest residence.

**Airborne Concentrations of Radionuclides.** In addition to the dose estimates, the MILDOS-AREA code presents the estimated airborne concentration of radionuclides at the various residential and boundary receptor locations near the processing sites. The MILDOS-AREA code was run for both the combined radon sources at the two facilities and, in a separate calculation, for the minimal particulates released from drying and packaging areas. A table of the calculated radon-related concentrations, for the same receptor locations as shown in Table 4.18, is shown in Table 4.19 for Crownpoint and Unit 1.

At Crownpoint, the nearest residence is found adjacent to the plant site, less than 1 km (0.6 mile) away. Projected concentrations of airborne radionuclides there were modeled assuming no emission controls for radon. The resulting values are small percentages of the allowable effluent limits for unrestricted

**Table 4.19. Airborne concentrations of radon and daughters at selected receptor locations near the Crownpoint and Unit 1 facilities**

| Location | Rn-222 (WL)[a] | Pb-210[b] | Bi-210[b] | Po-210[b] |
|---|---|---|---|---|
| | | **Crownpoint** | | |
| MX1 | 1.55E-05 | 2.3E-18 | 5.4E-21 | 3.4E-25 |
| MX2 | 1.55E-05 | 2.3E-18 | 5.5E-21 | 3.6E-25 |
| MX3 | 1.55E-05 | 2.3E-18 | 6.1E-21 | 4.4E-25 |
| MX4 | 1.5E-05 | 2.2E-18 | 6.0E-21 | 4.4E-25 |
| MX5 | 1.3E-05 | 2.1E-18 | 5.9E-21 | 4.6E-25 |
| MX6 | 1.2E-05 | 2.0E-18 | 5.7E-21 | 4.5E-25 |
| MX7 | 9.8E-06 | 1.7E-18 | 4.8E-21 | 3.8E-25 |
| NR[c] | 1.6E-05 | 2.3E-18 | 6.4E-21 | 4.9E-25 |
| School | 5.8E-06 | 1.5E-18 | 4.9E-21 | 4.7E-25 |
| | | **Unit 1** | | |
| U1RX1 | 2.5E-05 | 3.8E-15 | 8.0E-21 | 4.6E-25 |
| U1RX2 | 2.4E-05 | 3.5E-18 | 7.0E-21 | 3.9E-25 |
| U1RX3 | 2.3E-05 | 6.6E-18 | 2.3E-20 | 2.1E-24 |
| U1RX4 | 2.3E-05 | 6.6E-18 | 2.2E-20 | 2.0E-24 |
| U1RX5[c] | 2.3E-05 | 6.6E-18 | 2.2E-20 | 2.0E-24 |
| U1RX6 | 2.4E-05 | 6.5E-18 | 2.2E-20 | 2.0E-24 |
| U1RX7 | 2.4E-05 | 6.8E-18 | 2.3E-20 | 2.1E-24 |
| Limits[d] | 1.1E-3 | 4E-12 | 2E-10 | 7E-12 |

[a]Units of working levels, which accounts for levels of short half-lived daughter products.
[b]Units of $\mu$Ci/mL; for pCi/m$^3$, multiply by $10^{12}$; for Bq/m$^3$, multiply by $3.7 \times 10^{10}$.
[c]Nearest residence downwind, assuming Gallup wind rose.
[d]Concentration limits in 10 CFR Part 20, Appendix B. Continuous exposure to concentrations at the limit will result in approximately 0.5 mSv (50 mrem) per year.

areas (Table 4.19, receptor NR). Predicted radon-222 values are 1.5 percent of the maximum limit. Each radon daughter modeled was several orders of magnitude less than the allowable limits. For other nearby residences, the projected concentrations of airborne radionuclides were similar to or lower than those at the nearest residence, and therefore, well below the maximum allowable concentrations for unrestricted areas.

**Evaluation of Radiological Impacts on the Public.** Calculated annual individual dose commitments are only small fractions of the NRC limits for radiation exposure in unrestricted areas, as specified in 10 CFR Part 20, *Standards for Protection Against Radiation*. Calculated dose commitments to actual receptor locations are also well below limits specified in EPA's standards (40 CFR Part 190 and 40 CFR Part 61, Subpart I). Verification that these regulatory criteria are not exceeded would be provided by the required environmental monitoring program.

### Liquid Waste Disposal

HRI has proposed two possible ultimate waste disposal techniques for wastewater remaining after volume reduction has been completed: evaporation ponds and land application. The use of evaporation ponds would result in minimal off-site releases under normal operations because of the proposed pressurized system's removing the radon from the circuit and future decontamination and disposal of the pond residues in licensed waste disposal facilities. Land application could result in exposures to individuals, not only during operations but also in the far future, long after operations have ceased. HRI did not submit a detailed plan for land application and would need to submit a detailed license amendment in the future to use land application for wastewater. This evaluation is based on the assumptions and information presented by HRI in its general concepts on using land application. An environmental assessment of the license amendment for land application would be completed as part of the licensing process.

The land application option would only be used for mine wastewater resulting from restoration activities at each of the facilities. Each facility would have a separate irrigation plot of 21 ha (52 acres) on Section 12. Air releases of radon during irrigation were analyzed using MILDOS-AREA with the source term as described above. The potential impacts to a future resident of Section 12 for ground contamination are assessed using the RESRAD code (ANL 1995), which was developed by the U.S. Department of Energy to calculate the risks from residual amounts of radioactivity in the environment.

The treated wastewater would have average constituent values of 37 Bq/m$^3$ (1 pCi/L) and 1 mg/L for radium and uranium, respectively. HRI estimates that restoration would take 4 pore volumes. Based on this volume flow and the individual irrigation plot area of 21 ha (52 acres), the estimated maximum radionuclide concentrations are shown in Table 4.20. Since the expected accumulation would be sensitive to the amount of water needed for restoration, if the number of pore volumes needed increased, radionuclide concentrations (and calculated doses) would increase similarly, unless HRI used larger irrigation plots to counter the increased volume of water. HRI has additional acreage available in Sections 12 and 17 for irrigation area.

**Table 4.20. Estimated accumulation in land application soils**

| Parameter | Unit 1 | Crownpoint | Church Rock |
|---|---|---|---|
| Ra-226 (pCi/g) | 0.068 | 0.081 | 0.061 |
| Uranium (ppm) | 16.7 | 20.0 | 15.2 |

Radon was assumed to be released from the restoration water immediately prior to land application at the center of Section 12 for both restoration flows. Receptor locations at the edges of Section 12 were analyzed, resulting in the estimated doses in Table 4.21.

**Table 4.21. Estimated doses at the boundary of Section 12 due to land application of restoration fluids**

| Location | TEDE (mrem/yr) |
|---|---|
| East (IBR 1) | 0.31 |
| North (IBR 2) | 0.42 |
| West (IBR 3) | 0.28 |
| South (IBR 4) | 0.21 |

To calculate potential future exposure, the following conservative scenario is assumed. Immediately after cessation of operations, it is assumed that an individual or family moves onto the irrigation plot, unaware of the residual radioactivity present. The individual, who is termed an inadvertent intruder, proceeds to spend 55 percent of the time indoors on site, 21 percent outdoors on site (5 hr per day for 365 days) and 24 percent of the time away from the site. A garden grown in the contaminated area is assumed to supply 50 percent of the resident's vegetable, grain, and fruit diet. The resident maintains a small group of cattle, which supply all of the resident's milk and 50 percent of the meat diet. Water for drinking and other uses is assumed to come from off-site because of two site-specific conditions: (1) nearly the entire population surrounding Crownpoint receives water from the town water supply wells; and (2) uranium and radium are not expected to migrate from the ground surface to the usable aquifer in the next 1000 years. Additionally, no aquatic food sources are assumed to be contaminated.

An assessment is calculated for each section. For the intruder into Section 12, the ground concentration for the entire 104 acres of land application area is conservatively assumed equal to the higher concentration estimated for the main facility. The highest exposures could occur immediately after closure, and the maximum calculated doses are shown in Table 4.22. The highest dose occurs in Section 12, which would have not only higher concentrations of radionuclides, but also a larger area of residual radioactivity. The calculated doses are within acceptable levels for waste disposal techniques and potential exposures in unrestricted areas.

At each site, land application would be restricted to the lease areas held by HRI, and would be regulated by irrigation standards or water use standards adopted by the appropriate regulatory authority (State of New Mexico Environmental Department or U.S. EPA), generally using a zero-release NPDES permit.

**Table 4.22. Potential doses to residential farmers**

| Nuclide[a] | Section 12 mSv (mrem) | Section 17 mSv (mrem) |
|---|---|---|
| Ra-226 | 0.09 (9) | 0.07 (7) |
| Uranium | 0.025 (2.5) | 0.02 (2) |
| Total | 0.115 (11.5) | 0.09 (9) |

[a]Includes all appropriate doses from daughter products.

### Decontamination and Disposal

As discussed in Section 4.2.3, HRI would be required by license condition to submit a detailed decommissioning plan to NRC 1 year prior to beginning closure of either the Crownpoint or Unit 1 production facilities. Before release of an area to unrestricted use (i.e., well field, land application area, production facilities), HRI would be required to provide information to NRC to verify that radionuclide concentrations meet applicable radiation standards. Currently, the soil cleanup criterion for natural uranium not in equilibrium with its daughters is 1.1 Bq/g (30 pCi/g), and for radium is 0.19 Bq/g (5 pCi/g) in the top 15 cm and 0.57 Bq/g (15 pCi/g) for other soils.

## 4.6.1.2 Church Rock

### Air Releases

Project operations at the Church Rock site would be similar in scope and function to those at the Unit 1 site. The proposed time scale of operations is 8 years, as shown in Table 4.23. The only radiological air effluents during operations would be radon. To minimize releases, HRI proposes to use a pressurized circuit.

**Table 4.23. Church Rock timeline**

| Year | Actions |
|---|---|
| 1 | Production flow with limited restoration |
| 2–3 | Production flow only |
| 4–6 | Full production and restoration flow |
| 7–8 | Restoration flow only |

Calculations for all the facilities were conducted on the radon released from two source terms: resin transfer and pressure vents. In the process circuit, consisting of circulating production water through ion exchange columns, the calculated radon release was 66 GBq (1.784 Ci) per year. This value assumes that each ion exchange column would contain 1.323 $m^3$ (13,230 L) of process water and would be vented three times a day. This value is conservative because each column would actually contain a large volume of resin, and less water. It is further assumed that the water contains a dissolved radon concentration of 4.8 kBq/L (129,610 pCi/L) with a very conservative 95 percent radon evolution value. No particulate source terms exist for the Church Rock facility because the dryer would be located at the Crownpoint main facility.

The process circuit pressure vents situated on trunk lines would discharge for 2 s every 5 min. With a carrying capacity of 0.25 $m^3/s$ (4000 gpm) for each trunk line and 20 total vents, the radon released by this system would be approximately 110 GBq/yr (2.96 Ci/yr). This value is conservative because it assumes that all trunk lines are functioning continuously at the maximum proposed flow rate.

For the Church Rock site, 575 people live within 5 km (3.1 miles) and approximately 74,000 persons live within the 80-km (50-mile) radius. Residences found within lease areas, the nearest residence downwind, and total populations were used in each modeling run to determine compliance with regulatory dose restrictions. Seventeen receptors were modeled near the Church Rock facility (Figure 4.5). Other modeling assumptions are similar to those made for the Unit 1 and Crownpoint sites. The calculated exposures for the receptor locations are shown in Table 4.18. Calculated airborne concentrations of radon and daughters at the site boundary and nearest downwind residence (based on Gallup wind rose) are shown in Table 4.24.

For the Church Rock analysis, radon emission controls reduce the airborne concentration by approximately a factor of 10 (see Table 4.24). The resulting values at the nearest residence are approximately 0.5 percent and 7.6 percent of the limit, with and without the emissions controls, respectively. The calculated exposures and potential concentrations, with emission controls, are a small fraction of the regulatory limits.

### Liquid Waste Disposal

Similar to both the Crownpoint and Unit 1 facilities, the Church Rock facility may use land application to dispose of its restoration wastewater. This wastewater would be pre-treated to minimize contaminants and volume. The wastewater would then be applied to a 21-ha (52-acre) site in Section 17. Additional area in Section 17 is available, if needed.

Expected air concentrations due to land application would be similar to the analysis for the Crownpoint/ Unit 1 land application area. As indicated in Table 4.20, expected soil concentrations for the Church Rock property are lower than concentrations expected from either Unit 1 or Crownpoint. The resulting peak exposure to the intruder is approximately 0.09 mSv/yr (9 mrem/yr), which would occur in the first year after cessation of irrigation (Table 4.22). The calculated dose is within acceptable levels for waste disposal techniques and potential exposures in unrestricted areas.

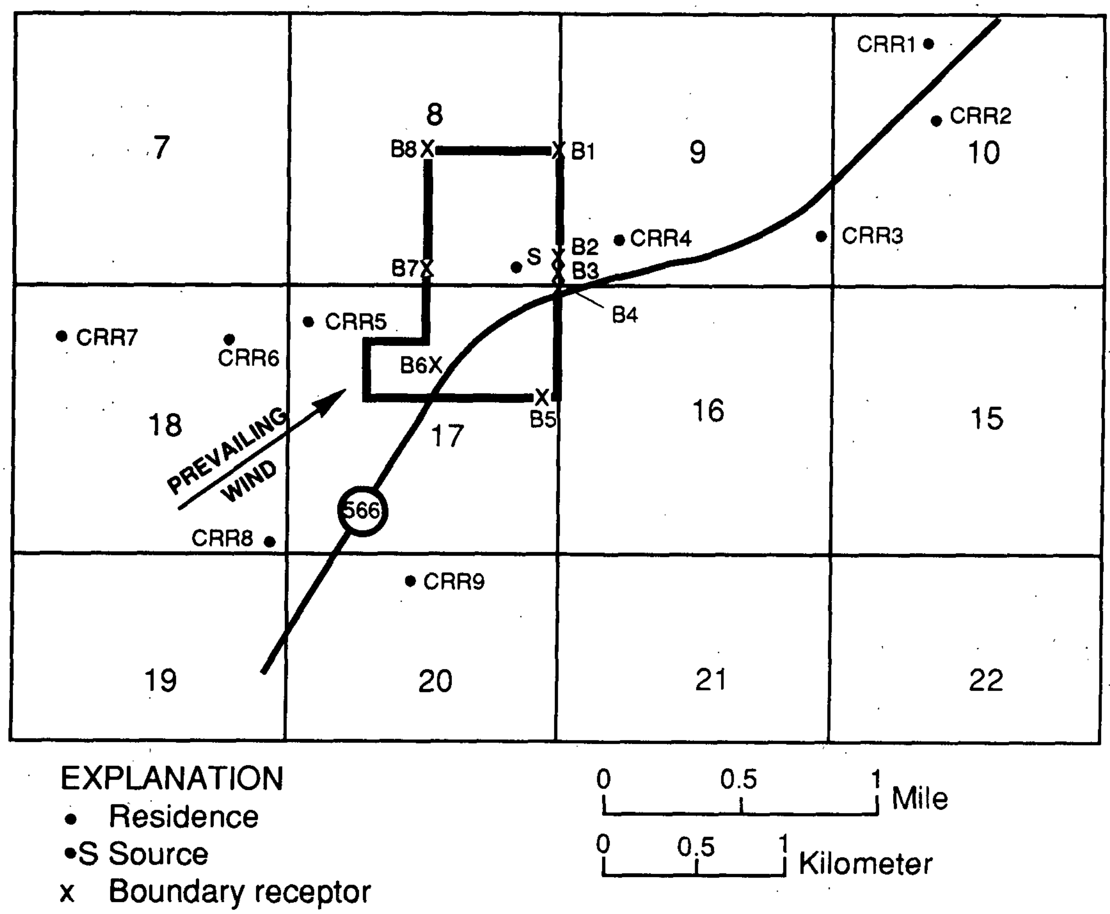


**Figure 4.5. Residences and boundary receptors in the Church Rock area.**

**Table 4.24. Airborne concentrations of radon and daughters at selected receptor locations near the Church Rock satellite facility**

| Location | Rn-222 (WL)[a] | Pb-210[b] | Bi-210[b] | Po-210[b] |
|---|---|---|---|---|
| | | **Totals (pressurized system)** | | |
| BR-1 N | 3.6E-06 | 3.3E-20 | 1.5E-23 | 1.9E-28 |
| BR-2 NE | 1.1E-06 | 8.5E-21 | 2.0E-24 | 1.4E-29 |
| BR-3 E | 8.1E-06 | 6.2E-21 | 1.4E-24 | 9.9E-30 |
| BR-4 SE | 3.5E-06 | 4.8E-21 | 1.1E-24 | 7.8E-30 |
| BR-5 S | 7.3E-07 | 9.2E-21 | 4.6E-24 | 6.7E-29 |
| BR-6 SW | 1.8E-06 | 1.8E-20 | 8.6E-24 | 1.2E-28 |
| BR-7 | 6.7E-06 | 1.8E-20 | 5.8E-24 | 5.8E-29 |
| BR-8 NW | 2.2E-06 | 2.8E-20 | 1.4E-23 | 2.1E-28 |
| CRR 4[c] | 5.7E-06 | 2.5E-20 | 8.8E-24 | 9.6E-29 |
| | | **Totals (unpressurized system)** | | |
| BR-1 N | 5.4E-05 | 4.3E-19 | 1.7E-22 | 2.0E-27 |
| BR-2 NE | 3.4E-05 | 1.8E-20 | 4.1E-24 | 2.8E-29 |
| BR-3 E | 2.8E-05 | 1.3E-20 | 2.9E-24 | 2.0E-29 |
| BR-4 SE | 1.3E-05 | 1.0E-20 | 2.3E-24 | 1.6E-29 |
| BR-5 S | 7.3E-06 | 8.8E-20 | 4.4E-23 | 6.3E-28 |
| BR-6 SW | 1.4E-05 | 1.8E-19 | 8.9E-23 | 1.3E-27 |
| BR-7 W | 4.7E-05 | 2.6E-19 | 9.7E-23 | 1.0E-27 |
| BR-8 NW | 2.0E-05 | 3.2E-19 | 1.8E-22 | 2.8E-27 |
| CRR 4 | 8.4E-05 | 1.6E-19 | 4.1E-23 | 3.3E-28 |
| Limits[d] | 1.1E-03 | 4E-12 | 2E-10 | 7E-12 |

[a]Units of working levels, which accounts for levels of short half-lived daughter products.
[b]Units of $\mu$Ci/ml; for pCi/m$^3$, multiply by $10^{12}$; for Bq/m$^3$, multiply by $3.7 \times 10^{10}$.
[c]Nearest residence downwind, assuming Gallup wind rose.
[d]Concentration limits in 10 CFR Part 20, Appendix B. Continuous exposure to concentrations at the limit will result in approximately 0.5 mSv/yr (50 mrem/yr).

### Decontamination and Disposal

As discussed in Section 4.2.3, HRI would be required by license condition to submit a decommissioning plan to NRC 1 year prior to beginning closure of the Church Rock facility. Before release of an area to unrestricted use (i.e., well field, land application area, production facilities), HRI would be required to provide information to NRC to verify that radionuclide concentrations met applicable radiation standards. Currently, the soil cleanup criterion for natural uranium not in equilibrium with its daughters is 1.1 Bq/g (30 pCi/g), and for radium is 0.19 Bq/g (5 pCi/g) in the top 15 cm and 0.57 Bq/g (15 pCi/g) for other soils.

## 4.6.2 Alternative 2 (modified action)

### 4.6.2.1 Alternative Sites for ISL Mining

Reducing the number of sites would reduce the number of potential sources of radon. Estimated environmental effects of the proposed project are small; removing sources would result in further reduction of the dose to both local and regional populations. The largest reductions would be related to the land application of restoration water. Under the proposed action, most of the radiological exposures are from the land application facilities. Each land application facility constructed and operated would result in effluent of 2.9 TBq (79.35 Ci) $^{222}Rn$ per year and 21 ha (52 acres) of land that would have elevated levels of uranium and radium.

At the Church Rock site, areas of the site have greater concentrations of residual radioactivity present than would be allowed in decommissioning the site. Under the proposed action, these areas would generally be cleaned up as part of the well field decontamination. Under the alternative where the Church Rock site is not mined, the residual radioactivity would remain in these areas and would not necessarily be remediated.

### 4.6.2.2 Alternative Sites for Yellowcake Drying and Packaging

HRI proposes to use a vacuum dryer, which would result in nearly zero releases for the drying and packaging of product, and the resulting environmental impacts of air emissions would be minimal. Therefore, selection of another site would result in a minimal change in the dose received by the population surrounding Crownpoint. However, a very small impact would occur to the population surrounding whichever site is selected.

### 4.6.2.3 Alternative Liquid Waste Disposal Methods

HRI proposes to use wastewater volume reduction techniques, evaporation ponds, and land application to dispose of liquid radioactive wastes. Two other waste disposal techniques could be used: surface water discharge and deep well injection.

HRI would need to receive a NPDES permit from the appropriate authority (EPA or the State of New Mexico) to allow surface discharge of wastewater. Based on the expected water quality for the land application information, the expected concentration of radium [37 $Bq/m^3$ (1 pCi/L)] would be below applicable standards for both process and restoration wastewater. The expected concentration of uranium in wastewater (1 mg/L) would be below allowable standards for restoration wastewater, but process wastewater would exceed the allowable concentration average in 10 CFR Part 20, Appendix B (0.44 mg/L). Allowance to dispose of process water as surface water discharge, based on current expected uranium concentrations, would require HRI to submit information to NRC, as per 10 CFR § 20.2002, to request an exemption to 10 CFR Part 20, Appendix B, for uranium, in addition to the required NPDES permit. Based on the conservative assumptions used in developing Appendix B of 10 CFR Part 20, exposures to individuals who supply their annual drinking water from the surface-discharged process water at the expected uranium concentrations prior to full mixing in the stream could result in an individual dose in excess of the 1 mSv (100 mrem) limit.

Disposal of wastes by deep well injection would reduce exposures to the public from waste disposal techniques to nearly zero. The requirements and concepts behind deep well disposal would result in no credible scenario in which members of the public could contact the waste, especially at initial concentrations. HRI has indicated it might consider deep well disposal for the Crownpoint Project. To be allowed to conduct deep well disposal, HRI would be required to submit information to NRC in a license amendment application, as per 10 CFR § 20.2002, detailing the operations and hazards of the proposed deep well.

### 4.6.3 Alternative 3 (The NRC Staff-recommended Action)

This section provides a summary of additional NRC staff requirements and recommendations based on its evaluation of the proposed action. The following list supplements the commitments already made by HRI in its license application. Subsequently, HRI has formally agreed to these conditions as expressed in its letter to NRC dated December 26, 1996 (see Appendix B). The staff believe that the previously identified impacts of this project can be mitigated through the measures discussed below.

If a license were issued for the proposed project, those items listed as requirements would be incorporated in the license either as separate license conditions or combined as one general license condition that references HRI's consolidated operations plan. For those items listed as NRC staff recommendations, BIA, BLM, and other cognizant regulatory agencies will be responsible for ensuring that HRI has complied with this guidance.

The proposed project would have negligible effects in terms of health physics and radiological impacts (Section 4.6.1). However, to further protect public health and safety, if a license is issued for the proposed project, NRC staff would require the following license conditions in addition to HRI's commitments and the NRC license condition requiring an approved decommissioning plan (Appendix B):

- HRI shall store all yellowcake inside the restricted area. Liquid oxygen tanks shall be located in the well fields. Other chemical storage tanks shall be located on the concrete pad near a waste retention pond.

- HRI shall maintain an area within the restricted area boundary for storing contaminated materials prior to their disposal. All contaminated pond residue and other waste shall be disposed of at an NRC- or Agreement State-licensed radioactive waste disposal site. Prior to beginning operations, HRI shall develop and maintain an agreement for the disposal of 11e(2) by-product material with a facility licensed by the NRC or an Agreement State to accept such material.

### 4.6.4 Alternative 4 (No Action)

If no action is taken, no radiological exposures are estimated to the general public other than natural background, medical-related exposures, and exposures from existing residual contamination. At the Church Rock site, areas of the site have greater concentrations of residual radioactivity present than would be allowed in decommissioning the site. With the proposed project, these areas would generally be cleaned up as part of the well field decontamination. Under the no-action alternative, the residual radioactivity would remain in these areas and would not necessarily be remediated.

## 4.7 ECOLOGY

### 4.7.1 Alternative 1 (the proposed action)

#### 4.7.1.1 Crownpoint, Unit 1, and Church Rock

Construction and operation of the proposed project would damage and destroy flora and fauna in limited areas at each of the three sites. Most of the impacts would occur during initial facility construction, particularly at well and building sites. However, the proposed project is not likely to adversely affect sensitive plant or animal species because no Federally- or State-listed or proposed endangered or threatened species or proposed or designated critical habitats occur on project lands (Section 3.5.1.4). Similarly, the absence of permanent surface water on the project sites limits impacts to aquatic resources (Section 3.5.1.3). In contrast, the ecological effects of underground mining and the associated uranium ore milling are, in general, considerably greater (FWS 1980).

**Construction**

Most impacts on ecological resources would result from land disturbance during well field construction. Construction of HRI's proposed project would include vegetation removal during clearing for facilities (e.g., individual well sites, metering and processing buildings, roads, parking, storage pads, retention or evaporation ponds) and monitoring rings (i.e., monitoring wells surrounding a well field). Approximate land areas of various habitat types that would be disturbed for proposed facilities (excluding evaporation ponds) are listed in Table 4.25. Approximately 40 ha (100 acres) of additional habitat, probably grassland, would be destroyed at each site by clearing and excavation for evaporation ponds.

**Table 4.25. Approximate areas of habitat types to be disturbed by construction at the three project sites**

| Site | Previously disturbed ha (acres) | Habitat type disturbed in hectares (acres) | | | Total ha (acres) |
|---|---|---|---|---|---|
| | | Grassland ha (acres) | Sagebrush-grassland ha (acres) | Juniper/Oak/Pinyon ha (acres) | |
| **Church Rock** | | | | | |
| Facilities | 10 (25) | 0 | 27 (66) | 0 | 37 (91) |
| Well Ring | 7 (17) | 0 | 28 (70) | 8 (19) | 43 (106) |
| **Crownpoint** | | | | | |
| Facilities | 28 (70) | 52 (129) | 0 | 0 | 80 (199) |
| Well Ring | 10 (25) | 52 (129) | 0 | 0 | 62 (154) |
| **Unit 1** | | | | | |
| Facilities | 0 | 187 (462) | 0 | 0 | 187 (462) |
| Well Ring | 0 | 116 (287) | 0 | 0 | 116 (287) |
| Totals | 55 (137) | 407 (1007) | 55 (136) | 8 (19) | 525 (1299) |

The total land area disturbed would be about 743 ha (1858 acres), or 73 percent of the approximately 1,022 ha (2,552 acres) comprising the three project sites. HRI has stated that after operations are completed, buildings would be removed and disturbed areas would be revegetated with native plants (Section 2.3.3 and Table 2.5). HRI would be required to submit an updated reclamation plan for approval, following review by appropriate State and Federal agencies. HRI proposes to stockpile topsoil removed during construction for subsequent use to reclaim disturbed areas. HRI proposes to use the seed mixtures listed in Table 2.6 for revegetation.

Project construction would displace or destroy smaller, less mobile wildlife species on each of the three sites. Small mammals and reptiles would be more subject to mortality from construction than other groups, but impacts would be minor on a regional basis. Many of the affected species, especially small mammals, have high reproductive potential, are common in surrounding habitats, and therefore would be minimally impacted. Larger mammals, birds, and some reptiles would be able to avoid construction areas temporarily and possibly return to remaining suitable habitat after construction is completed. In general, however, it can be assumed that loss of various animal populations would be proportional to the amount of their habitat which is lost (Kroodsma 1985).

The off-site impacts of construction would be small. Construction activities would produce a minor increase in vehicle traffic and, hence, in animals killed on the highway. Construction also would produce a temporary increase in dust, some of which would be deposited on vegetation both on- and off-site. However, vegetation in this naturally dusty, arid region is assumed to be adapted to moderate temporary increases of this sort. Excessive dust production would be limited by water application in construction areas, according to standard regional construction practices.

## Operations

Potential impacts associated with routine project operations would be minimal. Large mammal populations would be excluded from the facilities during operations by on-site fencing, but should return to these areas following restoration and reclamation.

No large fresh water bodies occur near the Crownpoint or Church Rock areas; thus, there are no regional sources from which waterfowl might be attracted to wastewater retention ponds or to evaporation ponds on a year-round basis. The area is, however, a flyway corridor for migrating waterfowl, although not a high-concentration corridor (Bellrose 1978). Thus, ponds may provide a stopover or resting spot for waterfowl during the spring and fall migration periods. The ponds are not expected to pose significant risk to any migrating waterfowl using them because concentrations of hazardous constituents would be negligible or small. The ponds would store water during the treatment process, and would contain either purified water before it is released (evaporation ponds) or brackish water and briny sludge (process wastewater retention ponds).

The degraded wastewater in the retention ponds would have elevated concentrations of dissolved solids, potentially elevated levels of trace metals, mildly alkaline pH values, and low concentrations of radionuclides. If the chemical composition of this water were similar to that of the lixiviant (see Table 2.2), the salinity would be in the brackish range (1500–5500 mg/L). This salt concentration would not be high enough to deter some species of waterfowl from using the ponds and might permit growth of salt-tolerant aquatic vegetation. If salinities were substantially higher, plant growth would be prevented and waterfowl use would be lessened. In any case, concentrations of potential harmful substances in the wastewater retention ponds would not be high enough to harm any birds that might choose to use the ponds as a temporary stopover or resting place during migration. Birds using the evaporation ponds would not be exposed to hazardous substances because the water would have been treated to remove most impurities.

Disposal of treated water by land application would not be likely to result in harmful accumulations of salts in soil and vegetation because the water would be relatively clean. HRI would be required to submit, in the form of a license amendment application, an irrigation plan for approval before implementing such a practice. The plan would address, among other things, application rates, water chemistry, and predicted salt accumulations and their potential impacts.

Well field buildings and trunk pipelines would form intrusions in the habitat of small reptiles and mammals. Pipelines installed on the ground surface would partially block movements by smaller animals. However, some movement would remain possible because each pipeline would be buried where it crosses local dirt roads. Long, continuous surface obstacles would be eliminated by providing either earthen berms over or underpasses below short sections of pipeline at regular intervals.

The off-site impacts of project operation would be minor. Flora and fauna in the areas surrounding the project sites are similar to those onsite and are common in the region. HRI would take steps to minimize erosion and sedimentation both on- and off-site by (1) not placing wells, roads, or other facilities on steep, currently eroding slopes; (2) vegetating and stabilizing topsoil stored for subsequent use; and (3) constructing drainage diversions where needed to limit flooding potential. Under normal operation, the only routine release would be low concentrations of radon and particulate radionuclides released to the airshed. Provided these concentrations are protective of human health, they would not be expected to adversely affect native plants and animals (Barnthouse 1995).

Accidental spills are not a common occurrence in modern ISL mining operations, but if they occur they would be cleaned up through implementation of HRI's standard operating procedure for spill responses. As a result, spills would be unlikely to extend off-site. Materials likely to be spilled, such as retained wastewater, would not contain hazardous constituents in concentrations that would be harmful to wildlife.

### 4.7.2 Alternative 2 (modified action)

Construction and operation of an ISL project under the modified action alternative would result in ecological impacts similar to, though not identical to, those of the proposed project (Section 4.7.1). The nature and extent of the differences would depend on the alternatives chosen. In general, limiting well field operations to no more than two of the three proposed sites would lessen the probable extent of impacts on biota by limiting the area involved.

Because none of HRI's proposed liquid waste disposal methods (i.e., reinjection, evaporation, and land application) is expected to harm biota significantly, selection of only one or two of these methods also would not result in significant impacts. Nonetheless, selection of only one or two methods would influence the level of potential impacts. In general, reinjection would pose the least risk to wildlife. Evaporation ponds would entail the greatest impacts because of the relatively large land areas required for pond construction.

### 4.7.3 Alternative 3 (The NRC Staff-Recommended Action)

This section provides a summary of additional NRC staff requirements and recommendations based on its evaluation of the proposed action. The following list supplements the commitments already made by HRI in its license application. Subsequently, HRI has formally agreed to these conditions as expressed in its letter to NRC dated December 26, 1996 (see Appendix B). The staff believe that the previously identified impacts of this project can be mitigated through the measures discussed below.

If a license were issued for the proposed project, those items listed as requirements would be incorporated in the license either as separate license conditions or combined as one general license condition that references HRI's consolidated operations plan. For those items listed as NRC staff recommendations, BIA, BLM, and other cognizant regulatory agencies will be responsible for ensuring that HRI has complied with this guidance.

The proposed project would not have significant impacts on ecological resources (Section 4.7.1). However, to further minimize potential impacts to ecological resources, staff recommend the following measures in addition to HRI's commitments and the NRC license condition requiring an approved site reclamation plan (Appendix B):

- HRI should revegetate disturbed areas with the seed mixture listed in Table 4.26. Seeding of Pinyon/Juniper and Ponderosa Pine areas should occur between July 15 and August 15. This time period is just before the wettest part of the year, and would ensure that seeds get water for germination and growth (NNEPA 1996). Seeding of Northern Desert areas should occur between November 1 and December 15. Seeding during this period would ensure that seeds get moisture for germination and growth from winter precipitation (NNEPA 1996).

- HRI should use a tractor with a mechanical grain drill to reseed areas, should plant seed into topsoil, should use straw or woodchip mulch on the seeding, and should fence reseeded areas to protect plantings.

- HRI should implement methods for discouraging waterfowl use of project retention or evaporation ponds. Possible methods include limiting bank vegetation, constructing ponds with steep banks, using visual and sound devices to frighten birds, and placing wire screens over the water surface.

### 4.7.4 Alternative 4 (No Action)

The no-action alternative would result in no change to existing ecological conditions at the three proposed sites or in the region. Land disturbance would be avoided and the area would continue to provide low to moderate quality vegetation communities and wildlife habitat typical of the region.

## 4.8 LAND USE

### 4.8.1 Alternative 1 (the proposed action)

Construction and operation of the proposed project would have adverse impacts on existing land uses at the three project sites. Although these impacts would be temporary because of the sequential nature of the proposed mining operations and because of HRI's proposals for site restoration and reclamation, some of the impacts would require appropriate mitigation.

The most obvious land use impact would be on-site disturbance and restrictions during project construction and operations. Including previously disturbed areas, approximately 70 percent [255 ha (638 acres)] of the Crownpoint site would be disturbed at some time during the project. If HRI

**Table 4.26. Seeding mixture recommended by NRC staff for revegetating sites with various soil characteristics**

| Plant species | Northern Desert sandy sites | Pinyon/Juniper and Ponderosa Pine clay and loamy sites |
|---|---|---|
| Western wheatgrass (Arriba) | 3.0[a] | 3.0 |
| Pubescent wheatgrass (Luna) | 0.0 | 0.0 |
| Fairway crested (Hycrest) | 3.0 | 0.0 |
| Fairway crested (Ephraim) | 0.0 | 3.0 |
| Slender wheatgrass (San Luis) | 0.0 | 3.0 |
| Alkali sacaton (Native Hachita) | 2.0 | 0.0 |
| Indian ricegrass (Paloma) | 3.0 | 3.0 |
| Galleta (Viva) | 2.0 | 0.0 |
| Sand dropseed (Native) | 2.0 | 2.0 |
| Blue grama (Lovington) | 0.0 | 2.0 |
| Sideoats grama | 2.0 | 2.0 |
| Fourwing saltbush | 2.0 | 2.0 |
| Scarlet globemallow (Native) | 0.5 | 0.5 |
| Lewis flax | 0.0 | 0.5 |
| Rocky mountain penstemon (Bandera) | 0.5 | 0.0 |
| Palmer penstemon (Cedar) | 0.0 | 0.5 |
| **Total pounds per acre** | **20.0** | **21.5** |

[a]In pounds per acre.
Name in parenthesis is the cultivar name.

disposed of wastewater from the Crownpoint and Unit 1 sites using off-site land application in Section 12, T17N R13W, an additional 256 ha (640 acres) could be disturbed. Including previously disturbed areas, approximately 70 percent [358 ha (896 acres)] of the Unit 1 site, and approximately 90 percent [130 ha (324 acres)] of the Church Rock site, would be disturbed. If HRI disposed of wastewater from the Church Rock site using off-site land application in Section 16, T16N R16W, an additional 256 ha (640 acres) could be disturbed. However, the impacts of this land disturbance are expected to be temporary and insignificant because of the sequential nature of the project and HRI's proposals for site restoration and reclamation. During construction, land use in each well field would be restricted in only about 24 ha (60 acres) at a time. Previous licensing experience indicates that well fields can be placed into production approximately 2 ha (5 acres) at a time. Therefore, drilling activities would be concentrated in a small percentage of the proposed sites at any time.

A second land use impact of the proposed project would be the temporary disruption of livestock grazing at project sites. Local residents have expressed concern that this disruption of grazing would adversely affect Navajo who have grazing permits for the land and rely on livestock as an important economic resource. It is true that individuals who currently have grazing permits on project lands would temporarily lose those permits if mining occurs. HRI has secured mineral leases from the individuals or organizations possessing legal titles or having allotments to the resources to be developed. Under the Federal General Mining Law of 1872, mineral rights owners can interrupt surface grazing permits in order to remove minerals. Therefore, HRI's leases prohibit livestock grazing during mining operations.

Another land use impact of the proposed project would be the potential relocation of residents within the Unit 1 site boundaries. Assuming a license were granted for the project, it would not be possible to determine how many individuals or families might have to be relocated until well drilling began. Field interviews conducted by HRI and NRC in July 1993 indicated that there were seven residences occupied by 26 persons in the Unit 1 lease area. These persons are Navajo allottees (who own the surface and mineral rights) or their tenants. Leases for both the surface use and mineral rights on these allotted lands are administered by the BIA. The BIA and the allottees who would be affected by the proposed project have signed agreements with HRI authorizing mineral leases and surface use of the land for mining activities. In most cases, the individuals and families who would be relocated or denied access to their land were voluntary signatories to the leases negotiated by HRI. The need for relocations and access restrictions, which would be temporary (i.e., for the duration of mining operations in the lease area and until the area has been released for public access), was explained to the signatories as a condition of the leases. However, there might be some instances where individuals or families who were living on allotted lands but who were not signatories to the leases would be required to relocate.

## 4.8.2 Alternative 2 (modified action)

### 4.8.2.1 Alternative Sites for ISL Mining

The land use impacts of developing alternative combinations of the three project sites would vary. In terms of land disturbance, developing only one or two of the project sites rather than three would decrease impacts proportionately. In terms of the temporary revocation of grazing permits, impacts would be reduced by not developing the Crownpoint and/or Unit 1 sites. The potential impacts of resident relocation could be avoided altogether by not developing the Unit 1 site.

### 4.8.2.2 Alternative Sites for Yellowcake Drying and Packaging

Changing the location of the yellowcake drying and packaging facilities from Crownpoint to one of the other two sites or to an existing site elsewhere would not result in significant impacts to land use. Adding drying and packaging facilities to HRI's proposed facilities at either the Unit 1 or Church Rock site would mean adding a yellowcake drum storage area, a dryer room, and an office and shower.

These minor additions would require a very small increment of land for the expanded plant. Using an existing processing plant elsewhere in New Mexico or in Texas would create no additional land use impacts.

#### 4.8.2.3 Alternative Liquid Waste Disposal Methods

Different combinations of alternative liquid waste disposal methods would have very different land use impacts. Generally, the more land required for a liquid waste disposal method, the greater the potential for land use impacts. Therefore, the most adverse impacts would likely result from methods that use large evaporation ponds or require more land area for surface discharge or land application.

### 4.8.3 Alternative 3 (The NRC Staff-recommended Action)

This section provides a summary of additional NRC staff requirements and recommendations based on its evaluation of the proposed action. The following list supplements the commitments already made by HRI in its license application. Subsequently, HRI has formally agreed to these conditions as expressed in its letter to NRC dated December 26, 1996 (see Appendix B). The staff believe that the previously identified impacts of this project can be mitigated through the measures discussed below.

If a license were issued for the proposed project, those items listed as requirements would be incorporated in the license either as separate license conditions or combined as one general license condition that references HRI's consolidated operations plan. For those items listed as NRC staff recommendations, BIA, BLM, and other cognizant regulatory agencies will be responsible for ensuring that HRI has complied with this guidance.

The proposed project would not have significant land use impacts (Section 4.8.1). However, to help mitigate the land use impacts that would occur, staff recommend the following measures:

- HRI should compensate individuals who hold livestock grazing permits on project lands that would be interrupted during project construction and operation. HRI should compensate these permitees directly (for private lands) or indirectly through the relevant tribal (for tribal lands) or Federal agency (BIA for allottee lands). Staff recommend that the Navajo Nation negotiate compensation arrangements for lands where grazing permits are held in tribal trust, and that BIA negotiate compensation arrangements for lands where allottees have grazing permits.

- HRI should evaluate potential impacts on and provide direct compensation to any residents of allotted lands who are not signatories to the leases negotiated by HRI but who may be required to relocate during project construction and operation.

### 4.8.4 Alternative 4 (No Action)

The no-action alternative would result in no land use impacts. There would be no project-related land disturbance, access restrictions, disturbance of grazing rights, or resident relocations at any of the three project sites.

## 4.9 SOCIOECONOMICS

### 4.9.1 Employment and Income

Assuming that ISL mining operations at Church Rock would begin in 1997, at Unit 1 in 1999, and at Crownpoint in 2001, Table 4.27 shows projected employment figures. As indicated in Table 4.27, long-term employment with the combined operation of Unit 1 and Crownpoint would be expected to occur starting in about 2003. Operations would continue through 2016 under the initial licensing period.

The employment estimates listed in Table 4.27 reflect only those employees who would work directly for HRI. In addition, HRI would contract for drilling rigs which would include three operating employees per rig and one backhoe operator for every two rigs. The number of rigs required would vary from month to month. A conservative estimate of average contract employment for operating the rigs would be 10 at Church Rock and a combined total of 30 for Unit 1 and Crownpoint. HRI has provided no information on whether the contractor would tend to hire local residents or bring in rig operators from other areas.

Peak HRI employment is expected to be about 180, lasting for 2 years about 4 years after Church Rock operations begin in 2001–2002. However, long-term HRI employment would be about 120 starting in 2003. There could be an additional 30 contractor employees for drill-rig operation. These projections are subject to uncertainty because employment and income from the proposed project would depend on the market price for yellowcake and the unit cost of the mining operation. A high market price and low per-unit production costs would tend to result in a project of greater production and longer duration. Therefore, local employment and income resulting from the project could be subject to significant variation over time.

HRI estimates that about 10 to 15 workers would be brought in to the Crownpoint/Church Rock area from outside (Pelizza 1996a). The licensing period for mining would be through 2016. As mentioned above, the long-term effect on the local economy would include wages for about 150 persons. HRI has made a commitment to hire from the local Navajo community as much as possible. Local hiring preferences are also written into royalty agreements with owners of allotment land at the Unit 1 site. The first hiring priority for these agreements is for the lessor and members of the lessor's immediate family, followed by a general preference for hiring members of the Navajo Nation. The following analysis assumes that beyond the hiring commitment in these lease agreements, HRI would fulfill its Navajo hiring commitment from members of the local communities within the Church Rock and

**Table 4.27. Summary of projected annual project and community employment, earnings, and royalty income**

| Site and period of operations | Annual project employment | Annual community employment | Annual project earnings[a] | Annual community employment earnings[b] | Annual community royalty income[c] |
|---|---|---|---|---|---|
| Church Rock (1997–2003) | 61 | 44 | $1,708,000 | $1,056,000 | |
| Unit 1 (1999–2016) | 57 | 38 | $1,596,000 | $912,000 | $1,099,000 |
| Crownpoint (2001–2016) | 66 | 47 | 1,848,000 | 1,128,000 | |
| Peak employment (2001–2003) | 214 | 144 | $5,992,000 | $3,456,000 | |
| Long-term employment (includes drill-rig operators) (2003–2015) | 153 | 100 | $4,284,000 | $2,400,000 | $1,552,000 |

[a]Project earnings include all earnings for all employees that work on the project in McKinley County.

[b]Community earnings are estimated for skills and expertise that are consistent with HRI's contractual and stated intention for preferential hiring of qualified Navajo. Although they could potentially reside anywhere within driving distance, NRC staff expect most Navajo workers to reside within the Crownpoint and Church Rock chapters.

[c]Assumes annual production of 1 million pounds yellowcake at Unit 1 at $15.70 per pound.

*Source*: Project employment based on projections by HRI; community employment based on NRC staff's assessment of job titles for which area Navajo residents would be qualified and available.

Crownpoint chapters. The focus of this analysis is mostly on potential effects within the Crownpoint Chapter because mining operations there (Unit 1 and Crownpoint) would occur from 2001 to 2016, while operations at Church Rock would occur from 1997 through 2003.

Employment of 150 persons would represent only about 0.5 percent of total existing employment in McKinley County. However, if Navajo hirees are selected from within the Crownpoint area, the employment would be a significant benefit for the Crownpoint Navajo Chapter. Based on a review of job descriptions, at least 85 of the 150 HRI long-term jobs could go to local residents. An additional 15 jobs for drill-rig operations would result in approximately 100 potential jobs for local residents. This would represent about 11.9 percent of the estimated Crownpoint Chapter labor force. The Native American unemployment rate in McKinley County in 1990 was 15.5 percent.

Predicting the effect on community employment of HRI's commitment to Navajo hiring preferences is uncertain. Some jobs would probably go to Navajo living outside the Crownpoint Chapter, and some jobs might go to Crownpoint residents now employed outside of the Crownpoint Chapter. Therefore, Crownpoint Chapter unemployment might not be reduced on a one-to-one basis with respect to potential project employment. However, if HRI's employment effort is successful in hiring employees from the Crownpoint Chapter, potential benefits to the local community would have a very significant positive effect.

Projected Navajo employment during operations at the Church Rock site is 44 (Table 4.27). Based on the Church Rock Chapter's 1993 estimated population and the 1990 Navajo average labor force participation rate for McKinley County, this would represent about 6.1 percent of the Church Rock Navajo labor force. If this employment went to persons in the Church Rock community it could result in a significant reduction in unemployment. Potential earnings from the Church Rock site would be about 12 percent of estimated Navajo earnings in the Church Rock Chapter. Some of the employment for the Church Rock site could go to Navajo from the Crownpoint Chapter because of the advantage in retaining experienced employees for operations at Unit 1 and Crownpoint. Conversely, any employees hired from the Church Rock community could continue employment for operations at Unit 1 and Crownpoint. It should be noted that operations at Church Rock are projected to last for only about 6 years, compared to 17 years at Unit 1 and 15 years at Crownpoint.

Estimated long-term earnings from the proposed project would represent an insignificant percentage of McKinley County income (approximately 0.9 percent). However, as indicated in Table 4.28, it could be a significant percentage of earnings within the local community. In addition to earnings from employment, allottment owners that have royalty agreements could make significant incomes depending on the production and price of yellowcake. Although significant in terms of local community earnings, royalty income would tend to benefit a very small part of the community because it would be concentrated on about nine allottees who own the property leased to HRI.

**Table 4.28. Potential employment and income effects on the Crownpoint Chapter**

| | |
|---|---|
| Average project earnings for all workers | \$28,000 |
| Average project earnings for existing residents | \$24,000 |
| Project employment as a percentage of estimated total Crownpoint Chapter employment | 11.9% |
| Estimated annual long-term earnings from project for local community members | \$2,400,000 |
| Project income as a percentage of estimated total Crownpoint Chapter income | 18.3% |
| Estimated annual royalty income to Crownpoint Chapter Residents (allotees for Unit 1 properties; based on Unit 1 recovery of 1 million lbs. per year at \$20 per lb). | \$1,099,000 |
| Estimated annual royalty income to Crownpoint Chapter Residents as a percentage of total Crownpoint Chapter income | 8.4% |
| Estimated total earnings and royalty income from the project as a percentage of estimated total Crownpoint Chapter income | 26.7% |

Note: The estimates contained in this table are intended to provide perspective on the potential effects of the proposed project on local employment and income. The estimates are not certain projections of what will actually happen. Many factors could decrease actual project effects, including hiring from outside local communities and reduced operating levels.

*Sources:* Crownpoint Chapter total employment estimate based on Crownpoint Chapter estimated 1993 population and average labor participation rates for McKinley County's Native American population reported in the 1990 U.S. Census. Crownpoint Chapter total income estimate based on Crownpoint Chapter estimated 1993 population and average Native American per capita income for McKinley County. Potential employment and income assumes that 100 Navajo residents of the Crownpoint Chapter would receive long-term employment.

There would also be purchases associated with the proposed project. For example, major project purchases would include electricity and chemicals. However, the local community would receive only minor benefits from these purchases because it does not supply the types of inputs that would be purchased. The proposed project would require some local overnight accommodations for personnel making site visits. At present, there are no hotel or motel accommodations in the Crownpoint area. This would be an opportunity for developing and operating accommodations in the Crownpoint area and could result in employment for Crownpoint residents.

There would be additional expenditures induced by project earnings. Those employed by the project would make purchases at businesses within the local community, resulting in a benefit to local businesses. For example, the local supermarket could receive a significant benefit from an increase in expenditures. Such increases in local expenditures could result in some additional local employment, although this would probably be on the order of only one or two additional jobs. Much of the additional expenditure resulting from project earnings would result in purchases in larger towns such as Gallup and Grants. Within McKinley County, the additional expenditures would add several jobs; however, the resulting increase in employment and income would not be noticeable at the county level because it would be a very small fraction of total employment and income in McKinley County.

### 4.9.2 Population

HRI estimates that it would be necessary for 10 to 15 employees to relocate from outside into the McKinley County area for the proposed project. Those relocating from outside would likely be managers and professionals. This influx would result in an increase in McKinley County's population of about 25 to 40 assuming an average household size of 2.5 persons per employee. This would represent less than 0.1 percent of McKinley County's 1990 population of 60,686. An influx of this size is far smaller than influxes that have characterized "boom town" effects. Historically, boom towns have resulted from large natural resource developments in isolated and sparsely populated areas. Such developments have resulted in sudden and relatively large changes in area populations. However, given HRI's commitment to hire locally, it is clear that the proposed project would not result in this type of large population change.

Within McKinley County, project employees could choose to relocate to areas convenient to the project sites. However, several factors suggest that relatively few employees would relocate into the Crownpoint or Church Rock areas. The limited number of employees that would come from outside the area would probably have very limited opportunity or desire to move into Crownpoint because of the limited housing, distance from urban services, and limited amenities. It is not unusual for Crownpoint residents to work in Gallup, or for Gallup residents to work in Crownpoint. For work at any of the project sites, management and professional personnel moving in from outside McKinley County might tend to settle in Gallup, trading the long commute to the Crownpoint area for access to the urban amenities available in Gallup. For outsiders wishing to avoid the commute from Gallup, the Thoreau community located about 38 km (24 miles) south of Crownpoint might be a viable alternative.

### 4.9.3 Housing

The number of in-migrating project employees that would require housing would be very limited (probably 10–15 persons). In general, housing is in chronically short supply in McKinley County. This situation would confront any project employees relocating from outside the area. However, the Crownpoint area is unlikely to experience in-migration because of the limited housing supply and the distance to urban services and amenities. Any significant housing accommodation within the Crownpoint area would have to be arranged through the Navajo Nation. For employees coming in from outside the area or current residents choosing to upgrade their housing, relocation to areas such as Thoreau, Gallup, and Grants could provide the required amount of additional housing although the available selection would be limited.

### 4.9.4 Infrastructure, Schools, and Public Services

Typically, most of the demand for public infrastructure associated with a proposed project would be related to increases in population, housing demand, and transportation. As discussed above, increases in population and housing demand associated with HRI's proposed project would not be significant relative to the existing situation. Therefore, no significant or detrimental effects on schools, utilities, or other public services are expected to occur as a result of project-related population growth in Crownpoint or other communities in the project vicinity (Van Dyke 1996i).

Mitigation measures designed to protect the Westwater Canyon aquifer that supplies water to the local community are outlined in Sections 4.3 and 4.12.1. Mitigation includes HRI paying for well replacement and reimbursing the community for operating costs that would occur because of the drawdown of the water table. Little or no adverse effect would occur to the community because the mitigation provides a process to ensure that replacement wells are acceptable.

Because project-related population increases would be very limited, there would be only slight changes in demand for emergency, fire, and police protection. Although the probability of accidents related to the project's operation is very low, the radioactive aspect of the processed material would result in the need for additional standby emergency services that currently are not required or available in the Church Rock and Crownpoint area. It would be necessary to have contingency plans in case such an accident occurred. HRI has provided a detailed contingency plan for uranium transportation accidents. Some additional equipment and training of local hospital personnel would be required to deal with radioactive contamination. HRI has made a written commitment to provide the local hospital with the proper equipment, on-going training for hospital staff, and a separate room equipped for decontamination (Pelizza 1996a). Similarly, HRI has made a written commitment to the Crownpoint Volunteer Fire Department to provide appropriate training and equipment to respond to a slurry truck accident (Pelizza 1996b). HRI has also proposed a memorandum of understanding that outlines respective responsibilities with regard to emergency medical response and training.

Traffic on roads near the three project sites would increase as project employees commuted during the work week. Existing traffic on the roads accessing the project sites is very light and the additional traffic associated with the project would not cause congestion or traffic problems. Average Annual

Daily Traffic for New Mexico 371 was 3234 in 1994, and was 3490 for New Mexico 566 from 1990 to 1994. This volume of traffic is consistent with a peak hour level of service (LOS) of C, which is characterized by stable traffic flows. Using the methodology in *Highway Capacity Manual* (Transportation Research Board 1985) for evaluating traffic flow on rural two-lane highways, at peak project employment (assuming the addition of 100 vehicles at rush hour), the additional traffic would not degrade the existing LOS.

## 4.9.5 Tax Collections and Distributions

### 4.9.5.1 McKinley County

The proposed project would generate local revenues for McKinley County through ad valorem taxes on the assets of the project, including facilities, equipment, and the production value of the mining operation. For McKinley County, real property, personal property, and improvements are all taxed at the same rate of $30.45 per $1,000 of assessed value (where assessed value is one-third of market value).

Table 4.29 provides estimates of the project's property tax payments to McKinley County for personal and real property. The personal property tax is based on the value of equipment at each of the proposed mining sites. The taxable value for mining operations is 50 percent of the market value of the mined commodity. Table 4.29 acknowledges the uncertainty of annual tax collection estimates by showing various production and price combinations for yellowcake.

The potential tax contribution of the proposed project to McKinley County would be a significant part of local tax revenues. Based on the assumptions in Table 4.29, McKinley County could collect from 1 to 7 percent of its existing property taxes outside Gallup from the project.

Table 4.30 indicates how McKinley County property taxes on the HRI project would be distributed. Most of the tax collections would go to the General County Operating Fund and to public schools.

### 4.9.5.2 The Navajo Nation

Potential tax collections by the Navajo Nation would be through the Navajo Business Activities Tax (BAT) and the BAT Construction Tax. The Navajo BAT is a 5 percent tax on gross receipts after deductions, including a standard 10 percent deduction for compensation paid to Navajo employees. The BAT Construction Tax is a 3 percent tax on payments to contractors and subcontractors without deductions for various construction activities including drilling wells.

The Navajo BAT and BAT Construction Tax apply to activities on the Navajo Reservation and in areas outside the reservation if such areas meet the definition of "Indian country". The proposed project would not be located on the Navajo Reservation. However, the BAT could apply to the project's gross receipts if it is determined that the project would be within Indian country. The definition of Indian country may be viewed by some as vague and may ultimately be determined through litigation. However, there is precedent that could apply to HRI's proposed project because the BAT is currently

**Table 4.29. McKinley County's annual property tax revenues compared to potential property tax revenues from the proposed project**

| | Market value | Taxable value | Estimated annual tax | Percent of annual McKinley County property tax outside Gallup |
|---|---|---|---|---|
| **McKinley County taxable value outside Gallup** | | 5,740,583 | | |
| Equipment for Church Rock | $6,473,000 | 2,157,667 | $36,680 | 0.60% |
| Equipment for Crownpoint | $5,340,000 | 1,780,000 | $30,260 | 0.50% |
| Equipment for Unit 1 | $4,447,000 | 1,482,333 | $25,200 | 0.41% |
| Production Value at $13/lb | | | | |
| **Lb** | | | | |
| 500,000 | $6,500,000 | $3,250,000 | $100,175 | 0.91% |
| 1,000,000 | $13,000,000 | $6,500,000 | $200,350 | 1.81% |
| 2,000,000 | $26,000,000 | $13,000,000 | $400,699 | 3.63% |
| 3,000,000 | $39,000,000 | $19,500,000 | $601,049 | 5.44% |
| **Production value at $15.70/lb (October 1996 spot price)** | | | | |
| **500,000** | **$7,850,000** | **$3,925,000** | **$120,980** | **1.10%** |
| **1,000,000** | **$15,700,000** | **$7,850,000** | **$241,961** | **2.19%** |
| **2,000,000** | **$31,400,000** | **$15,700,000** | **$483,921** | **4.38%** |
| **3,000,000** | **$47,100,000** | **$23,550,000** | **$725,882** | **6.57%** |
| Production Value at $20/lb | | | | |
| 500,000 | $10,000,000 | $5,000,000 | $154,115 | 1.40% |
| 1,000,000 | $20,000,000 | $10,000,000 | $308,230 | 2.79% |
| 2,000,000 | $40,000,000 | $20,000,000 | $616,460 | 5.58% |
| 3,000,000 | $60,000,000 | $30,000,000 | $924,690 | 8.37% |
| McKinley County residential taxable value | | $23,979,057 | | |
| Gallup residential taxable value | | $98,793,730 | | |
| Assume new housing for project employees (15 at $100,000 per house) | $1,500,000 | $500,000 | $15,412 | |

[a]Based on a 10-year average for the undepreciated taxable value.

*Source*: Kevin Rudolph, Finance Director, McKinley County, tax year 1996. Estimated annual tax is based on the McKinley County tax rate applied to the estimated taxable value of the HRI equipment and production value.

**Table 4.30. Distribution of McKinley County property tax revenues**

| Distribution of property tax revenues | Tax rate for 1996 | Annual revenue from proposed project assuming property value of $12 million |
|---|---|---|
| State debt service | 0.001556 | $18,672 |
| County | 0.013416 | $160,992 |
| School district | 0.010851 | $130,212 |
| Other (vocational education, local colleges, and the Rebohoth Christian Hospital) | 0.005 | $60,000 |

collected on a coal mining project which, like the proposed project, is located within the Eastern Navajo Agency but outside the Navajo Reservation (Van Dyke 1996j). The effective tax on the coal mining project after various deductions has been about 3 percent of gross receipts (Van Dyke 1996j). Table 4.31 presents estimates of potential Navajo tax collections based on various assumptions about the sale of yellowcake from the proposed project.

Tax revenues collected by the Navajo Nation would not be legally designated for the benefit of the Crownpoint or Church Rock Chapters or surrounding communities. All government funding to the chapters comes from the central Navajo Nation authority, but chapters where revenue-producing activities occur are likely to receive a higher than proportional benefit from taxes collected on the activities (Van Dyke 1996i). However, the Navajo Nation Tax Commission has indicated that distributions of tax collections to chapters is normally through capital improvement projects and that any higher than normal distribution to Crownpoint would depend on the Navajo Nation's demand for resources (Van Dyke 1996j). Therefore, tax payments to the Navajo Nation could benefit the entire Navajo community in northwestern New Mexico and northeastern Arizona, which could indirectly benefit the local communities because of their dependence on public services provided by the Navajo Nation.

The potential contribution of the proposed project to the Navajo Nation would be a significant part of Navajo Nation tax revenues. However, Navajo Nation tax revenues from the project could depend on unresolved legal issues related to taxing jurisdiction. Table 4.31 indicates that the Navajo Nation could receive significant revenues from the project if it has the legal jurisdiction to do so.

### 4.9.5.3 The State of New Mexico

The State of New Mexico would impose a 3.5 percent severance tax and a 0.75 percent natural resources tax on the sales price of yellowcake from the proposed project. The severance tax would raise revenue at a rate about 17 percent higher than shown in Table 4.31. The natural resources tax would raise 25 percent of the revenue shown in Table 4.31. Together, these taxes would raise $1.5 million annually on 2 million pounds of yellowcake at $20 per pound.

**Table 4.31. Potential business activities tax payments to the Navajo Nation from the proposed project**

| Production (lb) | Market value | Estimated annual tax at 3 percent effective rate |
|---|---|---|
| Annual gross receipts (production value = $13/lb) | | |
| 100,000 | $1,300,000 | $39,000 |
| 300,000 | $3,900,000 | $117,000 |
| 500,000 | $6,500,000 | $195,000 |
| 1,000,000 | $13,000,000 | $390,000 |
| 2,000,000 | $26,000,000 | $780,000 |
| Annual gross receipts (production value = $15.70/lb; October 1996 spot price) | | |
| **100,000** | **$1,570,000** | **$47,100** |
| **300,000** | **$4,710,000** | **$141,300** |
| **500,000** | **$7,850,000** | **$235,500** |
| **1,000,000** | **$15,700,000** | **$471,000** |
| **2,000,000** | **$31,400,000** | **$942,000** |
| Annual gross receipts (production value = $20/lb) | | |
| 100,000 | $2,000,000 | $60,000 |
| 300,000 | $6,000,000 | $180,000 |
| 500,000 | $10,000,000 | $300,000 |
| 1,000,000 | $20,000,000 | $600,000 |
| 2,000,000 | $40,000,000 | $1,200,000 |

[a]The business activities tax is 5 percent after deductions. The average effective rate has been about 3 percent on the pre-deduction valuation.

### 4.9.6 Alternative 3 (The NRC Staff-recommended Action)

This section provides a summary of additional NRC staff requirements and recommendations based on its evaluation of the proposed action. The following list supplements the commitments already made by HRI in its license application. Subsequently, HRI has formally agreed to these conditions as expressed in its letter to NRC dated December 26, 1996 (see Appendix B). The staff believe that the previously identified impacts of this project can be mitigated through the measures discussed below.

If a license were issued for the proposed project, those items listed as requirements would be incorporated in the license either as separate license conditions or combined as one general license condition that references HRI's consolidated operations plan. For those items listed as NRC staff recommendations, BIA, BLM, and other cognizant regulatory agencies will be responsible for ensuring that HRI has complied with this guidance.

The proposed project would have positive socioeconomic impacts in the region (Sections 4.9.1 through 4.9.5). To help ensure these positive effects, staff recommend the following measures:

- HRI should document its intention to hire local Navajo in a written project hiring plan. The plan should provide the basis for hiring qualified workers from the six local Navajo Chapters in the project area: Crownpoint, Church Rock, Nahodishgish, Standing Rock, Mariano Lake, and Pine Dale. The plan should be developed with input from and review by the BIA and the six local Navajo Chapters.

- HRI should provide an annual report stating the number of project employees who are Navajo, the number who are non-Navajo, and the number of Navajo employed from each Chapter. The report should be submitted to the BIA and the six local Navajo Chapters.

- HRI should develop a memorandum of understanding with appropriate local officials to outline respective responsibilities with regard to emergency medical response and training.

### 4.9.7 Alternative 4 (No Action)

Under the no-action alternative, socioeconomic conditions in the project area would be the same as the existing conditions described in Section 3.7.

## 4.10 AESTHETICS

Construction and operation of the proposed project would disturb the vegetative communities and landscapes where well field construction and development would occur. However, these lands should recover under reclamation at the project's conclusion.

The landscape reflects hundreds of years of use by the local Native American population. The natural aridity and soil conditions of the area, coupled with the grazing of livestock, especially sheep, have resulted in overgrazed, rolling sparse grasslands interspersed with piñon pines or junipers. Navajo residents have had mixed negative and positive experiences with past uranium mining. These feelings about uranium mining necessarily color their interpretation of the aesthetic impacts of the proposed project, no matter how temporary those impacts may be.

## 4.10.1 Alternative 1 (The Proposed Action)

### 4.10.1.1 Construction

Most impacts on aesthetic resources would result from well field construction. Building and facilities construction would generally be minor in scale and intrusion. Additional construction impacts would include noise and dust from clearing for parking, access roads, well sites, storage pads, retention or evaporation ponds, and monitoring rings. However, staff believe that the overall aesthetic impacts of project construction would not be significant.

Land areas totaling over 70 percent of the three project sites have been or would be disturbed by vehicular traffic and activities in the well fields, trunk lines, and storage areas. These disturbances would occur sequentially, over the life of the project. During construction, only about 24 ha (60 acres) would become restricted at any given time in each site. Smaller subsets of that area would then be only sequentially disturbed. HRI's reclamation plans should restore these disturbed lands to original conditions (i.e., reclaimed and revegetated, but most likely subject to the same intensive grazing pressures as the surrounding lands).

Drilling would be conducted 12 hr per day at the Church Rock site, but would be conducted 24 hr per day at the Crownpoint and Unit 1 sites because of the greater depth to the ore zone (HRI 1993; HRI 1995b). This could create a nighttime aesthetic impact in that the drill rigs would be lighted and would generate some noise (standard diesel engine noises associated with conventional construction activities—about the same as that from water-drilling operations or from a large bulldozer). Lights on drilling rigs would be most visible—and incongruous—from elevated areas.

HRI estimates that it would need four or more drilling rigs at each site. HRI experience indicates that well fields can be placed into production at about 2 ha (5 acres) at a time. This means the drilling activity would be concentrated in only a small percentage of each project site at any one time. Actual boundaries of areas to be mined would not be known until final exploration prior to initial mining and ahead of the evolving knowledge of the ore frontier. Precise locations of drilling sites would not be known until the project commenced. Planned access roads, pipelines, and potential locations of retention ponds would similarly be variable within each project site.

Construction of the process facilities at the Unit 1 site would be visible, but it would employ materials and paint that would blend in with the surroundings (HRI 1995b). HRI has stated that the facilities would be removed upon completion of project operations.

HRI states that it would not disturb any juniper or piñon pines found in the upper elevations of the project sites (HRI 1993a). Because these species are so slow-growing (1–2 cm in trunk circumference every 10 years) and long-lived (300–400 years), avoidance would help maintain the pre-project appearance of the landscape during mining and provide a strong visual foundation for restoration of the project lands' aesthetic quality after mining.

### 4.10.1.2 Operations

The network of pipes and cables associated with the proposed project would be most visible from elevated locations. Because of the rolling topography of most potential well sites, project operations would be variably visible, depending on observer position, intervening topography, distance, and lighting considerations. The network of pipes and wells would not be regular in pattern or appearance (i.e., not a grid), and some of the pipes would be buried for weather protection.

Only the processing plants would be a prominent feature of the landscape, and the largest proposed facility—the main processing plant at Crownpoint—already exists. Because well fields would be phased into operation in conjunction with exploiting the ore front, there would never be a large expanse of land undergoing the mining processes at one time.

Unit 1 and Crownpoint operations would be highly visible from many locations in and around Crownpoint. Church Rock operations would be readily visible only from Route 566. Later-stage development of the Crownpoint site along the eastern-most portions of the site would be easily visible from Route 371, which carries some through traffic going to or from the Chaco Culture National Historic Park.

What visibility of the proposed project might mean to local residents or visitors is speculative. For those opposed to uranium mining or believing that the rewards of mining are distributed unjustly or that the risks are too high, the network of pipes, wells, vehicles, and processing facilities could become a reminder of the implications of the project. To the extent that the land might be seen as not supporting Navajo life, it might be seen as *not beautiful* (see Section 3.8). For other persons, the sight of increased economic activity might not be displeasing. Other potential meanings (e.g., the potential for emigration from the area or the potential for selective "non-inmigration" by those offended by the presence of the mining operations) are possible. However, NRC staff believe that the overall aesthetic impacts of project operations would not be significant.

### 4.10.1.3 Reclamation

Once project operations are completed, all facilities would be removed. With time, the reclamation efforts should result in no permanent impacts to aesthetic resources.

As recommended by NRC staff in Section 4.7.3, species selected for reseeding should be adapted to the climate and soil conditions extant on the project sites, using forage characteristics of palatability, tolerance to grazing, and availability of year-round use (Thames 1977). HRI has stated that it would not disturb lands on steep slopes, so revegetation should not be necessary in these areas (HRI 1996a). In any event, prior to license termination, HRI would be required to submit an acceptable site reclamation plan pursuant to 10 CFR Part 40..

The major limiting factor to establishing vegetation in the project area would be available moisture. Timing of seeding is critical in New Mexico, and should generally be synchronized with the highest expected precipitation. Thus, coordinating revegetation efforts with the completion of various well field operations would necessarily involve tradeoffs in terms of speed of revegetation.

### 4.10.2 Alternative 2 (Modified Action)

Construction and operation of an ISL uranium project under the modified action alternative would result in aesthetic impacts similar to those of the proposed action. The nature and extent of the differences would depend on the alternatives chosen. Obviously, limiting well field construction and operation to just two of the three proposed sites would lessen the likely extent of aesthetic impacts by limiting the affected areas. Mining in the Church Rock area would have the least aesthetic impact because mining has already occurred in the area, it is remote, and ownership patterns are less likely to embitter viewers.

Because none of HRI's liquid waste disposal methods would be expected to cause substantial impacts to aesthetic resources, selection of only one or two methods would not likely result in changes in impacts. Reinjection would cause the least negative aesthetic impacts, with evaporation ponds creating the most. Ponds would appear hard-lined and incongruous with the surrounding landscapes at each of the proposed sites. They are least objectionable at Crownpoint because of the light-industrial character of the site and existing ponds. Reclamation of the ponds would take more time, but should be able to be accomplished such that the resultant landscape could appear comparable to the pre-mining condition.

### 4.10.3 Alternative 3 (The NRC Staff-recommended Action)

This section provides a summary of additional NRC staff requirements and recommendations based on its evaluation of the proposed action. The following list supplements the commitments already made by HRI in its license application. Subsequently, HRI has formally agreed to these conditions as expressed in its letter to NRC dated December 26, 1996 (see Appendix B). The staff believe that the previously identified impacts of this project can be mitigated through the measures discussed below.

If a license were issued for the proposed project, those items listed as requirements would be incorporated in the license either as separate license conditions or combined as one general license condition that references HRI's consolidated operations plan. For those items listed as NRC staff recommendations, BIA, BLM, and other cognizant regulatory agencies will be responsible for ensuring that HRI has complied with this guidance.

The proposed project would not have significant aesthetic impacts in the region (Section 4.10.1). However, to further minimize the potential for aesthetic impacts, if a license is issued for the proposed project, staff would require as a license condition that HRI submit an acceptable site reclamation plan as discussed in Section 4.10.1.3 and Appendix B.

### 4.10.4 Alternative 4 (No Action)

The no-action alternative would result in no change to existing aesthetic resources at the three project sites. No additional lands would be disturbed, and the areas would continue to provide low to moderate quality vegetation communities for grazing activities.

## 4.11 CULTURAL RESOURCES

### 4.11.1 Alternative 1 (the proposed action)

Archaeological resources from the Anasazi culture (including Basketmaker) have been identified at all three project sites. Other archaeological resources undoubtedly exist at the sites and are susceptible to potential impacts from ground disturbance during construction and operation of the proposed project. Cultural resource management plans produced for HRI indicate that archaeological resources potentially eligible for inclusion on the National Register of Historic Places are likely to be present in the unsurveyed areas of the Unit 1 and Crownpoint sites (Marshall 1991; Marshall 1992). Additional archaeological survey work is being conducted for the purposes of the National Historic Preservation Act Section 106 review (see Section 3.9).

Historic resources at all three sites include various Navajo artifacts, none of which is considered to be eligible for inclusion on the National Register. Some artifacts of European-American culture also have been identified, but they are not considered to be culturally important.

Traditional cultural properties, including sacred sites, sites associated with life-cycle rituals, prayer offering places, plant gathering locations, and important landscape formations, were the subject of preliminary investigations conducted by a cultural resource specialist with traditional Navajo practitioners and local informants. This preliminary traditional cultural property survey identified no such resources at the three project sites. The nearest cultural resource sites, which are not necessarily eligible for the National Register, are at least 0.6 km (1 mile) away and out of view from the project sites. No impact would occur to these off-site traditional cultural resources as a result of the proposed project. Contacts between HRI's cultural resources consultant and Pueblo tribes in the area (Zuni, Acoma, Hopi, and Laguna) have not identified any traditional cultural properties in the project area. More detailed traditional cultural property survey work is being conducted for Section 106 review. If that survey identifies traditional cultural properties on or near any of the three project sites, appropriate measures to eliminate or minimize potential impacts to such properties would be developed through the Section 106 consultation process, which involves potentially affected Native American groups.

Damage to cultural resources typically occurs through such human activities as removal of artifacts, destruction of walls of structures, plowing, mining, construction excavation, irrigation, and livestock herding. Damage can be incidental to other activities or intentional through looting or vandalism. Damage to the scientific understanding of such resources can occur simply by moving an artifact from its original location. Such movement destroys the archaeological "context" in which the artifact might have been better understood as a component of the overall culture. Damage to cultural resources can also occur through natural events, such as wind, rain, flooding, extreme heat or cold, burrowing by animals, insect activity, and fire. Considerable damage from natural causes has occurred to cultural resources in the three project sites, to the extent that almost all pre-Navajo resources are not discernible to the untrained observer. These resources typically are bare outlines of walls at ground level, eroded mounds of soil, or potsherds scattered about on the ground. Blowing soil and occasional floods have covered up the sites over the centuries.

The primary potential threats to cultural resources from HRI's proposed project are earth moving, incidental pedestrian and vehicle traffic, and looting following site identification. Relatively little looting is believed to have occurred at the three sites to date because Navajo reside near or on the sites, thereby discouraging "pothunters" (Marshall 1991; Marshall 1992).

The potential for adverse impacts of the proposed project on cultural resources would be reduced or eliminated by the policy set forth in HRI's preliminary cultural resource management plans (Marshall 1988; Marshall 1991; Marshall 1992). The principal objective of the policy is too avoid all cultural resources. The procedural outline of the policy calls for inventory of all project areas for cultural resources (a process currently under way), site demarcation, and development of specific avoidance procedures. Cultural resources identified in the lease areas would be recognized (and demarcated if appropriate) as protection zones where human activity would be prohibited. This policy is regarded as feasible because ISL mining allows considerable flexibility in the layout of facilities. Any construction or drilling activity requiring subsurface disturbances (e.g., leveling for a well pad) would be preceded by archaeological testing and an archaeological monitor would be present during construction and reclamation activities.

Even with these precautions, the possibility exists that subsurface artifacts or unmarked graves could be discovered. In the event that previously unidentified cultural resources were discovered during project activities, the archaeological monitor would halt work in the area and the artifacts or human remains would be evaluated for their significance in accordance with applicable laws and regulations including the Archaeological Resources Protection Act, National Historic Preservation Act, American Indian Religious Freedom Act, Native American Graves Protection and Repatriation Act, Navajo Nation Cultural Resources Protection Act, Navajo Nation Policy to Protect Traditional Cultural Properties, and the Navajo Nation Policy for the Protection of Jishchaa', Human Remains, and Funery Items, as well as policies of Puebloan tribes claiming descent from the Anasazi culture in the event Anasazi gravesites are discovered.

### 4.11.2 Alternative 2 (Modified Action)

In the modified action scenario, one or two of the proposed project sites, but not all three, would be developed. The location of the main processing facility could be changed from the Crownpoint site to the Church Rock or Unit 1 sites or to a processing facility elsewhere out of the Crownpoint region. Finally, liquid waste disposal methods could be changed to various combinations of evaporation ponds, injection wells, land application, and surface discharge.

#### 4.11.2.1 Alternative Sites for ISL Mining

Developing only one or two sites instead of three would be expected to reduce impacts to cultural resources proportionately. Less land would be subjected to surface disturbance and fewer cultural resources would be identified or inadvertently damaged by equipment, personnel, or even looting or vandalism. The density or concentration of surface disturbance would not increase—a factor that otherwise would hinder HRI's plan to avoid disturbing cultural resources. Thus, it does not appear that increased risk would occur to resources in those sites that would be developed.

#### 4.11.2.2 Alternative Sites for Yellowcake Drying and Packaging

Changing the location of the main processing plant from Crownpoint to one of the other two sites or to an existing site elsewhere would not affect cultural resources. The processing unit would add only a small facility consisting of a yellowcake drum storage area, dryer room, office and shower to either of the satellite facilities at the other two sites selected for the processing facility. This minor addition would require a very small increment of land for the expanded plant. Using an existing processing plant elsewhere in New Mexico or Texas would create no additional cultural resource impacts.

#### 4.11.2.3 Alternative Liquid Waste Disposal Methods

Different combinations of evaporation ponds, deep-well injection, land application, and surface discharge could affect the level of impacts to cultural resources. Generally, the more land required for a liquid waste disposal method, the greater the potential risk to cultural resources. As noted in Section 3.9, cultural resources are prevalent from the Anasazi culture, and more resources are likely to be found during ongoing cultural resources surveys, when archaeological testing is carried out, and during earth-moving operations. With methods that use larger evaporation ponds or require more land area for surface discharge or land application, the risk of coming in contact with more resources is increased. In addition, the flexibility to move such locations around to reduce adverse impacts is lessened because of size and configuration constraints. Thus, use of alternative liquid waste disposal methods appears to pose the greatest risk of increasing adverse impacts of any of the three categories of project modifications.

### 4.11.3 Alternative 3 (The NRC Staff-recommended Action)

This section provides a summary of additional NRC staff requirements and recommendations based on its evaluation of the proposed action. The following list supplements the commitments already made by HRI in its license application. Subsequently, HRI has formally agreed to these conditions as expressed in its letter to NRC dated December 26, 1996 (see Appendix B). The staff believe that the previously identified impacts of this project can be mitigated through the measures discussed below.

If a license were issued for the proposed project, those items listed as requirements would be incorporated in the license either as separate license conditions or combined as one general license condition that references HRI's consolidated operations plan. For those items listed as NRC staff recommendations, BIA, BLM, and other cognizant regulatory agencies will be responsible for ensuring that HRI has complied with this guidance.

Assuming HRI's successful implementation of the policy of avoidance outlined in its preliminary cultural resources management plans (Marshall 1988; Marshall 1991; Marshall 1992), the proposed project has minimal potential to result in significant impacts on cultural resources (Section 4.11.1). Therefore, the NRC staff recommend that if a license is issued it be conditioned on the development and implementation of a final cultural resources management plan for all mineral operating lease areas and other land affected by licensed activities. The plan would be developed pursuant to the National Historic Preservation Act Section 106 review and consultation process and would provide specific procedures to implement HRI's policy of avoiding cultural resources. The plan would include archaeological and traditional cultural property surveys of all lease areas; identification of protection areas where human activity would be prohibited; archaeological testing (by an archaeologist contracted to HRI and holding appropriate permits from the Navajo Nation and the State of New Mexico) before subsurface disturbance occurs at a specific location; and archaeological monitoring during all ground disturbing construction, drilling, operation, and reclamation activities. In the event that previously unidentified cultural resources or human remains are discovered during project activities, the activity in the area would cease, appropriate protective action and consultation would be conducted, and, if indicated, the artifacts or human remains would be evaluated for their significance.

### 4.11.4 Alternative 4 (No Action)

The no-action alternative would leave cultural resources in place at the three project sites and unaffected by any mining development. Thus, no adverse effects would be attributable to the proposed action. Conversely, no new cultural resources would be discovered and identified that might assist archaeologists in gaining new knowledge about ancient cultures. Although HRI proposes not to disturb such resources, their discovery and protection has consequences for descendants of the cultures represented by the resources and for scientific knowledge.

## 4.12 ENVIRONMENTAL JUSTICE

The approach used in this environmental justice analysis is based on interim guidance from the NRC and draft guidelines from the CEQ as outlined in Section 3.10. A significant environmental justice impact is an impact to human health or the environment that is high and adverse and that disproportionately affects a minority or low-income population. Because the population near the proposed project sites is made up almost entirely of Navajo, many of them living in poverty, any significant adverse impact resulting from the project would be an environmental justice impact. Other effects of the project that would be below significance levels in other locations may also have environmental justice implications.

The following sections summarize the potential impacts of the proposed project and discuss the relevant mitigation measures intended to reduce their consequences. Additional mitigation measures are proposed to reduce the local communities' sensitivity to the project. Because impacts to air quality

(Section 4.1) and geology and soils (Section 4.2) would be negligible and have caused little or no concern among the local populations, they are not discussed in this section.

### 4.12.1 Groundwater

Significant adverse effects to groundwater quality would result if an excursion (either horizontal or vertical) occurs or if, after routine mining, water quality is not restored.

Successful restoration of a production-scale ISL well field has not previously occurred. Further, site-specific tests conducted by HRI have not demonstrated that the proposed restoration standards can be achieved at a production scale. To preserve the community's use of the Westwater Canyon aquifer as a drinking water source, NRC staff would require several mitigation measures of HRI. All groundwater-related mitigation measures are included in Section 4.3.3 and listed in Appendix B. Generally, the measures include additional characterization, testing, and bonding above that proposed by HRI, for groundwater restoration. A groundwater restoration demonstration would be required at Church Rock before lixiviant could be injected at Unit 1 or Crownpoint. Additionally, HRI would replace Crownpoint's water supply wells before injecting lixiviant at Crownpoint, and placement of new wells would be coordinated with the Navajo Nation Department of Water Development and Water Resources and the NNEPA, NTUA, and BIA, as appropriate.

The groundwater analysis in Section 4.3 concludes that water consumption impacts would be significant during groundwater restoration activities. The maximum drawdown in the affected aquifer is 28 m (80 ft). This drawdown would not affect water availability to the community, but it would increase the cost of pumping water from the aquifer. Therefore, NRC staff would require that when groundwater restoration activities begin at a production-scale well (excluding the smaller-scale Church Rock demonstration), HRI would be required to reimburse operators of the Crownpoint community's water wells for increased pumping and well work-over costs.

Section 4.3 discusses notifications that would be made to the NRC in the event that a lixiviant excursion occurs, a retention pond leaks, or an embankment failure occurs. The NRC staff recommend the following additional notifications.

- In the event a lixiviant excursion is confirmed by groundwater monitoring, staff recommend that HRI notify the Navajo Nation (executive director, NNEPA, Shiprock Office), the BIA (branch chief, Minerals Section, Branch of Real Estate Services, BIA Navajo Area Office), and the BLM (minerals team leader, Albuquerque Field Office) by telephone within 24 hr, and by letter within 7 days from the time the excursion is confirmed.

- Staff recommend that a written report be submitted to the Navajo Nation (executive director, NNEPA, Shiprock Office), the BIA (branch chief, Minerals Section, Branch of Real Estate Services, BIA Navajo Area Office), and the BLM (minerals team leader, Albuquerque Field Office) within 60 days of excursion confirmation. The report should contain the same information as the report submitted to the NRC.

- In the event that retention pond standpipe water analyses indicate that a pond is leaking, staff recommend that HRI notify the Navajo Nation (executive director, NNEPA, Shiprock Office), the BIA (branch chief, Minerals Section, Branch of Real Estate Services, BIA Navajo Area Office), and the BLM (minerals team leader, Albuquerque Field Office) by telephone within 48 hours of verification.

- Staff recommend that a written report be filed with the Navajo Nation (executive director, NNEPA, Shiprock Office), the BIA (branch chief, Minerals Section, Branch of Real Estate Services, BIA Navajo Area Office), and the BLM (minerals team leader, Albuquerque Field Office) within 30 days of first notifying the agencies that a pond leak exists. The report should contain the same information as the report submitted to the NRC.

- Staff recommend that HRI notify the Navajo Nation (executive director, NNEPA, Shiprock Office), the BIA (branch chief, Minerals Section, Branch of Real Estate Services, BIA Navajo Area Office), and the BLM (minerals team leader, Albuquerque Field Office) by telephone within 48 hr of any solution spill or embankment failure which may have a radiological impact on the environment. Staff recommend that such notification be followed, within 7 days, by submittal of a written report to the agencies detailing the conditions leading to the failure or potential failure, corrective actions taken, and results achieved.

An injection well permit (or permits) under the SDWA would be required. Although permitting for the proposed action occurs separately from the EIS process, permitting issues have arisen in the NEPA context. Because these issues have heightened the community's sensitivity to the project, they are addressed here.

The U.S. EPA has a direct implementation program for all "Indian country" as defined in 18 U.S.C. Section 1151 (see 40 CFR § 144.3), which includes allotted land, trust land, and land within a dependent Indian community. The Navajo Nation has qualified for "treatment as a State" under the terms of the Federal SDWA and is developing its own UIC program, including policies regulating ISL mining. This program may supplant the U.S. EPA regulatory program within 4 years. The State's authority under the SDWA stems from a grant of primacy from U.S. EPA for administering the UIC program in New Mexico, excluding Indian country.

Competing jurisdictional claims exist because the Navajo Nation asserts that all the project area is in Indian country and the State claims that some is not. It is not the function of this EIS process in particular or the NRC in general to arbitrate among the competing jurisdictional claims. However, the NRC staff have identified certain issues to be considered in resolving this permitting jurisdiction issue. The first is the interest or preferences of the Navajo Nation. This issue is related to several other issues, namely the Navajo Nation's sovereignty, the Federal government's obligation to relate to the Navajo Nation on a government-to government basis, and the need to ensure environmental justice. Based on these considerations, and because the proposed action would occur in an area traditionally held and currently occupied mostly by Navajo people and some of the land is indisputably "Indian country," the NRC staff recommend the following:

- HRI work with the U.S. EPA and the State of Mexico to ensure that the Navajo Nation be involved in UIC permitting. Specifically, the Nation (particularly the NNEPA) should be a party to all negotiations regarding UIC permitting, and its concerns should be reflected in the permitting decisions and/or conditions. However, the outcome of such negotiations would affect only the permitting of the proposed action and is not to be construed as having implications for other jurisdictional disputes.

The conclusion of the water consumption analysis—that the proposed project would not significantly affect availability of water to the community—is contrary to perceptions of the project that have been voiced in the scoping process for this EIS. Throughout the western United States, water availability and possession of water rights is a contentious issue. The contention is worsened in this case because a second issue is involved, that of jurisdiction in administering water rights, involving the State of New Mexico and the Navajo Nation.

A specific issue regarding water rights at the Church Rock site was mooted by the State's district court when it ruled that the water rights HRI (through URI) sought to transfer were inadequate. Nevertheless, the issue of which sovereign—the Navajo Nation or the State of New Mexico—can administer the utilization of water rights remains. The Navajo Nation asserts that any claim of jurisdiction by the State engineer over water rights in tribal trust lands and Indian country interferes with tribal sovereignty. The Nation asserts its jurisdiction to administer water rights in Indian country through the Navajo Nation Water Code.

As in the case of UIC permitting, it is not the role of this EIS process in particular or the NRC in general to arbitrate among the competing claims regarding administration of water rights.

However, the NRC as an agency of the Federal government has an obligation to recognize and protect the tribal sovereignty of the Navajo Nation. In addition, the context and mandates of environmental justice suggest that the Navajo Nation (because Navajo people would potentially be affected) should be involved in the process to administer the utilization of water rights. To this end, the NRC staff recommend the following:

- HRI should facilitate negotiations between the State of New Mexico (i.e., the State engineer) and the Navajo Nation (i.e., the Department of Water Development and Water Resources) that would develop an approach and process through which HRI's applications for utilization of water rights would be considered.

### 4.12.2 Surface Water

Minimal impacts to surface water are expected during well field construction and operation.

Discharge of wastewater to surface water bodies is a disposal option only at the Church Rock site (Section 4.4.1.3). The expected average uranium concentration of process wastewater would exceed the allowable concentration average in 10 CFR Part 20, Appendix B (see Section 4.6.2.3). To discharge process wastewater into a surface water body, HRI would have to request an exemption to 10 CFR

Part 20, Appendix B, for uranium, and get an NPDES permit. If surface water discharge were to occur, exposures to individuals who drink the water prior to full mixing in the stream could result in an individual dose that exceeds the 1 mSv (100 mrem) limit. Exceeding a regulatory limit is considered a significant adverse effect. This alternative would, therefore, result in a significant environmental justice impact.

The conservative scenario that results in the individual dose is a highly unlikely occurrence because individuals are not likely to drink from the river at the wastewater discharge site. However, the local population is known to drink directly from the Rio Puerco and to water livestock there. The livestock provide milk and meat for their owners. Because of these subsistence activities, it is possible that individual doses could be much higher to the Navajo population than they would be to another population that did not participate in such subsistence activities. Further, this same stream has elevated background levels of naturally occurring uranium and has been contaminated further by a mill tailings dam break and mine dewatering effluent discharge (CDC 1980). Cumulative exposures to the population using the water are an important consideration under NEPA. This alternative must be fully analyzed before receiving further consideration.

Staff recommend the following mitigation measure, which is intended to allow Navajo Nation concerns to be reflected in a land application permit if one is issued.

- Should land application be planned for any land other than privately-owned or State land, HRI should work with the U.S. EPA to ensure that the Navajo Nation is involved in land application permitting.

### 4.12.3 Transportation Risk

The transportation risk analysis in Section 4.5 considered the high rate of accidents on highways near the project sites, a particular concern expressed by many commentors in scoping and the DEIS public meetings. The analysis concludes that there is only a very slight chance of an accident involving trucks delivering chemicals to the sites and transporting uranium slurry, 11e(2) by-product material, and yellowcake from the sites. The likelihood that the accident would result in a materials spill is small; an even smaller likelihood exists that a spill would affect human health. However small the chance, though, an accident could occur and could result in the deaths of those involved. It is probable that the victims of a local accident would be Navajo community members. Therefore, the NRC staff recommend the following measures to minimize these risks:

- All delivery trucks used to transport project materials [uranium slurry, yellowcake, process chemicals and 11e(2) by-product material] should carry the appropriate certifications of safety inspections.
- All delivery truck drivers should hold appropriate licenses.

## 4.12.4 Health Physics

No alternative—with the exception of process wastewater discharge into surface water bodies (see Section 4.12.2)—would exceed allowable limits for radiation exposure to the public. Further, the increase in TEDE equivalent is only slightly higher (well below a 1 percent increase) than the dose received from natural background radiation. This low TEDE would occur even if a family were to farm and herd animals on a land application site immediately after wastewater application ceased.

The model used to predict health physics impacts accounts for exposures possible from being outdoors much of the time and for consuming vegetative matter and animals affected by the project. Also, the dose assessment considered doses to infants, because they are more sensitive than the adult population.

The proposed project may result in a positive environmental health effect at the Church Rock site. This effect would occur because some areas of the site have higher concentrations of residual radioactivity (from previous mining activities) than would be allowed in decommissioning the site under the proposed action. Therefore, these areas may be cleaned up as part of the well field decontamination.

The analysis in Section 4.6.1.4 considers the cumulative effect of the long history of uranium mining in the area and the large exposures to radon (and other radioactive elements that form as radon decays) that occurred primarily to miners and resulted in a high incidence of cancer among them. It concludes that the proposed project would result in a negligible increase in existing impacts to the area due to mining and milling.

The NRC staff is aware that to some members of the local community, any increase in the cumulative effect or in radioactivity, brought to the surface by any uranium mining activity, would be unacceptable. This perception is likely to be most prevalent among those whose health has been, or who have family members or friends whose health has been negatively affected by uranium mining activity.

## 4.12.5 Ecology

Members of the Navajo Nation have expressed concern over the need to protect wildlife in the project area. No significant impacts to wildlife and vegetation in the area are expected, although some localized habitat disturbance may result from construction activities. It is possible that waterfowl would use the retention ponds as stopovers during migration. The analysis in Section 4.7 concludes that concentrations of harmful substances in wastewater retention ponds would not be high enough to harm any birds that use the ponds.

Although information about the local population's subsistence consumption of migrating birds is unavailable, it is highly possible that some birds would be consumed. To minimize any potential health consequences of the consumption of birds and to protect the birds themselves, the NRC staff recommend the following mitigation be implemented as soon as possible if birds begin to use the ponds:

- Bank vegetation that would provide cover for the birds should be removed, and visual or sound devices should be installed to ward off birds. If these measures fail to keep birds from the ponds, wire screens should be placed over the water's surface.

### 4.12.6 Land Use

The analysis in Section 4.8 concludes that, without mitigation, the proposed project has the potential for short-term adverse effects to land use. This constitutes an environmental justice impact. Mitigation measures recommended in Section 4.8 include compensating grazing rights permitees for the temporary loss of their permits and residents who are not signatories to leases but who would be required to relocate.

Concerns were expressed during scoping about a lack of access to lands used for traditional activities (e.g., gathering plants) and ceremonies. The preliminary traditional cultural properties survey (Becenti 1996; HRI 1996c) indicates that the lands are not used for such activities. Therefore, no additional impact is anticipated.

### 4.12.7 Socioeconomics

The analysis of socioeconomic impacts in Section 4.9 indicates that the proposed project would have a positive effect on the local economy due primarily to the jobs that would be available to local Navajo. To ensure that local Navajo are provided job opportunities, the NRC staff recommend the following mitigation measures:

- HRI, with input from and review by the BIA and officials of the six local chapters (see Section 4.9), should develop a hiring plan that outlines how members of local chapters would be informed of job opportunities in a timely manner.

- HRI should provide an annual report to the BIA and the six local chapters indicating the number of employees who are Navajo, their chapter affiliation, and the number of non-Navajo employees.

HRI has made commitments, and the NRC staff recommend that the commitments be adhered to, for equipment and training to be provided to the local hospital and fire department so that they are prepared and equipped to respond should an accident occur and so that the hospital's future delivery of service would not be affected by handling a decontamination case. These commitments are outlined in Section 4.9.

### 4.12.8 Cultural Resources

The cultural resources analysis (Section 4.11) concludes that, given the available information and HRI's plan of "total avoidance," no significant impacts to cultural resources are likely. Other, more specific mechanisms to prevent impacts to cultural resources may be developed during the National Historic Preservation Act Section 106 consultation process.

Some Native Americans hold spiritual or religious beliefs that any mining activity upsets the balance among nature, people, and their creator. It is difficult to determine the significance of such an impact, either in terms of cultural resources or environmental justice. The NRC staff recommend the following mitigation to help minimize such concerns:

- HRI's cultural resources specialist should consult with traditional practitioners of both the Crownpoint and Church Rock chapters to ascertain whether specific ceremonies or blessings are in order. Based on these consultations, the cultural resource specialist should identify those ceremonies that must be facilitated by HRI (e.g., by HRI's granting access to the site or supplying resources required for the ceremony).

### 4.12.9 Process Components of Environmental Justice

Involvement of Native American tribes in a manner consistent with the cooperative government-to-government relationship between the United States and Native American tribes helps to ensure environmental justice. A primary mechanism affording such involvement in NEPA is the role of the cooperating agency. The Navajo Nation declined to participate in this EIS as a cooperating agency.[1] However, the Nation and the chapters have provided a considerable amount of information incorporated into the analyses of impacts. Also, the Navajo Nation and the Hopi Tribe participated in the scoping and public meeting processes, and their comments have been both addressed in the comment responses appended to this FEIS and considered in the analyses conducted for the FEIS.

To fulfill the U.S. government's trust obligation to the Navajo people, and to operate in a manner consistent with the government-to-government relationship maintained between the United States and Native American tribes, the NRC staff have recommended mitigation measures (see preceding sections) that take into account the concerns of the Navajo Nation.

Native American groups that have ties to the project areas, in addition to the Navajo, are the Pueblos of Acoma, Laguna, and Zuni, and the Hopi Tribe. Interest in or concerns about the project that these Native American groups have expressed have focused on the potential for cultural resource impacts. The National Historic Preservation Act Section 106 review process provides opportunity for these concerns to be addressed and for participation of the concerned parties. Each of these groups, along with the Navajo Nation, is involved in the ongoing Section 106 consultations.

The Navajo Nation's moratorium on all uranium mining activity is to be effective on Navajo lands until such a time that the Navajo people are assured that the safety and health hazards associated with uranium mining activity can be addressed and resolved. However, the Church Rock and Crownpoint Chapters where the proposed project would be located held referenda indicating their support for HRI's proposal despite the moratorium. Also, given that many allottees have agreed to lease their land to HRI, the applicability of the moratorium to allotted lands is not clear. At issue is whether the Nation's

[1]The NNEPA petitioned NRC for cooperating agency status in October 1996, after such status was declined by the Navajo Nation in 1993. Because the petition was made when the NEPA assessment process was coming to a close, the petition was denied by NRC.

moratorium overrides the individuals' decisions about their land. Given these conflicts, the NRC has proceeded with the EIS process and with a Safety Evaluation Report to determine what impacts, including human health and safety, would result from HRI's proposed project and the alternatives. The licensing decision—which will be based on the FEIS, the Safety Evaluation Report, and the hearing record and decision of the presiding officer if an adjudicatory hearing is held—and which will incorporate all license conditions, will be the NRC staff's determination of whether the local community's safety and health can be ensured.

The NRC staff acknowledge that the technical information contained in this FEIS can be a challenge to native speakers of languages other than English. The NRC has tried to facilitate communication during the scoping and public meeting process by providing translators. To facilitate local community members' understanding of the conclusions drawn in this FEIS, a summary will be translated into Navajo using video. The Navajo-language summary video will be available within 30 days of the notice of availability of the FEIS (published in the *Federal Register*). Copies of the Navajo-language video will be provided to the Church Rock and Crownpoint Chapter Houses, and notices (in English and Navajo) posted at chapter houses will announce the availability of this FEIS.

### 4.12.10 Alternatives

The discussion in the preceding environmental justice sections applies broadly to the proposed action and all alternatives, except the no-action alternative. To the extent that the impact analyses of each resource (e.g., groundwater, cultural resources) have concluded that lesser impacts would result from mining at one or two sites, but not all three, environmental justice impacts would also be reduced. The no-action alternative would not result in any adverse impacts to the community. However, the primary benefit of the proposed action—the economic gain resulting from employment of local Navajos—would not occur.

## 4.13 CUMULATIVE IMPACTS

The CEQ regulations for implementing NEPA define cumulative impact as "the impact on the environment which results from the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). The regulations further explain that cumulative impacts "can result from individually minor but collectively significant actions taking place over a period of time." Thus, the proposed project could contribute to cumulative impacts when its impacts overlap with those of other past, present, or reasonably foreseeable future actions. For this FEIS, other past, present, and future actions in the project area include (but are not limited to) underground and ISL uranium mining; road construction and maintenance; irrigation, farming, and livestock grazing; urban and residential development; and State, Federal, and Tribal management of land, water, and wildlife.

### 4.13.1 Air Quality and Noise

The development of the proposed project would not make a significant contribution to cumulative impacts on air quality and noise in the region. Existing air quality in the project vicinity is good, the impacts of the project on air quality are expected to be small (Section 4.1), and there are no reasonably foreseeable future actions that would combine with the project to significantly affect air quality. The proposed project would generate some impacts associated with additional noise in the immediate vicinity (Section 4.1). However, the combination of existing background noise, noise from the project, and noise from reasonably foreseeable future actions is not expected to represent a significant cumulative impact.

### 4.13.2 Geology and Soils

The proposed project would contribute to impacts on geology and soils in the region (Section 4.2), but the cumulative impacts of this contribution combined with other past, present, and future actions are not expected to be significant. The region's geology has been affected, and could be affected in the future, by underground uranium mining. The southern end of the Church Rock site was developed as an underground mine, and drilling and groundwater flow associated with the proposed project could combine with existing mine workings to affect geology. However, NRC staff do not believe that this combination would create a significant cumulative impact.

The region's soils have also been affected by underground uranium mining, and could be affected in the future by both underground and ISL mining. At Church Rock, the site topography was changed by underground mining as a result of pond and shaft construction. Soils at the Church Rock site also may have been affected radiologically by underground mining, but the site has been decommissioned to remove any radioactive materials left behind in surface soils or previous pond areas. Underground mining at the Church Rock site also resulted in off-site impacts to soils as a result of the creation of a uranium mill and tailings pile north of the site. The mill has been dismantled and decommissioned, and the tailings pile is being stabilized and reclaimed.

The proposed project would involve disturbing up to 752 ha (1858 acres) for buildings, well fields, and production ponds, and land application could affect an additional 518 ha (1280 acres). If land application is used, total soil disturbance for the project could be as much as 1270 ha (3138 acres). However, the contribution of this disturbance to past, present, and future impacts on soils in the region is not expected to create a significant cumulative impact because HRI would be required to decommission and reclaim each of the project sites. As has been demonstrated by the reclamation of a small ISL well field constructed at the Unit 1 site, the proposed project's contribution to cumulative impacts on soils is likely to be small and temporary.

### 4.13.3 Groundwater

As proposed by HRI, the project would make a significant contribution to cumulative impacts on groundwater in the region (Section 4.3). However, the license conditions that would be required by

NRC staff (see below) would mitigate these potential impacts. Assuming successful groundwater restoration, some water quality parameters would be returned to background and some would be higher than background, but less than Federal primary and secondary drinking water standards. The total volume of groundwater that would be chemically affected by ISL mining is estimated to be 3.3 million $m^3$ (2671 acre-ft). This volume was calculated from pore volume and restoration volume data submitted by HRI (HRI 1996a). In calculating this value, the following assumptions were made:

1. Final constituent concentrations, on a well field average, would comply with the restoration goals established in the license.
2. No lateral or vertical excursions would occur during operations.
3. The total amount of pore space within the mined portion of the aquifer at the well field represents the water available for consumption after restoration.
4. The porosity is 0.28 and the combined horizontal and vertical dispersion factors are 1.95.

It is estimated that practical production-scale groundwater restoration activities would at most require a 9 pore volume restoration effort. For 4 and 9 pore volume restoration efforts, the estimated water consumption over the life of the project at all three sites is shown in the following table.

**Water consumed**

| | 4 pore volumes | | 9 pore volumes | |
|---|---|---|---|---|
| **Restoration alternatives** | **Million $m^3$** | **Acre-feet** | **Million $m^3$** | **Acre-feet** |
| Groundwater sweep | 12.9 | 10,525 | 29.0 | 23,681 |
| Reverse osmosis | 3.3 | 2632 | 7.4 | 5922 |
| Brine concentration | 0.03 | 24 | 0.07 | 54 |

Potentially significant impacts on groundwater quality would be mitigated by the NRC staff requirement that HRI move the existing town of Crownpoint water supply wells. During groundwater restoration activities, the town of Crownpoint would experience increased pumping costs at the existing water supply well locations. This impact would be mitigated by the NRC staff requirement that HRI reimburse the town of Crownpoint for any additional costs due to increased pumping.

After the town of Crownpoint water supply wells are moved, groundwater at the new wells may be degraded by ISL mining activities at the Unit 1 and Crownpoint sites. However, groundwater quality would not be degraded below EPA primary and secondary standards and the NRC standard of 0.44 mg/L for uranium.

If the town of Crownpoint water supply wells were moved to another location in the Westwater Canyon aquifer, any groundwater quality changes that could occur as a result of ISL mining activities at the Unit 1 and Crownpoint sites would happen after a very long time period. If the wells were moved farther from the project sites than their present location, the time period required for water movement from the sites would increase greatly.

Past actions that have contributed to cumulative impacts on groundwater in the region include underground uranium mining at the Church Rock site, which would have dewatered the Westwater Canyon aquifer and the Brushy Basin "B" Sand aquifer in the area of the existing workings and may have had some dewatering effects on the Dakota Sandstone aquifer. Dewatering effects would have lowered water levels in these aquifers for some distance around the workings and may have oxidized some of the rock around the workings by exposing it to the atmosphere. When mining stopped, the workings flooded, and after several years groundwater levels returned to pre-mining levels. Water quality in the workings was probably degraded, but groundwater quality outside the mine workings does not appear to have been affected.

Future actions that could contribute to cumulative impacts on groundwater in the region include continued uranium mining. The depth of the uranium deposits in the project area means that any future mining activities would probably use underground or ISL mining techniques. A uranium deposit extends from the Church Rock site to east-southeast of the Crownpoint site. Other deposits are found in the area both north and south of the town of Crownpoint. All these deposits are found in the Westwater Canyon aquifer. Therefore, in the future, uranium mining might occur close to any of the proposed project sites or the town of Crownpoint. Since all of these deposits are in the Westwater Canyon aquifer, it is reasonable to assume that this is the aquifer that would be most affected by future mining activities. If, as in the past, the town of Crownpoint continues to grow and obtain its drinking water from the Westwater Canyon aquifer, the town wells would have increased influence on the direction of groundwater flow, water levels, and groundwater velocities in the Westwater Canyon aquifer.

ISL mining at the Church Rock, Unit 1, and Crownpoint sites would geochemically change the chemistry of the groundwater in the Westwater Canyon aquifer, but not so much as to degrade its use. Some temporary impacts on groundwater level would occur, but at the Church Rock site these impacts would be less than the effect of past underground mining activities on water levels. If the town of Crownpoint water supply wells are moved a significant distance away from the Crownpoint and Unit 1 sites, increased pumping of water by the town wells is not likely to significantly affect water flow velocities beneath the Unit 1 and Crownpoint sites. As a result, projected impacts on water quality would not be changed. If the town of Crownpoint wells are located in an aquifer other than the Westwater Canyon aquifer, increased pumping by town wells would not have any effect on the velocity of groundwater beneath the Unit 1 and Crownpoint sites. Future mining in the area could affect groundwater flow velocities, water levels, flow direction, and water quality. At this time, the NRC staff is unaware of any other operations that have been licensed to conduct uranium mining or processing in the area. Therefore, should mining occur at other locations in the future, the impact of those operations on existing operations, on planned operations with licenses to operate, on the environment, and on the health and safety of the local community would be considered at that time.

### 4.13.4 Surface Water

The proposed project would not make a significant contribution to cumulative impacts on surface water in the region. Because of the ephemeral nature of the surface water bodies in the area and the relatively low level of surface disturbance associated with the project, impacts on surface water quality and quantity are not expected to be significant (Section 4.5). In addition, there are no reasonably foreseeable future actions that would combine with the project to significantly affect surface water quality or quantity.

### 4.13.5 Transportation Risk

Shipments associated with the proposed project would contribute to transportation risk on roads in the region (Section 4.5), but the project's contribution to the cumulative impacts of other past, present, and future actions is not expected to be significant. Although some roads in the project vicinity have had relatively high accident rates in the past, increased traffic due to project shipments is not likely to significantly increase transportation risk. In addition, there are no reasonably foreseeable future actions that would combine with the project to significantly increase local transportation risk.

### 4.13.6 Health Physics and Radiological Impacts

The proposed project would make a minor contribution to cumulative impacts in terms of health physics and radiological impacts (Section 4.6). Annual doses to the population within 80 km (50 mi) of the project from air releases have been estimated as part of the MILDOS-AREA calculations. The total annual population dose was estimated for the period in time of greatest releases from all three project sites. Two population dose estimates were calculated: one for the Crownpoint/Unit 1 sites and one for the Church Rock site. As the area of impact is similar for both calculations, the results were combined with a total population dose less than 0.01 man-Sv/year (1 man-rem/year). The population within the 80 km (50 mi) radius of the entire project is approximately 76,500 persons. Population dose commitments resulting from facility operations represent less than 1 percent of the dose from natural background sources. The population dose from natural background would be approximately 170 man Sv/year (17,000 man-rem/year).

Northwest New Mexico has a long history of uranium mining and milling. Effects of previous mining and milling operations in the area are considered here as they relate to the proposed licensing action. The Church Rock facility as proposed would mine an area previously mined by underground mining to supply ore to the Church Rock mill site. Uranium mining was a large employer in the area and many individuals worked in the mining and milling operations. Early mines and mills operated under much less stringent standards than exist today, and this resulted in large exposures to radioactive materials, especially radon and its daughters. The exposures were large enough to result in a high incidence of cancer among workers, and information gathered on these workers resulted in development of risk factors on radon.

In addition, the methods used to mine and mill the uranium (i.e., "conventional" mining) resulted in very large amounts of radioactively and chemically contaminated sands and slimes, also known as tailings. In 1978, the U.S. Congress passed the Uranium Mill Tailing Radiation Control Act, which required standards to be developed to control exposures from tailings and clean up past sites of uranium milling. In 1979, the tailings pond dam at the Church Rock site failed and approximately $3.56 \times 10^5$ $m^3$ (94 million gal) of tailings liquid and 1100 tons of tailings solids were released into the Rio Puerco River (NRC 1981a). The area contaminated by the spill was surveyed and cleaned to standards developed by the New Mexico Environmental Improvement Division.

The proposed project would result in a negligible increase in cumulative impacts in the area due to uranium mining and milling. HRI has proposed an ISL process which, by its nature, does not result in large amounts of tailings or environmental releases of radioactive particulate material. Additionally, HRI has proposed to use a vacuum dryer, which reduces the total releases of radioactive particulates to nearly zero, and a pressurized process circuit with a feedback system to return radon to the mine zone, which reduces environmental radon releases. The expected exposures from the remaining possible sources of radon are a very small fraction of the allowable limits for exposure of the public. The amount of generated tailings is very small, in the tens of cubic meters per year, and would be disposed of at an off-site licensed facility. In addition, the facility and related well fields would be required to be decontaminated and decommissioned to the appropriate State and Federal standards.

### 4.13.7 Ecology

The proposed project would contribute to ecological impacts in the region (Section 4.7), but the cumulative impacts of this contribution combined with other past, present, and future actions is not expected to be significant. Much of the project area and the region already has been affected by past actions including livestock grazing and uranium mining and milling. However, the amount of land that would be temporarily disturbed by the project (land disturbance would be the primary source of any adverse impacts to ecological resources) is small relative to the amount of similar wildlife habitat available in the region. Also, the land disturbed by the project would be reclaimed and revegetated upon project completion. Compared to past uranium mining and milling operations in the area, the proposed project would limit negative impacts by avoiding the ecologically damaging consequences of pit mining and/or ore tailings production. In addition, there are no reasonably foreseeable future actions that would combine with the project to create significant cumulative impacts on ecological resources.

### 4.13.8 Land Use

The proposed project would not make a significant contribution to cumulative land use impacts in the region. Although construction and operation of the project would have adverse impacts on land use at each of the three sites (Section 4.8), most of the impacts would be temporary because of the sequential nature of the mining operations and to HRI's proposals for site restoration and reclamation. Including previously disturbed areas, a total of approximately 743 ha (1858 acres) would be disturbed at various times during project construction and operation at the three sites. If HRI disposes of wastewater using off-site land application in Section 12, T17N R13W, and Section 16, T16N R16W, an additional 512 ha (1280 acres) could be disturbed. This disturbance would contribute to the impacts of other past and present land uses in the area, including uranium mining, livestock grazing, road construction, and urban and residential development. However, because of the nature of ISL mining operations and of HRI's proposals for site restoration and reclamation, the combination of existing land disturbance, new disturbance related to the project, and disturbance from reasonably foreseeable future actions is not expected to represent a significant cumulative impact.

### 4.13.9 Socioeconomics

The proposed project would make a positive contribution to cumulative socioeconomic impacts in the region. The project would provide the long-term benefits of employment, wages, and tax revenues without major adverse impacts to housing or the local infrastructure (Section 4.9). Impacts that would occur to the local infrastructure (e.g., the need to replace BIA and NTUA water supply wells in Crownpoint) would be mitigated by NRC license conditions requiring HRI to replace these wells. In terms of present and future actions, NRC staff are not aware of any other large projects or developments in the region that could combine with the proposed project to create adverse socioeconomic impacts. It is likely that additional uranium mining operations will be developed in the project area in the future because the region is relatively rich in uranium ore. If additional uranium mining occurs, it is likely that the positive socioeconomic effects described in Section 4.9 would be accentuated.

### 4.13.10 Aesthetics

The proposed project would contribute to aesthetic impacts in the region (Section 4.10), but the cumulative impacts of this contribution combined with other past, present, and future actions are not expected to be significant. The project area's landscape reflects hundreds of years of use by the local Native American population. The natural aridity and soil conditions of the area, coupled with the grazing of livestock, especially sheep, have resulted in overgrazed, rolling sparse grasslands interspersed with piñon pines or junipers. Other actions, including uranium mining, road construction, and urban and residential development, have also had aesthetic impacts in the area. NRC staff are not aware of any other large projects or developments in the region that could combine with the proposed project to create significant cumulative impacts to aesthetic resources. However, it is likely that the livestock grazing, uranium mining, road construction, and urban and residential development that have affected the area in the past will continue.

### 4.13.11 Cultural Resources

Because cultural resource sites at the project sites would be protected zones where no activity would be allowed, significant effects to cultural resources are not likely to result from the project under the staff-recommended action (Section 4.11). HRI's leases would preclude other activities at the project sites, so no cumulative effects would occur to cultural resources. Also, HRI's proposed activities would not contribute to effects on archaeological resources outside the project sites or traditional cultural properties located beyond the immediate vicinity of the project.

### 4.13.12 Environmental Justice

The environmental justice analysis described in this FEIS is, to a great extent, a cumulative analysis in that it considers the local community's previous experience with natural resource development activities, particularly uranium mining. Although the FEIS concludes that impacts to groundwater quality and consumption would be significant, the NRC staff requirements and recommendations would reduce the severity and likelihood of impacts. No cumulative impacts to groundwater or other resources are projected. Therefore, no cumulative environmental justice impacts are anticipated.

# 5. COSTS AND BENEFITS ASSOCIATED WITH THE PROPOSED PROJECT

HRI's proposed project would be a private venture and, as such, would not have a direct public purpose. However, because the project would provide a domestic source of uranium that would eventually be used in nuclear reactors to generate electricity, it would have a public benefit. Existing statutes oblige the U.S. Secretary of Energy to have a "continuing responsibility" for the domestic uranium mining industry "to encourage use of domestic uranium" (42 USC §§ 2201b and 2296b-3). The NRC recognizes that the viability of the industry is a Federal concern and that there is a public interest in the uranium supply. Between 1985 and 1994, annual domestic uranium production decreased by 75 percent, while annual imports of uranium increased by 300 percent (DOE 1994b). In 1994, domestic uranium production was less than 5 million lb, while uranium imports totaled more than 35 million lb (DOE 1994b). The proposed project, which would produce about 1 million pounds of uranium per year at each of the three project sites, would have the beneficial effect of helping the United States offset this deficit in domestic production.

From HRI's perspective, the benefits of the project would be the revenues that would be generated from the sale of processed uranium. The costs would be the expenses, including the cost of land, labor, and capital, required to mine and process the uranium. Also, there would be costs to meet regulatory standards, including environmental protection and restoration. The amount of revenue that the project would ultimately generate is subject to the uncertainty inherent in the uranium market. The benefits and costs that are internal to HRI are not subject to government regulation and, therefore, are not assessed in this FEIS.

In economics terminology, "benefit-cost analysis" can be defined as a decision-making technique for evaluating the advantages and disadvantages of a government action. In this vein, this section describes the benefits and costs of the project for members of the local communities, local governments, and the State of New Mexico. These effects would include those that are brought about by HRI's proposed operation, including the expansion of tax bases related to the mining and processing operation, and any additional demands on the infrastructure and public services that would be imposed by the project. They also would include the beneficial effects of project employment.

## 5.1 OTHER BENEFITS OF THE PROPOSED PROJECT

The major potential benefits to the local community include employment income, royalty income, and tax revenues that would be generated by the mining operation. The project would develop little in the way of infrastructure, such as roads or buildings, that would be useful to the surrounding communities once the project is completed. It could provide some improvement to over-grazed lands by closing off grazing for a period of time while well fields are developed and operated. However, this would be a very small benefit because the land affected has only a very small value for grazing.

### 5.1.1 Potential Production

Both the employment generated and the taxes paid by HRI would depend on the production of yellowcake. The amount of yellowcake produced would depend on the market price and the cost of production. Table 5.1 shows HRI's projected costs of producing yellowcake for the alternative operations. Table 5.2 provides the current price of $U_3O_8$ and the latest government projection of price through 2010. It should be noted that the spot-market price in October 1996 was $3 higher than the projected price for the same year. Over the last 10 years, the spot-market price has been very volatile, fluctuating from a high of over $16 in 1987 to a low of less than $8 in 1991. As late as 1995, the price was less than $10 per pound.

**Table 5.1. Average production costs per pound of yellowcake under alternative project designs**

| Alternative configurations | Church Rock | Unit 1 | Crownpoint |
|---|---|---|---|
| Haul loaded resin to other site for processing and drying | $11.36 | $10.46 | $9.46 |
| Ship yellowcake slurry to dryer at other site for drying | $11.32 | $10.48 | $9.40 |
| Ship yellowcake slurry to Texas for drying | $11.83 | $11.05 | $9.87 |
| Stand-alone—all processing done at each site | $11.30 | $10.51 | $9.38 |

*Source*: HRI, *Response to Request for Additional Information, Issue 92: Cost/Benefit Analysis*

**Table 5.2. Projected price of $U_3O_8$**

| Year | Latest DOE/EIA spot market projection (adjusted to 1996$) |
|---|---|
| Current price on spot market (10/21/96) | $15.70 |
| 1996 | $12.72 |
| 1997 | $12.74 |
| 1998 | $12.62 |
| 1999 | $13.00 |
| 2000 | $13.31 |
| 2005 | $14.86 |
| 2010 | $17.38 |

*Source: Uranium Industry Annual 1995* [DOE/EIA-0478(95)]. Energy Information Administration, Office of Coal, Nuclear, Electric and Alternate Fuels, U.S. Department of Energy, May 1996.

With additions for taxes and royalties, HRI's costs could be 5 to 15 percent higher than projected in Table 5.1. This suggests that the Church Rock operation could become marginal if the price of $U_3O_8$ falls back to the projected prices shown in Table 5.2. The important point relevant to assessing the project's potential benefits to the local community is that the benefits depend on HRI's costs being lower than the future price of $U_3O_8$, which has been quite volatile. If the price of $U_3O_8$ is less than the costs of operation, then operations may be discontinued. If this happens, there would be no economic benefits to the local community.

Table 5.1 points out several alternative production configurations for HRI. HRI's proposal is to ship yellowcake slurry from the Church Rock and Unit 1 sites to the Crownpoint site for drying and processing. The alternative of shipping yellowcake slurry to Texas for drying would have the lowest potential benefit to local communities in New Mexico because it would require less employment for processing. Also, this alternative would have the highest potential cost because of the cumulative increase in risk of a slurry spill to local communities along the transportation route. The "stand-alone" alternative would have slightly less risk of a spill on public roads used to transport yellowcake slurry, including Navajo 49 and New Mexico 371 and roads through parts of the town on Crownpoint, than HRI's proposal.

## 5.1.2 Benefits from Employment and Royalty Income

The most important local benefit from the proposed project would be opportunities for employment and earnings. The degree to which the local communities benefit would depend on the available supply of qualified labor and HRI's hiring policies. NRC staff review indicates that about 100 long-term jobs may be available that would not require highly specialized experience or skills. It appears that members of the local communities could fill most, if not all, of these jobs. If trends similar to the rest of McKinley County are representative of the Navajo communities surrounding the proposed project, 47 percent of the population above 25 years of age have a high school degree or more, and about 7 percent have an associate, bachelor's, or graduate degree (Rodgers 1992). Presently, there are seven students from the Church Rock Chapter and 72 students from the Crownpoint Chapter enrolled in the Crownpoint Institute of Technology (CIT) (Van Dyke 1996k). Enrollment at CIT is important because it demonstrates that local community members desire and receive training such as office administration and building trade skills that are relevant to employment opportunities with the proposed project.

It also appears that members of the local community would have the economic incentive to fill all the available jobs. In 1989, about 76 percent of Navajo households in McKinley County had incomes below \$30,700 (adjusted to 1996 dollars), and 57 percent were below \$18,400 (adjusted to 1996 dollars) (U.S. Bureau of the Census 1990). This indicates that the HRI jobs, which would average about \$24,000 per year, would be very attractive to members of the local community. Based on the skill levels required and attractive wages relative to existing opportunities, the NRC staff believes that up to 100 jobs could be filled by members of the local community depending on how well HRI executes its stated intention to hire local Navajo.

Table 5.3 indicates that Navajo earnings from the project could be up to about \$2.4 million annually at the long-term operation level suggested by HRI. This level of operation is consistent with the

**Table 5.3. Summary of annual community earnings**

| | Potential Navajo employment | Potential Navajo earnings |
|---|---|---|
| Church Rock (1997–2003) | 44 | $1,053,000 |
| Unit 1 (1999–2016) | 38 | $905,500 |
| Crownpoint (2001–2016) | 47 | $1,124,700 |
| Peak | 129 | $3,083,200 |
| Long Term (2003–2016) | 100[a] | $2,400,000 |
| Average total project earnings per HRI job: $28,000 | | |
| Average local community earnings per HRI job: $24,000 | | |

*Source*: See Section 4.9 of this FEIS.

[a]Includes 85 direct jobs for Unit 1 and Crownpoint from HRI and 15 jobs for drill rig contractor.

production of about 1 million pounds of yellowcake annually from the Unit 1 site and 1 million pounds of yellowcake annually from the Crownpoint site. Table 5.4 presents a summary of the estimated benefits.

There could be about $1.1 million in annual royalty income going to holders of leases negotiated with HRI, depending on production from Unit 1 and the price of $U_3O_8$. However, this income would be concentrated (about nine lease holders), and would probably not have a widespread effect.

### 5.1.3 Benefits from Tax Revenues

As indicated in Table 5.4, significant tax revenues would be collected by McKinley County and possibly the Navajo Nation. Although not shown in Table 5.4, the State of New Mexico could also collect about $1.5 million annually from severance and natural resource taxes. The Navajo Business Activities Tax and Construction Tax apply to activities that occur on the Navajo Reservation and in areas outside the Navajo Reservation that meet the definition of "Indian country." The proposed project would not be located on the Navajo Reservation; however, the gross receipts of the project may be taxed by the Navajo Nation if it is determined that the project is located within "Indian country." The local communities, such as the town of Crownpoint or the Crownpoint Navajo Chapter, do not have any taxing authority.

There is no direct connection between the various taxes that may be collected and the local communities. The best chance for local communities to benefit from tax collection would be through the Navajo Nation, which funds local community capital improvement projects and public services.

**Table 5.4. Annual project benefits**

| Benefit | Navajo Nation | Local Navajo communities | McKinley County/ Non-Navajo |
|---|---|---|---|
| Employment | NA | Of 100 long-term jobs that would not require highly specialized skills, local communities could get up to 100, depending on how well HRI executes its intention to hire local Navajo | Total estimated long-term jobs less those going to Navajo (about 40 if Navajo get 100) |
| Earnings | NA | Average annual earnings for local employees of about $24,000 | Average annual earnings for management/ technical positions of about $36,000 |
| Royalties | None | $1,099,000 annually distributed among 9 lessors of Unit 1 properties[a] | None |
| Taxes | $942,000 annually for Business Activities Tax;[b] $15,000 for construction tax[c] | None; no taxing authority | $484,000 annually for real property tax;[d] $55,000 for personal property (based on value of assets at Unit 1 and Crownpoint) |
| Other benefits | NA | Several jobs related to income expenditure in local community or incidental services required by the project | Several jobs related to expenditures in the local community or incidental services required by the project |

*Source*: See Section 4.9 of this FEIS.
[a]Assumes 1 million lb of yellowcake produced annually from allotment leases at $15.70/lb.
[b]Assumes 2 million lb of yellowcake at $15.70/lb and contingent on legal authority to tax.
[c]Assumes $500.00 in drill rig contracts.
[d]Assumes 2 million lb of yellowcake at $15.70/lb.

However, there is no legal requirement for the Navajo Nation to fund projects in a specific area based on tax collections from that area. Crownpoint would indirectly benefit from Navajo Nation tax collections because these revenues enhance the Nation's ability to provide services and Crownpoint is the center for providing many of these services within the Eastern Navajo Agency (see Section 3.9).

## 5.2 COSTS OF THE PROPOSED PROJECT

Table 5.5 presents the potential costs of the proposed project to the local communities. Infrastructure costs related to population changes would be insignificant because population change would be small.

**Table 5.5. Project costs to the local community**

| Costs | Crownpoint | Church Rock | Navajo Nation | McKinley County |
|---|---|---|---|---|
| Infrastructure related to population increases induced by employment | No significant costs | No significant costs | No significant costs | No significant costs |
| Fire and emergency related to potential accidents on public roads | Additional training to deal with potential transport accidents; HRI would supply or pay for emergency response training and any costs for health care facility | Covered by Crownpoint emergency services | Covered by Crownpoint emergency services | Covered by Crownpoint emergency services |
| Risk of contaminating and/or degrading public water supply | Replacement wells and distribution system, to be paid for by HRI, along with the additional annual costs of system operation and maintenance | No risk to water supplies | No risk to water supplies | No risk to water supplies |

*Source*: NRC staff.

The local communities would require increased emergency response and medical treatment capabilities because of the small risk of a slurry truck transport accident on public highways. HRI is committed to provide training and/or cover the costs of training for the Crownpoint health clinic (Section 3.9). Similarly, HRI has made a written commitment to the Crownpoint Volunteer Fire Department to provide appropriate training and equipment to respond to a slurry truck accident (Section 3.9). Therefore, these requirements should not result in additional costs to the local community.

The most significant risk of the proposed project to the local community is the potential for contamination or degradation of the local water supply due to ISL mining operations. However, NRC staff would require that HRI replace the town of Crownpoint water supply wells before mining at the Crownpoint site (Section 4.3.1.1). Thus, the community would not have to bear the costs of replacing these wells.

After HRI replaces the existing water supply wells and water delivery system, there would be increased annual costs of operating and maintaining the wells. There would also be an additional annual cost due to lowered water tables if mining occurs at Unit 1 or Crownpoint. The NRC staff's groundwater mitigation actions (Section 4.3.3 and Appendix B) would require HRI to take appropriate mitigation measures.

# 6. CONSULTATION AND COORDINATION

As discussed in Section 1.6, the BLM and BIA are serving as cooperating agencies in the NEPA assessment and licensing/leasing process for the proposed project. These two agencies are involved because they have jurisdiction over the mineral operating rights and leases on Federal and Indian lands that HRI would need for the proposed project. The BLM and BIA's need for action is to fulfill their statutory responsibilities to regulate mining activities on Federal and Indian lands (see Section 1.3).

The Navajo Nation was invited to be a cooperating agency during preparation of the DEIS. The Nation declined this original invitation, but petitioned the NRC for cooperating agency status in October 1996. Because the petition was made when the NEPA assessment process was coming to a close, the petition was denied.

Despite not being a cooperating agency, the Navajo Nation has provided a considerable amount of information for the analyses contained in this FEIS. In addition, several of the staff-recommended measures identified in Section 4 involve consultation and coordination among HRI, the Navajo Nation, and the Federal and State regulatory agencies involved in the proposed project.

Native American groups that have ties to the project areas, in addition to the Navajo, are the Pueblos of Acoma, Laguna, and Zuni, and the Hopi Tribe. Each of these groups, along with the Navajo Nation, is being consulted by NRC under Section 106 of the National Historic Preservation Act (see Appendix C).

The U.S. EPA and the State of New Mexico Environmental Department have been consulted and have provided information related to the proposed project. The responsibilities of these two agencies are described in Section 1.7. NRC is also consulting with the U.S. Fish and Wildlife Service and the New Mexico Department of Fish and Game under Section 7 of the Endangered Species Act (see Appendix D).

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Harriet Smiley

James Smiley

Joe Lee Smiley

Lilly Smiley

Mattie Smiley

Robert Smiley

Sandra S. Smiley

Spencer Smiley

Tommy (Tommie) Smiley

Johnny Slim

Dorothea J. Smith

Landon Smith, New Mexico Archeological Council

Rob Smith, Sierra Club (Phoenix Area)

Tom Snyder

Henry Spencer, Tsayatoh Chapter

Sammy E. Spencer, Red Rock Chapter

Joe Sphar, New Mexico Arizona Land Company

L. Leigh Sprague, Geologic Resources, Inc.

State of New Mexico

Jameson Stevenson, Lake Valley Chapter

M. Stodalski, U.S. Bureau of Reclamation

Nellie B.Succo

Mike Taylor, Office of Environmental Health and Engineering, Indian Health Service

Nelson V. Thompson, Ramah Chapter

George H. Tolth, Casamero Lake Chapter

Fred Tragillo, Counselor Chapter

Daniel E. Tso, Torreon Chapter

Leonard Tsosie, State Senator

Lloyd Tsosie

U.S. Department of Commerce, Assistant Secretary for Legislative and Intergovernmental Affairs

U.S. Department of Defense, Environmental Planning

U.S. Department of Health and Human Services, Director of Environmental Affairs

U.S. Department of the Interior, Director, Office of Environmental Affairs

U.S. Department of Transportation, Assistant Secretary for Policy and Internal Affairs

U.S. Environmental Protection Agency, Office of Federal Activities

U.S. Environmental Protection Agency, Office of Radiation Programs, Las Vegas Facility

U.S. Environmental Protection Agency, Regional Administrator, Region VI

U.S. Environmental Protection Agency, Regional Administrator, Region IX

U.S. Fish & Wildlife Service, Regional Director

U.S. Office of Management and Budget, Budget Examiner

Johanna Wald, Natural Resources Defense Council

William Waldman, The Nature Conservancy

Jim Walker, U.S. Environmental Protection Agency, Region IX

Dana Ward

Clarence L. Warner

David C. Warner

Leo C. Watchman, State Representative

Lisa Welch, Pic Technologies, Inc.

White Rock Chapter

Barbara B. Whitehair

Neil H. Whitehead, New Mexico Bureau of Mines

Nancy Whittaker, Animal Protection Institute of America

Frank Chee Willeto, Pueblo Pintado Chapter

Gene Wilson, & Associates

Richard Wilson, United Nuclear

Walter Wolf, Jr.

Lawrence R. Wolfe, U.S. Department of Agriculture

Thomas D. Wolsko, Argonne National Laboratory, Environmental Association and Sciences Information

Bonnie B. Yazzie

Cecelia S. Yazzie

Gladys Julian Yazzie

Paul David Yazzie

Peterson Zah, Navajo Nation

# APPENDIX A

## NRC STAFF'S RESPONSES TO WRITTEN COMMENTS ON THE DEIS

# A.1 INTRODUCTION

This appendix contains the NRC staff's responses to written comments on the *Draft Environmental Impact Statement to Construct and Operate the Crownpoint Uranium Solution Mining Project, Crownpoint, New Mexico* (NUREG-1508). The comments, which were submitted by agencies, organizations, and individuals during the public comment period in 1994, have been grouped by topic and summarized in the following sections. For each group of comments, this appendix provides the names of the commenters, a summary of the issues raised in the comments, and the NRC staff discussion of and response to the comments. The complete text of the written comments is available in the project docket file.

# A.2. PREVIOUS MINING AND MILLING ACTIVITIES

## A.2.1 Cleanup and Impacts

### A.2.1.1 Church Rock Uranium Mill Tailings

*Commenters*
Mervyn Tilden

***Summary of Issues.*** One commenter referenced the 1979 embankment failure at the United Nuclear Mill Tailings Impoundment, which released tailings into the Puerco River. The commenter also stated that the tailings are still on the surface generating radon gas and exposed to wind and rain.

***Discussion and Response to Comments.*** Comment noted. The commenter's reference to the 1979 United Nuclear Corporation (UNC) Church Rock embankment failure is correct but has little relationship to the proposed action. The UNC Church Rock facility operated as a conventional uranium mill in which large volumes of tailings were produced and remained on-site. The proposed action is an in-situ extraction method and does not involve the construction of a large tailings impoundment or encompass the same safety and environmental impacts as conventional milling.

Evaporation impoundments and other facilities constructed for the proposed project would be decommissioned and removed at the conclusion of operations. A financial surety to cover decommissioning and closure costs would be provided by HRI before operations commence to ensure that site closure can proceed if HRI becomes financially insolvent in the future.

The UNC Church Rock facility is under license by the NRC and is pursuing reclamation and closure in accordance with license requirements. Detailed descriptions of the UNC Church Rock reclamation are beyond the scope this action. The 1979 embankment failure at the UNC Church Rock facility was considered in the cumulative impacts section and referenced in the environmental justice evaluation of the FEIS.

#### A.2.1.2 Abandoned Mines Cleanup

*Commenters*

Bernadine Martin
M. K. Clark

***Summary of Issues.*** One commenter described the Navajo Nation's Abandoned Mine Lands Reclamation Program, the Uranium Mill Tailings Remedial Action Program, the reparations program for former Navajo uranium miners, prior uranium mining, UMTRA mill tailings, natural flushing for cleanup, and care of Navajo uranium miners. Another commenter said that past activities have caused health effects in former mine workers and their families and that they deserve compensation from the Federal government.

***Discussion and Response to Comments.*** Comments noted. Section 3.10 of the FEIS describes the previous impacts from uranium mining and milling and the potential perceptions and sensitivities of the Navajo people. Potential cumulative impacts from HRI's proposed action have been evaluated as a part of the FEIS. The FEIS concludes that there is no potential for additional significant impacts on the Navajo people above the cumulative impacts imparted from past uranium mining and milling activities.

Although a requirement to provide compensation to past uranium miners and mill workers is not a license condition that could be imposed on HRI for the proposed project, the health and environmental impacts from past uranium mining activities are considered in the discussions of cumulative impacts in Sections 4.1 through 4.12 of the FEIS.

## A.3. OTHER APPLICABLE REQUIREMENTS AND JURISDICTIONS

### A.3.1 Safe Drinking Water Act

*Commenters*

Mary Lou Jones, Zuni Mountain Coalition

***Summary of Issues.*** One commenter stated that the proposed project is contrary to the Safe Drinking Water Act because it endangers drinking water sources and would cause closure of well NTUA-1.

***Discussion and Response to Comments.*** Determining the conformance of the proposed project with the Safe Drinking Water Act is beyond the NRC's statutory authority. Other Federal and State agencies are authorized to issue permits and enforce the provisions of the Safe Drinking Water Act as they apply to the proposed action. These reviews and issuances of appropriate permits must be completed before HRI can operate the proposed facilities.

## A.3.2 Operational Permits

*Commenters*

W. Peter Balleau

***Summary of Issues.*** One commenter stated that jurisdiction over the land application permitting process was uncertain.

***Discussion and Response to Comments.*** Comment noted. The NRC does not have the statutory authority for permitting injection wells, granting aquifer exemptions, permitting surface water discharges, permitting the land application of treated wastewater, or other land use permits. These authorities reside with other Federal, State, and Navajo agencies which claim authority and jurisdiction over these matters.

The jurisdictional authority of an agency has a strong bearing on the issuance of necessary permits and the operation of HRI's proposed project, but the jurisdictional question has little bearing on the identification and evaluation of environmental impacts and mitigative measures in the FEIS.

NRC licensing is the lead Federal action for the HRI's proposal, but not the only action. NRC's licensing authority does not preempt the authority of other agencies in this action. Before operations commence, HRI must comply with all applicable requirements from other agencies once the jurisdiction question has been resolved.

# A.4. HEALTH AND SAFETY IMPACTS

## A.4.1 Safety Impacts and Relationship of Safety Evaluation Report (SER) to EIS

*Commenters*

Mary Lou Jones, Zuni Mountain Coalition
Anne Reitz, M.D., IHS-Crownpoint Health Care Facility
Don Schrader
Valarie V. Murphy
Chris Shuey, Southwest Research and Information Center
Lalare Charles
Herbert Enrico
Frank Chee Willeto
Anna Frazier, Dineh Citizens Against Ruining our Environment (Dineh CARE)
Johnny Henry

***Summary of Issues.*** Several commenters questioned why safety issues were not addressed in the DEIS and stated that safety should be evaluated. Some of these issues included an epidemiological study of the region related to uranium mining and milling, remediation activities and exposures related to the 1979 Church Rock dam break, emergency readiness plans, worker protection programs, and other operational protocols. One commenter indicated the understanding that the NRC would develop a Safety Evaluation Report (SER) to address safety issues, but asked why the SER was lagging behind the NEPA [EIS] process. One commenter asked how the EIS can be used as a decision-making document without a safety evaluation. One commenter asked for the highest safety standards to be applied if the project is approved.

*Discussion and Response to Comments.* Some of the issues identified by the commenters are beyond the scope of the EIS, but are reviewed as part of the findings for the SER. The SER documents the NRC staff's safety review process, which is conducted in parallel with the NEPA process. The issues identified by the commenters that will be evaluated in the SER include emergency response plans, worker protection programs, and other operational protocols. Some details on emergency response plans are included in the EIS, as necessary, in evaluation of the response to accidents and possible mitigation.

The remediation of the Church Rock dam break and epidemiological studies are beyond the scope of this EIS and the SER. Many studies have been completed on uranium mining, especially related to radon and exposure to radiation. Some of these studies have focused on Navajo workers and individuals living near uranium mines and mills. Information on the remediation of the Church Rock dam break has been previously published by the NRC (NRC 1981a). As part of this EIS, a short discussion has been included on previous impacts on the environment as part of the section on cumulative effects in Section 4.6.

Both the EIS and the SER document the environmental and safety reviews of HRI's proposals and are components of the NRC's licensing action. The environmental review, as documented in the FEIS, is an analysis of the environmental impacts of the proposed action. The safety review, as documented in the SER, is an analysis of whether the proposed action complies with applicable NRC regulations. The SER documents the staff's basis for its determination on the licensing action. Appeal of the licensing action can be requested through an adjudicatory hearing, as provided in 10 CFR Part 2, Subpart L. The NRC's licensing action is a decision to either license the proposed action or deny the application. The DEIS provided a preliminary assessment which supported licensing the proposed action. The final licensing decision will be made after the staff has completed the SER and after any decisions from potential adjudicatory hearings requested by several petitioners.

## A.4.2 DEIS Inadequately Addresses Health and Safety

### A.4.2.1 Radiation Risks and Dose Limits

*Commenters*

Gedi Cebas, New Mexico Environmental Department
Mary Lou Jones, Zuni Mountain Coalition
Stephanie Weigel
Jeannette Vice, Eastern Navajo Health Board
Ann Reitz, M.D., IHS-Crownpoint Health Care Facility
Joan Klonowski, M.D.

Glojean B. Todacheene
E. Ann Hosmer, M.D.
LaJuanna Daye
Jana Gunnell, M.D., New Mexico Department of Health
Emma J. Begay
George Brodie
Lalare Charles
Johnny Henry
M. K. Clark
Mitchell Capitan
Bernadine Martin
Harrison Martin

***Summary of Issues.*** Several commenters expressed varied concerns on the effects of operational releases from the facilities. These included general effects on public health, possible toxic effects of uranium, basis for regulations, carcinogenic effects, and possible intergenerational effects. Concerns about thorium-230 and radium-226; alpha, beta, and gamma radiation; and uranium radiation also were expressed. One commenter requested that epidemiological surveys of the health effects due to uranium mining be performed and published in the EIS. Another indicated that the local population was already exposed to significant radiation levels and that the DEIS did not mention any studies related to long-term exposure of additional radiation or describe a system to monitor the health of the population under these conditions. Additionally, commenters were concerned with the proximity of individuals to the site. One commenter felt that there was an attempt to "exterminate" him.

***Discussion and Response to Comments.*** The annual public radiation dose limit is 1 mSv (100 mrem) to the highest exposed individual. This limit is supported by national and international recommendations on radiation dose limits. Another important part of the regulations is that licensees must reduce exposures to both workers and public individuals to as low as reasonably achievable (ALARA).

NRC regulations and limits are based on the linear dose hypothesis, in which every unit of dose received increases the chance of stochastic effects. Limiting the potential for stochastic effects, such as cancer and intergenerational effects, due to radioactive materials has been taken into consideration in developing the public and worker dose limits. Although no published human studies of radiation exposure have shown strong evidence for intergenerational effects, emphasis is placed on protecting the public from potential genetic effects in future generations, as can be seen in the weighting factors for organ doses. Doses to the sex organs are weighted the most (0.25 vs 0.12 for the lung, the next highest weighted organ system) when calculating dose equivalent to the whole body. The purpose of the weighting factors is to account for the radiosensitivity, either known or suspected, of each organ system.

At the relatively low concentration levels allowed by the public dose limit, uranium's hazard is the possibility of stochastic effects occurring, because possible daily intakes are small. At much higher concentrations, far above the allowable limits, ingestion of large amounts soluble uranium are possible and will result in toxic effects such as kidney failure from heavy metal poisoning. Public dose limits and allowable concentrations of uranium in both water and air are designed to limit dose and its effects and completely prevent toxic effects.

In addition, HRI's proposed project includes minimization of possible releases to the environment with equipment and processes such as the vacuum dryer and the pressurized system to remove radon from wastewater. As a result of these actions and the ISL mining process, expected doses to the maximally exposed individual are a small fraction of the public dose limit. To calculate the maximally exposed individual, the proximity of housing is taken into consideration in this licensing action. The modeling of potential air releases accounts for the location on the nearest individuals to the facilities. Additionally, to protect the public from accidental exposures, well fields would be required to be fenced during mining and restoration, and spills in the well fields would be required to be cleaned up to the appropriate standard.

In the event of an accidental airborne release of material, the release would be short-lived and would not result in an exceedance of the annual dose limit because of the license conditions and the amount of radioactivity involved. In the assessment of operational radiological releases, 95 percent of the radon in a source is assumed to be released into the air if it does not have a emission control device or process. Therefore, for the sources which do not have emission control devices, nearly all of the radioactivity that could become airborne is considered to be released routinely. In the case of sources that are to be mitigated by the emission controls or the dryer, license conditions would require the controls to be active during operations and for operations to cease if the emission controls are not available. In addition, Section 4.6 of the FEIS contains a table depicting potential impacts if the radon emission controls are not operating for the Church Rock satellite facility.

Under the Atomic Energy Act of 1954, as amended, the NRC has statutory responsibility for the protection of public health and safety and the environment related to source and by-product nuclear material. Thus, NRC's role as a regulatory agency is to protect, not endanger, public health and safety.

### A.4.2.2 Long-Term Effects of Trace Metals

*Commenters*

Mary Lou Jones, Zuni Mountain Coalition
Mervyn Tilden
David J. Farrel, USEPA Region 9

*Summary of Issues.* Three commenters stated that the DEIS was not clear or did not address the effects and fate of trace (heavy) metals that would be mobilized by the solution mining.

*Discussion and Response to Comments.* Effects and fate of nonradiological trace metals were not individually evaluated as a part of the EIS. The primary pathway of exposure for these constituents is by direct ingestion of drinking water. The proposed project would be required to monitor concentrations of heavy metals beyond the mining zone and maintain levels within the premining baseline concentrations. Potential excursions from these levels outside the mining zone are not expected, but if they occur they would be limited in extent and short term. Restoration of the mining zone after mining would be performed to reduce the heavy metal concentrations to the premining baseline or within the premining water use concentrations limits established be the appropriate State or Federal agency. Long-term impacts from trace metals are not expected after successful well field restoration.

### A.4.2.3 Health Effects from Plutonium, Polonium, Neptunium, and Fluorine Gas

*Commenters*

Mervyn Tilden

*Summary of Issues.* One commenter stated that the DEIS does not mention plutonium-230, polonium, neptunium-237, or fluorine gas as mining by-products.

*Discussion and Response to Comments.* The proposed project would not generate, use, or otherwise handle plutonium-230, neptunium-237, or fluorine gas. Plutonium and neptunium are not naturally occurring radionuclides and are not associated with any uranium milling or in situ extraction operation. Fluorine gas is not used in any uranium milling or in situ extraction process. Polonium is a daughter product of the decay of radon gas. The expected air concentrations and doses associated with polonium are included in Section 4.6 of the FEIS.

## A.4.3 Air Quality and Noise

### A.4.3.1 Air Releases

*Commenters*

Gedi Cebas, New Mexico Environmental Department
Glojean B. Todacheene
David J. Farrel, USEPA Region 9
Herbert Enrico
Mitchell Capitan

*Summary of Issues.* Several commenters requested that additional information be provided on air releases and effects on existing air quality. Commenters requested additional information on constituents in the National Emissions Standards for Hazardous Air Pollutants. Total annual tonnage estimates were requested by one commenter.

*Discussion and Response to Comments.* The FEIS discusses potential air emissions (radioactive, chemical, and dust) in Sections 4.1 and 4.5. Adherence to existing NRC and EPA regulations would ensure that existing air quality is maintained. Information on the National Emissions Standards for Hazardous Air Pollutants has been added to Sections 3.1 and 4.1 to detail both the current compliance levels and the potential impacts related to the proposed project. The EPA has rescinded Subpart I of 40 CFR Part 61 as it applies to NRC licensees (*Federal Register*, December 30, 1996). The EPA has made a finding that the NRC program provides an ample margin of safety contingent upon the NRC adding a 0.1-mSv (10-mrem) total effective dose equivalent (TEDE) (except radon) constraint limit to its regulations. The NRC is undertaking rulemaking at the present time to satisfy the condition. A short discussion of 40 CFR Part 61, Subpart I, has been added in Section 4.6, but it only focuses on compliance with the 0.1-mSv (10-mrem) standard. Additional information regarding nonradioactive air emissions for other subparts of 40 CFR Part 61 has been added to Sections 3.1 and 4.1. Also, text about estimated source terms for gaseous and particulate releases for materials other than radioactive materials has been revised to estimate total annual project emissions and average annual concentrations.

### A.4.3.2 Measurement Locations

*Commenter:*
Richard Brostrom, M.D.

***Summary of Issues.*** One commenter requested that a radon/particulate monitoring station be located at the local hospital.

***Discussion and Response to Comments.*** HRI's proposed monitoring plan does not include a monitoring location at the hospital. NRC staff reviewed HRI's monitoring plan and concluded that it is satisfactory for compliance with the regulations based on the level of radiological hazards. Additional locations, such as the hospital, may be monitored at HRI's discretion.

### A.4.3.3 Receptors Modeled

*Commenters*
Jon Martin, Bureau of Indian Affairs

***Summary of Issues.*** One commenter asked if the boundary receptors discussed in the DEIS would be permitted under a irrevocable use permit.

***Discussion and Response to Comments.*** The receptors identified in the DEIS represent existing or hypothetical locations near each of the proposed facilities where an exposure potential exists for the purpose of dose modeling with the MILDOS computer code. The boundary receptors are hypothetical facility and well field boundary locations used to simulate the nearest point a potential receptor could receive a potential dose from the proposed operations.

### A.4.3.4 Noise

*Commenters*
Ray Morton

***Summary of Issues.*** One commenter was concerned that project activities, such as increases in truck traffic, would increase noise levels significantly.

***Discussion and Response to Comments.*** Additional noise from increased traffic would be comparable to noise from typical construction activities at worst and, under normal conditions, to typical commercial activities. Noise associated with ISL drilling activities would be comparable to that of drilling for water wells (i.e., the sound of standard diesel engines encountered in traditional construction activities).

### A.4.4 Errors in DEIS

***Commenters***

Richard Brostrom, M.D.
Patrick Antonio, Navajo Nation EPA
Julie Curtiss, Navajo Nation EPA

***Summary of Issues.*** Commenters identified errors in the DEIS text and graphics. These included Figure 4.4 and Table 4.9 of the DEIS.

***Discussion and Response to Comments.*** HRI used wind data from Gallup, New Mexico, for its modeling of potential air releases from the proposed project. These data have a predominate prevailing wind direction from the southwest. The assumed prevailing wind direction based on the Gallup wind data will be added to the figure in the FEIS.

Table 4.9 in the DEIS has been revised into two tables in the FEIS: one for Crownpoint and Unit 1 and the other for Church Rock. Additionally, data on the expected concentrations, if HRI did not use the radon removal equipment, are only compared for the Church Rock site to reduce the potential for confusion. The DEIS table was confusing because receptors for all three sites were mixed.

## A.5. WASTE GENERATION AND HANDLING

### A.5.1 Amount, Composition, Storage, and Disposal

#### A.5.1.1 Volume, Type, and Composition of Wastes

***Commenters***

Anne Reitz, M.D., IHS-Crownpoint Health Care Facility
Mervyn Tilden

***Summary of Issues.*** Commenters asked what the predicted composition and volume of waste (total and annually) would be from the proposed project.

***Discussion and Response to Comments.*** The volume of liquid waste that might be consumed over the life of the project is contained in the response to comment A.5.3. The chemical composition of wastewater could vary from the concentrated waste streams produced by the reverse osmosis and brine concentration groundwater restoration options to better than original aquifer water quality.

#### A.5.1.2 Waste Storage

*Commenters*

Anne Reitz, M.D., IHS-Crownpoint Health Care Facility
Multiple signatures on written comments
Jon Martin, Bureau of Indian Affairs
LaJuanna Daye
Mervyn Tilden

*Summary of Issues.* Several commenters inquired about how mill tailings from this project would be handled, where wastes would be stored, what storage time limits would be, and where the interim storage of yellowcake and wastes would occur.

*Discussion and Response to Comments.* Storage of dried yellowcake contained in metal drums would occur on platforms and in buildings at the Crownpoint processing facility. ISL mining does not generate mill tailings. Small amounts of solid radioactive waste, such as small volumes of soils, contaminated used equipment, and laboratory samples, would be produced each year, and radioactive materials would be accumulated as solid material in ponds at the processing sites. As part of operations and decommissioning activities, radioactive waste would be shipped by truck to an NRC-licensed waste disposal site for burial.

There are no prescriptive restrictions on the volume or time limit HRI could store 11e(2)by-product material on-site before shipment to an off-site disposal facility. ISL facilities typically generate small volumes of 11e(2) by-product material. HRI would be required by the NRC license condition to maintain an arrangement at a licensed facility for the disposal of 11e(2) by-product material or cease lixiviant injection. The timing of waste shipments would be determined by HRI and is generally dictated by the economies of transportation and the need to keep worker exposure as low as reasonably achievable.

#### A.5.1.3 Waste Disposal

*Commenters*

Gedi Cebas, New Mexico Environmental Department
Mary Lou Jones, Zuni Mountain Coalition
Ann Reitz, M.D., IHS-Crownpoint Health Care Facility
Jon Martin, Bureau of Indian Affairs
LaJuanna Daye
David J. Farrel, USEPA Region 9
Mike Johnson, Department of Water Resource Management, Navajo Nation
Chris Shuey, Southwest Research and Information Center
Paul Robinson, Southwest Research and Information Center
Mervyn Tilden

Lester Sharpton, M.D., Crownpoint Hospital
Anna Frazier, Dineh Citizens Against Ruining our Environment (Dineh CARE)
Mr. Largo

*Summary of Issues.* Commenters expressed a general concern with waste disposal and the lack of discussion in the DEIS pertaining to the final waste disposal location. Several commenters are concerned that wastes would be disposed of on-site because the DEIS did not identify the final disposal site for wastes. One commenter questioned whether an off-site disposal facility would be available over the next 20 years (the projected life of the proposed action). Two commenters requested that the FEIS discuss the current and anticipated capacities of licensed disposal sites. Two commenters asked about the disposition of evaporation pond sludges. One commenter inquired about the transportation methods and routes for transporting sludges.

*Discussion and Response to Comments.* On-site disposal of 11e(2) by-product material from ISL extraction operations is largely prohibited to avoid the proliferation of small waste disposal sites and to reduce the perpetual surveillance obligations. NRC regulations (10 CFR 40, Appendix A, Criterion 2) specify that 11e(2)by-product material from ISL extraction operations must be disposed of at an existing large mill tailings disposal site, except if such disposal is impracticable or the advantage of on-site burial clearly outweighs the benefits of reducing the perpetual surveillance obligations.

Any future request by HRI to dispose of 11e(2) byproduct material on site would require a separate Environmental Assessment to comply with NRC's NEPA requirements in 10 CFR Part 51.

HRI has not requested approval to dispose of 11e(2) by-product material or other wastes at any of the proposed project sites. On-site disposal of 11e(2) by-product material would not be authorized under this licensing action. Any future request by HRI to dispose of 11e(2) byproduct material on site would require a separate Environmental Assessment to comply with NRC's NEPA requirements in 10 CFR Part 51.

Other NRC-licensed ISL extraction facilities are required to have an agreement for the disposal of 11e(2) by-product material with a facility licensed to accept such material. Currently, 11e(2) by-product material disposal capacity includes four NRC-licensed uranium mill tailings sites, two mill tailings sites licensed by NRC Agreement States, and one NRC-licensed commercial disposal facility. In the event its disposal agreement expires or is terminated, HRI would have to attain a new agreement within a specified time period or stop lixiviant injection. This is a standard requirement for all NRC-licensed ISL extraction facilities.

## A.5.2 Evaporation Ponds

### A.5.2.1 Health Impacts from Evaporation Ponds

*Commenters*
Emma J. Begay

***Summary of Issues.*** One commenter stated that the health effects of the evaporation ponds and their contents need to be examined.

***Discussion and Response to Comments.*** The primary health effect associated with the evaporation ponds during operations would be radon emission to the atmosphere. The impacts associated with these emissions are described in Section 4.6. HRI proposes to reduce radon emissions from other portions of its operations by using the pressurized system described in Section 2. The contents, components, and any contaminated soil associated with the evaporation ponds would be removed at the end of operations and transported to a licensed waste disposal facility.

### A.5.2.2 Operation, Design, and Monitoring of Evaporation Ponds

***Commenters***

Patrick Antonio, Navajo Nation EPA
Frank Chee Willeto

***Summary of Issues.*** Commenters expressed concern about the design, operation, and monitoring of the proposed evaporation ponds (impoundments) at each proposed project site. One commenter stated that the impoundments needed PVC liners, two berms to protect against spills, and monitoring equipment to detect leaks. The commenter also stated that the evaporation ponds should be designed above grade, in accordance with NRC guidelines. The second commenter expressed concern with the compatibility of the liner material with the proposed wastes from the drying circuit and the process bleed. A second concern was expressed regarding whether the ponds would be built with piping below the liner for leak detection and to drain potential seepage before migrating into the underlying soils. The commenter recommended that uranium, radium, and pH be used as indicators of pond leakage.

***Discussion and Response to Comments.*** Impoundments constructed to contain wastewater from the proposed project would be constructed with synthetic liners, which would be inert to the wastewater, and leak detection systems beneath the liners. Section 4.3 describes the leak detection system that would be employed at all retention ponds. The leak detection system typically includes drainage pipes and sumps within an engineered sand bedding layer beneath the liner. The piping is designed to intercept any water that may inadvertently pass through the liner, and route that water to the sumps. Water quality samples would be collected from a sump if measured water levels exceed 6 inches in the sump. This limit is necessary because small amounts of water can condense from the air in the pipes, which in turn would signal a false alarm that the system is leaking. Chemical assays for specific conductance and chloride would be used to determine if water in the sumps are from the ponds. These constituents provide a relatively rapid confirmation of leakage, and would not require off-site laboratory analysis as would other constituents. Elevated levels of these constituents would confirm a liner leak, and would be reported to the NRC within 48 hours. Corrective actions would commence upon leak confirmation and would consist of transferring the solution to another pond so liner repairs could be made. HRI would perform and document pond freeboard and checks of the leak detection system daily, including weekends and holidays.

HRI proposes to construct impoundments below grade and maintain operational fluid levels (freeboard) below the ground surface. This design greatly reduces the risk of releasing wastewater from the impoundment due to embankment failure. HRI would be required to apply the criteria of NRC Regulatory Guide 3.11, *Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills*. In addition, staff would require that HRI show through detailed engineering analyses that the impoundments and diversion channels around the impoundments would be stable under a probable maximum flood condition, in accordance with NRC Staff Technical Position #WM-8201, *Hydrologic Design Criteria for Tailings Retention Systems.*

### A.5.2.3 Evaporation Pond Failure and Impacts

*Commenters*

Gedi Cebas, New Mexico Environmental Department
Jon Martin, Bureau of Indian Affairs
Frank Chee Willeto
Richard Brostrom, M.D.
David J. Farrel, USEPA Region 9

***Summary of Issues.*** Commenters expressed concerns about the potential impacts of impoundment failure. One commenter discussed a potential contamination of the Puerco River from impoundment spills and excessive irrigation of wastewater. One commenter was concerned about failure of an earthen impoundment embankment. One commenter stated that the DEIS did not consider the potential flooding of evaporation ponds. One commenter recommended that the FEIS clarify how the evaporation ponds would be restricted to protect humans and wildlife. One commenter recommend that the BIA specify the fencing to be placed around the impoundments.

***Discussion and Response to Comments.*** Section 4.4 estimates the potential for pond failure. The NRC staff would require HRI to apply the criteria of U.S. Regulatory Guide 3.11, *Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills*. In addition, staff would require that HRI show through detailed engineering analyses that the impoundments and diversion channels around the impoundments would be stable under a probable maximum flood condition, in accordance with NRC Staff Technical Position #WM-8201, *Hydrologic Design Criteria for Tailings Retention Systems*. Accordingly, HRI would be required to provide detailed analyses to document the adequacy of the system during an occurrence of the probable maximum flood. Analyses and hydraulic design computations would be reviewed by NRC staff for peak flows, peak velocities, and water surface profiles. In general, HRI has committed to follow the guidance suggested in NRC Staff Technical Position *Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites*.

HRI proposes to construct fences around the impoundments to restrict wildlife and livestock access to the area. Specific configurations and fencing designs may be specified in the BIA permits that would be issued for this action.

## A.5.3 Wastewater Storage and Disposal

*Commenters*

David J. Farrel, USEPA Region 9
Frank Chee Willeto
Emma J. Begay

***Summary of Issues.*** Commenters expressed concerns about wastewater disposal and storage. One commenter asked where wastewater would be disposed of. One commenter stated an understanding that each project site would produce 21 million gallons of wastewater annually that would be stored in evaporation ponds covering 300 acres. One commenter recommended that the FEIS specify the composition, amounts, and disposition of the liquid wastes from the proposed project.

***Discussion and Response to Comments.*** Water would be disposed of by evaporation, land application, deep well injection, or, at the Church Rock site, surface water discharge. It is estimated that practical production scale groundwater restoration activities will at most require a nine pore volume restoration effort. For a four and nine pore volume restoration effort, the water consumed over the life of the project at all three sites is estimated to be:

| | Water consumed | | | |
|---|---|---|---|---|
| | 4 pore volumes | | 9 pore volumes | |
| Restoration alternatives | (million $m^3$) | (acre-feet) | (million $m^3$) | (acre-feet) |
| Groundwater sweep | 12.9 | 10,525 | 29.0 | 23,681 |
| Reverse osmosis | 3.3 | 2,671 | 7.4 | 5,922 |
| Brine concentration | 0.03 | 24 | 0.07 | 54 |

The chemical composition of wastewater could vary from the concentrated waste streams produced by the reverse osmosis and brine concentration options to better than original aquifer water quality.

## A.5.4 Land Application of Wastewater

### A.5.4.1 Sampling, Quality, and Transportation of Wastewater for Land Application

*Commenters*

David J. Farrel, USEPA Region 9
Stephen Hoffman, USEPA HQ

***Summary of Issues.*** Commenters indicated that the DEIS did not describe the quality of wastewater that would be used for land application or the sampling requirements prior to disposal. One commenter indicated that the DEIS did not describe the method of wastewater transport from the processing facilities to the land application sites.

*Discussion and Response to Comments.* Water would be transported to the land application areas by pipeline. Before water would be disposed of at a land application site, radionuclide concentrations would be reduced to acceptable levels. From the Crownpoint site application, it is estimated that the average radium-226 concentration would be approximately 1 pCi/L and about 0.3 mg/L for uranium. It is estimated that the water disposed of at the land application sites would contain an average concentration of 21.7 mg/L calcium, 244 mg/L sodium, 1.2 mg/L magnesium, 30 mg/L carbonate, and 740 mg/L bicarbonate.

### A.5.4.2 Soil Impacts from Land Application

*Commenters*

Ann Reitz, M.D., IHS-Crownpoint Health Care Facility
Glenn B. Sekavec, US DOI
David J. Farrel, USEPA Region 9
W. Peter Balleau
Stephen Hoffman, USEPA HQ

*Summary of Issues.* Commenters expressed concern about potential soil impacts resulting from land application of treated wastewater. One commenter expressed a general concern about land and air contamination. One commenter questioned how soils with low Sodium Adsorption Ratios (SAR) would not promote salt accumulation. One commenter indicated that soil salinity should be monitored and corrected during land application. One commenter stated that the FEIS should provide the New Mexico standards for land application. Two commenters asked what effect land application of wastewater would have on the Westwater Canyon aquifer.

*Discussion and Response to Comments.* Before water is disposed of at a land application site, radionuclide concentrations would be reduced to acceptable levels. Metal accumulation in the soils, including selenium, molybdenum, uranium, or radium-226, is not expected to be a problem at the land application sites. The salinity of the proposed irrigation water would be tolerable for the irrigation of pasture grasses. However, the salinity of the proposed irrigation water would cause permeability problems with clay soils in the irrigation plots. It is expected that problems would not be sufficient to preclude irrigation, but monitoring of soil electrical conductivity would be required on a regular basis. Land application is not expected to have any impact on groundwater in the Westwater Canyon formation because of the relatively small application rate of the treated wastewater and the depth to the Westwater Canyon formation.

HRI must secure a permit for land application of treated wastewater from the appropriate permitting authority before commencing land application activities. Specific operational parameters such as application rate, slopes, and confirmation soil sampling would be evaluated as a part of the permit review. An amendment to the NRC license would also be required before commencement of land application activities. Impacts on soils in proposed land application areas are described in Section 4.2 of the FEIS.

### A.5.5 Disposal of Wastewater

*Commenters*

Bernadine Martin

***Summary of Issues.*** One commenter stated that the term "treated" water for the purpose of reinjection was not clear in the DEIS. The commenter further asked how the term "treated" is defined.

***Discussion and Response to Comments.*** Treated wastewater refers to water used in the ISL extraction process that has been chemically or physically treated to remove contaminants that have been introduced as a result of the process. Water treatment processes such as barium chloride treatment, reverse osmosis, or brine concentration would be used to treat raw process wastewaters. Section 2.1.2.3 of the FEIS discusses wastewater treatment processes.

## A.6. WATER RESOURCE IMPACTS

### A.6.1 Consumptive Use and Water Quality Degradation

#### A.6.1.1 Water Resource Consumption and Impacts

*Commenters*

Sally Buell
Mary Lou Jones, Zuni Mountain Coalition
Multiple signatures on written comments
Frances H. Harwood, Rio Grande Bioregional Project
Frank Chee Willeto
Ann Reitz, M.D. IHS-Crownpoint Health Care Facility
LaJuanna Daye
David J. Farrel, USEPA Region 9
W. Peter Balleau
Mike Johnson, Department of Water Resource Management, Navajo Nation
Emma J. Begay
Jim Lewis, Jr.
Bob Becenti
Billy Martin
Frank Chee Willeto
Peter Jordan
Vera Murphy

Lester Sharpton, M.D., Crownpoint Hospital
Harrison Martin
Ray Morton

***Summary of Issues.*** Several commenters expressed general concerns about the potential consumption and depletion of groundwater over the life span of the proposed project. Several commenters indicated that the DEIS did not adequately address the consumptive impacts on neighboring industries, stock watering, domestic supplies, surface water, and public supplies. The particular concern expressed by many commenters centered on excessive drawdown from the proposed project causing wells to go dry, including shallower wells in the Morrison Formation. Two commenters inquired about what would happen to the water once it was pumped from the aquifer, and one commenter asked what percentage of pumped water would be returned to the aquifer. One commenter stated that the DEIS did not clearly present the cumulative effects of mining and restoration in conjunction with the drawdown from the Crownpoint water supply wells. Three commenters indicted that the consumptive use analysis presented in the DEIS was inadequate and unclear. One commenter recommended mapping (inventory) the domestic, stock, and public water supply wells within a 2-mile radius of the proposed project sites.

***Discussion and Response to Comments.*** HRI must secure adequate water rights for consumptive and nonconsumptive groundwater use to support its proposed mining and restoration operations. HRI has indicated in responses to NRC questions that it possesses adequate water rights for the production phase at all three sites. HRI has indicated that additional consumptive water rights must be secured for the use of wastewater land application at the Church Rock site. HRI has indicated that it possesses sufficient water rights for any proposed wastewater alternative at the Unit 1 and Crownpoint properties.

After successful groundwater restoration, some of the water quality parameters in the groundwater in mining areas will have been returned to background and some to higher than background but lower than Federal primary and secondary drinking water standards. The volume of this water is estimated to be 3.3 million $m^3$ (2,671 acre-ft). It is estimated that practical production-scale groundwater restoration activities will at most require a nine pore volume restoration effort. For a four and nine pore volume restoration effort, the water consumed over the life of the project at all three sites is estimated to be:

| | Water consumed | | | |
|---|---|---|---|---|
| | 4 pore volumes | | 9 pore volumes | |
| Restoration alternatives | (million $m^3$) | (acre-feet) | (million $m^3$) | (acre-feet) |
| Groundwater sweep | 12.9 | 10,525 | 29.0 | 23,681 |
| Reverse osmosis | 3.3 | 2,671 | 7.4 | 5,922 |
| Brine concentration | 0.03 | 24 | 0.07 | 54 |

These estimates are based on four and nine pore volume efforts to restore groundwater quality. If more pore volumes are needed, restoration water consumption would increase accordingly.

The cumulative drawdown at the end of 21 years of mining at both Unit 1 and Crownpoint sites is projected to 15 to 17 m (49 to 55 ft) for the area of the town of Crownpoint water supply wells. The maximum projected drawdown from the two sites is anticipated to range from 21 to 24 m (70 to 80 ft) for the area of the town wells. Therefore, when groundwater restoration activities begin at a production-scale well field at either the Unit 1 or Crownpoint site, HRI would be required to reimburse the town of Crownpoint for increased pumping and well work over costs. This requirement does not include smaller restoration demonstration well fields.

### A.6.1.2 Water Quality Impacts

*Commenters*

Jeanette Vice, Eastern Navajo Health Board
Ann Reitz, M.D. IHS-Crownpoint Health Care Facility
Joan Klonowski, M.D.
Glojean B. Todacheene
E. Ann Hosmer, M.D.
David J. Farrel, USEPA Region 9
Mark Pelizza, HRI, Inc.
W. Peter Balleau
Paul Robinson, Southwest Research and Information Center
Mervyn Tilden
Lalare Charles
Bob Becenti
Herbert Enrico
Tony Johnson
Billy Martin
Frank Chee Willeto
Celia Nez
Alice Holgan
Lillian Becenti
Lester Sharpton, M.D., Crownpoint Hospital

***Summary of Issues.*** Several commenters expressed general concerns about the potential impacts of the proposed project on water quality. Concerns primarily focused on short-term and long-term degradation of water quality and impacts to drinking water and livestock. Four commenters asked for unspecified restrictions on the proposed project and assurances that groundwater would not be contaminated. One commenter asked what impacts the proposed project would have on water color, taste, and odor. One commenter stated that the proposed project was too close to domestic water wells and residences. One commenter recommended that the FEIS assess potential irretrievable commitment of the aquifer, which may not be suitable in the future for domestic, stock, and public-supply uses.

Two commenters stated that they did not believe the mining would affect water and that there are no cases of public water wells being affected by ISL extraction operations.

***Discussion and Response to Comments.*** Two potential impacts to water quality are conceivable as a result of the proposed project. During mining operations, mining fluids could be chemically detected in the perimeter monitoring well network at a well field. This detection would be considered an excursion and would compel HRI to initiate corrective action to control and remedy the condition causing the excursion. HRI would then take measures to clean up any groundwater impacted by the excursion. Excursions represent a localized and short-term impact to groundwater quality.

The second impact could result during groundwater restoration for a well field after mining has been completed. Restoration criteria would be established on a parameter-by-parameter basis. The primary goal of restoration would be to return all parameters to average premining baseline conditions. In the event that water quality parameters cannot be returned to average premining baseline levels, the secondary goal would be to return water quality to the maximum concentration limits as specified in EPA 40 CFR § 141 and 143.3, secondary and primary drinking water regulations. The secondary restoration goal for barium and fluoride would be the State of New Mexico primary drinking water standard. For uranium the secondary goal would be 300 pCi/mL (0.44 mg/L). This concentration was obtained from 10 CFR § 20 (Appendix B, Table 2) and is suitable for unrestricted release of natural uranium to water. This means that the secondary restoration goal would be equal to or below both State of New Mexico and EPA primary and secondary drinking water standards.

ISL uranium solution mining is not expected to affect the taste of the groundwater. If groundwater restoration is successful, the proposed secondary standards would be equal to or below both Federal and State of New Mexico secondary standards. These standards set concentrations for chloride, copper, iron, manganese, phenols, sulfate, total dissolved solids, zinc, and pH. Of these parameters, zinc, copper, iron, manganese, and chloride (at high concentrations), can affect taste (Hem 1970). The possibility does exist that ISL mining could affect the taste and smell of groundwater near the end of the restoration phase. Hydrogen sulfide would be injected into the well field at the end of restoration to reestablish reducing conditions in the aquifer. This could impart a slight rotten egg odor and a sulfur taste to the groundwater. The impact from this procedure is expected to be short in duration due to the small amount of hydrogen sulfide used in relation to the amount of groundwater involved and the size of the aquifer matrix.

### A.6.1.3 Radius of Impact

***Commenters***

Valarie V. Murphy
Chris Shuey, Southwest Research and Information Center
Mervyn Tilden
Emma J. Begay
Lynda Lovejoy, Leo Watchman, Wallace Charley, John Pinto,
Leonard Tsosie, Navajo members of the New Mexico State Legislature
Frank Chee Willeto

Peter Jordon
Anna Frazier, Dineh Citizens Against Ruining our Environment (Dineh CARE)
Herman Devare

***Summary of Issues.*** Several commenters expressed concern that the proposed project would affect a larger area and population than was considered in the DEIS because of the disperse distribution of the population. Several commenters stated that some people travel as far as 90 to 100 miles to use the Crownpoint water supply wells. Other commenters stated that the proposed project would affect water quality for a 50- to 150-mile radius from the sites.

***Discussion and Response to Comments.*** Potential impacts of the proposed project on the town of Crownpoint water supply wells have been evaluated, and mitigative measures are described in the FEIS. Section 4.3.3 and Appendix B describe the mitigative measures that would be required by NRC staff to protect the community's water supply. One requirement is that before mining can occur at the Crownpoint site, HRI must relocate the BIA and NTUA wells to provide a water supply of equivalent quality and quantity as supplied by the existing system. This mitigative measure would protect access to the water supply for individuals currently plumbed to the water system and to those beyond the community system who travel significant distances to haul water.

## A.6.2 Crownpoint Drinking Water Supply

### A.6.2.1 Mining in Public Water Supply

***Commenters***

Don Schrader
Multiple signatures on written comments
David J. Farrel, USEPA Region 9
Jana Gunnell, M.D., New Mexico Department of Health

***Summary of Issues.*** Commenters expressed concerns about ISL mining in a public water supply. Comments generally opposed the proposed action and questioned the feasibility of uranium mining in a domestic water supply. One commenter stated that HRI must perform and submit results of a study to determine the potential effects of mining on Crownpoint drinking water supply wells.

***Discussion and Response to Comments.*** Many of the aquifers in which ISL mining occurs are used as sources of drinking water. However, the Crownpoint project is unique in that it would be located near a public water supply. To address this issue, contaminant transport modeling was conducted to evaluate potential impacts to groundwater quality in the town of Crownpoint water supply wells (Section 4.3) from mining activities at the Unit 1 and Crownpoint sites. The NRC staff would require that before the injection of lixiviant at the Crownpoint site, HRI must replace the town water wells, construct new pipeline, and connect the water supply systems. The wells would be located so that the town of Crownpoint would continue to have a water supply system of equal quantity and a quality that can be maintained below EPA primary and secondary drinking water standards and the NRC 0.44 mg/L standard for uranium. Although the magnitude of potential impacts to the town of Crownpoint wells is not definitive, the NRC staff's requirement to move the wells before mining can occur at the Crownpoint site is consistent with the conservative licensing approach used by the NRC to mitigate potential risk and ensure the protection of public health.

### A.6.2.2 Contaminating Municipal Water Supply

*Commenters*

Ann Reitz, M.D., IHS-Crownpoint Health Care Facility
Matthew Dixon
Lila Bird, Water Information Network
Jim Walker, Navajo Nation EPA
Mervyn Tilden
Alfred Chavez
Vera Murphy
Mitchell Capitan
Thelma Nakai
Dorothy Smith

***Summary of Issues.*** Commenters expressed concern that the proposed project would contaminate the surrounding water supply. One commenter stated that HRI has not provided satisfactory proof that contaminants would not migrate to existing municipal water supply wells. Another commenter said the DEIS does not sufficiently address protection of public water supplies from mining contamination. One commenter stated that the older water supply wells provide potential conduits for migration of contaminants into overlying aquifers.

***Discussion and Response to Comments.*** Contaminants transport modeling was conducted to evaluate potential impacts to groundwater quality in the town of Crownpoint water supply wells from ISL mining activities at the Crownpoint and Unit 1 sites (Section 4.3). In conducting this analysis, the NRC staff decided that water quality in the town of Crownpoint wells could be degraded, but not to the point that Federal drinking water standards and the uranium concentration limit from 10 CFR § 20 (Appendix B, Table 2) would be exceeded. In Section 4.3 of the FEIS the potential for excursions from the Unit 1 and Crownpoint sites to influence water quality in the town of Crownpoint wells is discussed. These evaluations resulted in the staff recommendations described in Section 4.3.3 and Appendix B of this FEIS.

### A.6.2.3 Suspension of Pumping the Public Water Supply

*Commenters*

Mike Johnson, Department of Water Resource Management, Navajo Nation
Chris Shuey, Southwest Research and Information Center

***Summary of Issues.*** Commenters objected to the statement in DEIS Section 4.1.3 that "Pumping from the domestic water supply wells completed in the Westwater Canyon must be suspended if they are capable of altering lixiviant migration." Commenters stated that the proposed project is of secondary importance to the public water supply, and that the interest of the mining operation should not be placed above that of the public water supply.

*Discussion and Response to Comments.* Comments noted. The discussion in FEIS Section 4.3 concerning the potential impacts of the proposed project on the public water supply wells near the town of Crownpoint has been expanded to clarify the NRC's position. The Crownpoint site is the only site where pumping by the existing town of Crownpoint wells could significantly influence lixiviant migration during mining activities. As a result, the NRC staff would require that prior to the injection of lixiviant at the Crownpoint site, HRI must replace the town water wells, construct new pipeline, and connect the water supply. The wells must be located so that the town of Crownpoint continues to have a water supply system of at least equal quantity and a quality that can be maintained below EPA primary and secondary drinking water standards and 0.44 mg/L of uranium. HRI would be required, by NRC license condition, to provide a suitable alternative public water supply through the appropriate local utility authority before mining can commence near the town of Crownpoint wells.

### A.6.2.4 Relocation of Well NTUA-1, BIA wells

*Commenters*

Jon Martin, Bureau of Indian Affairs
Malcolm P. Dalton, Navajo Tribal Utility Authority
Patrick Antonio, Navajo Nation EPA
Stephen Hoffman, EPA HQ
Frank Chee Willeto

*Summary of Issues.* One commenter noted that the BIA owns water wells in the project area and asked if these wells are managed by [BIA] Facility Management. Four commenters provided comments on the potential impacts to well NTUA-1, which supplies most of the drinking water for the town of Crownpoint. One commenter stated that the DEIS inaccurately stated that HRI had reached an agreement or understanding with the Navajo Tribal Utility Authority for relocating the public water well.

*Discussion and Response to Comments.* The BIA manages the BIA wells in and around Crownpoint. When the DEIS was published, well NTUA-1 was within the Crownpoint site boundary. HRI has since revised the proposed site boundary such that the well is outside the site boundary. HRI would be required to restore groundwater quality in the well field to the primary restoration goal of premining baseline water quality or the appropriate water use standard on a parameter-by-parameter basis. However, as an added conservatism, the NRC staff has concluded that the potential risk is too great for groundwater to be degraded below EPA primary and secondary drinking water standards and the NRC 0.44 mg/L of uranium standard. As a result, the NRC staff would require HRI to replace the town water wells, construct new pipeline, and connect the new wells to the existing water supply system before lixiviant injection is started at the Crownpoint site. The new wells must be located to provide a continued water supply of equivalent quality and quantity as provided by the existing system to the town of Crownpoint.

# A.7. ISL EXTRACTION FACILITY OPERATIONS

## A.7.1 Process Circuit Operations

### A.7.1.1 Thorium Mobilization

*Commenters*

Mary Lou Jones, Zuni Mountain Coalition
Mervyn Tilden

***Summary of Issues.*** Commenters stated that the DEIS did not mention the mobilization and hazards of thorium-230 due to ISL mining. The commenters recommended that the FEIS thoroughly address all potential problems related to thorium-230 and radium-226.

***Discussion and Response to Comments.*** Comment noted. Thorium-230 is a daughter product from the decay of uranium-238. Studies have shown that thorium-230 is mobilized (dissolved in the groundwater) by bicarbonate leach based *in situ* mines (NRC 1978). However, studies have also shown that thorium-230 is restored by the groundwater restoration phase of ISL mining operations (NRC 1978). After restoration, it is expected that thorium in the groundwater would not remain in solution because the chemistry of thorium causes the element to precipitate and chemically react with the rock matrix (HEM 1970; Langmuir and Herman 1980). Therefore, because of low solubility in natural waters, thorium is found in ultra-trace concentrations. Chemical tests for thorium are expensive and are not commonly included in water analyses at ISL mines. Radium-226 and radon-222 are daughter products from the decay of thorium-230. After restoration, radium-226 and radon-222 would continue to form from the decay of thorium. However, they would not form at any greater rate than they did prior to mining. Section 4.3 of the FEIS has been expanded to include discussions of radium-226 mobility and potential water quality impacts on the town of Crownpoint water supply.

REFERENCES:

Hem, J. D. 1970 *Study and Interpretation of the Chemical Characteristics of Natural Water.* U.S. Geological Survey Water-Supply Paper 1473.

Langmuir, D., and Herman, J. S. 1980. "The Mobility of Thorium in Natural Waters at Low Temperatures." *Geochimica et Cosmochimica Acta.* Vol 44, pp. 1753 to 1766.

NRC 1978. *Final Environmental Statement, Related to Operation of the Highland Uranium Solution Mining Project, Exxon Minerals Company, U.S.A,* Docket No. 40-8102.

### A.7.1.2 Recovering Uranium and Extracting Radium and Trace Metals

*Commenters*

David J. Farrel, USEPA Region 9
Julie Curtiss, Navajo Nation EPA

Lalare Charles

*Summary of Issues.* Commenters expressed concerns that all the mobilized species of uranium might not be recovered in ion exchange columns and asked how radium and other trace metals would be removed from the groundwater.

*Discussion and Response to Comments.* All the uranium isotopes would be equally removed from the groundwater by the resin in the ion exchange columns. Radium and other chemical species would not be removed by the ion exchange columns but would be removed by groundwater restoration activities. HRI has proposed three restoration alternatives: (1) 100 percent groundwater sweep (groundwater is pumped from the aquifer but not returned to the aquifer); (2) reverse osmosis treatment with 3 parts treated water (permeate) and 1 part reject (brine); and (3) brine concentration and reverse osmosis reject with 99 parts treated water (distillate) and 1 part reject (brine). Any of these three alternatives would remove uranium, radium, and other trace metals from the groundwater.

### A.7.1.3 Spill Containment and Pipeline Ruptures

*Commenters*

David J. Farrel, USEPA Region 9
Ann Reitz, M.D. IHS-Crownpoint Health Care Facility
Joan Klonowski, M.D.
Jon Martin, Bureau of Indian Affairs
Mark Pelizza, HRI, Inc.
Julie Curtiss, Navajo Nation EPA

*Summary of Issues.* Commenters expressed concerns and raised questions relating to spills and pipeline breaks. One commenter stated that the worst-case pipeline spill described in DEIS is greatly overstated and that a one-time spill would not elevate soil concentrations above cleanup standards. One commenter asked what constituted a significant pipe break. Other commenters recommended secondary containment, leak detection, instrumentation, automatic shut-offs, and automatic alert systems to mitigate any potential spill or pipeline break. One commenter expressed concern that expertise to control a spill or leak would not be available because of site accessibility difficulties. One commenter stated that wild animals and flash floods could disrupt surface/near-surface piping. One commenter asked if the pipelines crossing roads would be encased in a culvert.

*Discussion and Response to Comments.* HRI proposes to use high-density polyethylene to construct its well field distribution pipelines. The proposed pipe material exhibits high chemical resistance and is suitable for operating pressure up to 265 psi and operating temperatures from below freezing to approximately 80 °C (180 °F). ISL mines in Wyoming routinely operate in high summer temperatures and below-freezing winter temperatures. Therefore, if pipelines are properly designed and installed, well field pipeline leaks should not be a routine problem.

Flow rates on each injection and production well, and injection manifold pressures on the entire system, would be measured and recorded daily. In addition, meters would monitor pressures for each well, and the entire injection and production system would be metered on the trunk lines for continuous monitoring in the processing plant. As a result, any large pipeline breaks should be detected quickly. Because piping is a large part of an ISL mining operation, HRI would maintain expertise and readily available equipment on-site to repair any pipe breaks. At road crossings and other high-traffic areas, pipelines would be encased in a steel culvert and buried. Reporting requirements and action levels for significant releases of licensed material are described in 10 CFR § 40.60.

#### A.7.1.4 Process Flow Diagram

*Commenters*

W. Peter Balleau
Julie Curtiss, Navajo Nation EPA

*Summary of Issues.* Commenters noted inconsistencies with tables and descriptions of restoration bleed, brine production, and wastewater flow in the DEIS.

*Discussion and Response to Comments.* Comment Noted. Figure 2.9 in the DEIS is incorrect. A 756 L/m (200 gpm) reverse osmosis feed is projected to produce 567 L/m (150 gpm) permeate and 189 L/m (50 gpm) brine. DEIS Figure 2.9 has been removed from the text, and a new figure has been added to the FEIS.

#### A.7.1.5 Emergency Power

*Commenter:*

Ann Reitz, M.D., IHS-Crownpoint Health Care Facility

*Summary of Issues.* One commenter requested information on the ability of HRI to maintain control of process equipment during a power outage.

*Discussion and Response to Comments.* HRI would be required to maintain emergency diesel generating capacity to maintain well field bleed and emergency lighting in the event of power outage.

### A.7.2 Well Field Operations

#### A.7.2.1 Background [Baseline] Water Quality

*Commenters*

Mary Lou Jones, Zuni Mountain Coalition
Jon Martin, Bureau of Indian Affairs
Matthew Dixon
Patrick Antonio, Navajo Nation EPA

*Summary of Issues.* Commenters asked general questions about determining baseline water quality before mining operations commence. One commenter asked where the baseline data were being collected, and another commenter was concerned that the submitted data did not accurately reflect water quality. One commenter stated that the baseline groundwater molybdenum and selenium concentrations did not support HRI's claim that selenium would not be a problem for groundwater restoration.

*Discussion and Response to Comments.* Well field baseline or premining water quality is determined for the mining zone and the overlying aquifer prior to mining because water quality typically varies between different aquifers and from location to location within an aquifer. Baseline water quality data are used to determine if the well field is being operated safely and whether groundwater restoration has been successfully completed. Premining groundwater quality data are presented for each site in FEIS Section 3.3. However, detailed baseline water quality data for each well field would be collected in each well field by HRI prior to lixiviant injection and would be available for inspection by the NRC.

Molybdenum and selenium water quality data are presented in FEIS Section 3.3 and show that these parameters occur in very low concentrations in the groundwater. HRI's claim that molybdenum can be restored to restoration goals is based on its observation that the concentration of molybdenum as determined from core samples is much less at the Church Rock, Unit 1, and Crownpoint sites than the concentrations found in the core at the Mobil test site. Therefore, HRI's contention is not based on measured baseline water quality data but on the analysis of solid material from the uranium ore body. HRI's contention that selenium and molybdenum would not be significantly elevated during mining is based on its core leach studies. Section 4.3 of the FEIS discusses the success of core tests in achieving restoration goals.

### A.7.2.2 Well Completions and Well Patterns

*Commenters*

Glenn B. Sekavec, U.S. DOI
Patrick Antonio, Navajo Nation EPA
Julie Curtiss, Navajo Nation EPA
Jim Walker, Navajo Nation EPA

*Summary of Issues.* Commenters provided comments pertaining to various aspects of well completion, well testing, and demonstrating the mechanical integrity of a well after installation. One commenter was specifically concerned about using PVC (polyvinyl chloride) pipe for completing deep wells. Another commenter suggested that HRI be required to sample and analyze for mercury, selenium, and polycyclic aromatic hydrocarbons during drilling. One commenter requested an explanation of a "line drive pattern" as referenced in the DEIS.

*Discussion and Response to Comments.* If wells are not properly completed, lixiviant can flow through casing breaks and into overlying aquifers. Casing breaks can occur if a well is damaged during well construction activities. Casing breaks can also occur if water injection pressures exceed the strength of the well materials. To inspect for casing leaks after well completion activities, each well casing would be filled with water. The well would then be pressurized with either air or water to 862 kPa (125 psi) or 25 percent above the expected operating pressure, whichever is greater

(HRI 1996a). A well would have passed the test if a pressure drop of less than 10% occurs over 1 hour (HRI 1992a; HRI 1992d; HRI 1992b). Operating pressure would vary with the depth of the well and would be less than formation fracture pressure.

Fiberglass or steel casing would be used at all three project sites. PVC pipe would only be used at the Church Rock site. Section 4.3 of the FEIS describes well field casing integrity testing and provides an analysis of the use of PVC at the Church Rock site.

The need to specifically sample for mercury, selenium, and polycyclic aromatic hydrocarbons during drilling has not been demonstrated and would not be required.

A "line drive" pattern is a type of injection well/production well pattern where injection and production wells are alternately located in a near-liner arrangement. Line drive patterns are often used to optimize uranium recovery when the ore zone is narrow.

### A.7.2.3 Pumping Tests and Modeling

*Commenters*

Matthew Dixon
David J. Farrel, USEPA Region 9
W. Peter Balleau
Patrick Antonio, Navajo Nation EPA
Stephen Hoffman, EPA HQ
Julie Curtiss, Navajo Nation EPA
Jim Walker, Navajo Nation EPA
Mike Johnson, Department of Water Resource Management, Navajo Nation

***Summary of Issues.*** Commenters expressed concerns about pumping tests and modeling of HRI's proposed action. Comments focused on concerns that the pumping tests presented in the DEIS were inadequate, insufficient, or inconclusive, and commenters recommended additional and more extensive pumping tests. Comments expressed various concerns that the modeling results presented in the DEIS were based on inaccurate assumptions and insufficient data, which call into question the validity of the modeling.

***Discussion and Response to Comments.*** One purpose of pumping tests is to evaluate the potential for vertical connection between the mining horizon and shallower aquifers at the sites. Pumping tests were conducted at the Church Rock, Unit 1, and Crownpoint sites using monitor wells completed into the overlying aquifer. The NRC asked HRI many questions about these pumping tests. At best, each of the tests could only test a small area of each site for vertical confinement. The NRC staff concluded that with the exception of the Church Rock site, the Brushy Basin shale would provide vertical confinement. This conclusion is based on site geology, previous borehole sealing procedures, and HRI's planned well integrity testing program. Section 4.3 of the FEIS describes premining hydrologic tests that would be conducted in each well field prior to the injection of lixiviant to evaluate vertical confinement of the well field.

Values for transmissivity and storage coefficient were determined from each of HRI's pumping tests. Values derived from the Church Rock and Unit 1 tests appear to be the least questionable because the Crownpoint pumping test was complicated by the influence of the town of Crownpoint wells. Section 3.3 of the FEIS contains hydraulic parameter values derived from each of the three sites. An analysis of the storage coefficient for the Westwater Canyon shows that storage coefficients are in the $10^{-4}$ to $10^{-5}$ range, which is in agreement with typical values and ranges for a confined aquifer. It is also important to note that groundwater flow and drawdown model output usually show little sensitivity to this range of storage coefficients.

Transmissivity values for the Westwater Canyon aquifer at the Crownpoint site are in the 232 $m^2$/day (2,500 gpd) range, while at the other two sites they tend to cluster in the 92.9 $m^2$/day to 130 $m^2$/day (1,000 gpd to 1,400 gpd) range. These values are within an order of magnitude of each other, which adds confidence that the values calculated by the Crownpoint tests fall within the expected range of values. Pumping test data that cover an entire site are not usually submitted as part of an ISL mine application. Therefore, pumping tests are conducted prior to well field operation to further define the hydraulic parameters and to aid in well field design and potential excursion evaluation.

The FEIS references three uses of groundwater flow models: (1) to evaluate horizontal excursion potential; (2) to determine potential water level declines; and (3) to determine groundwater flow direction and velocity. Westwater Canyon aquifer hydrologic parameters from the Crownpoint and Church Rock sites were used in models for each respective site. The models of horizontal excursion potential show that it is possible to design well fields under constant head gradients using values that are within the range of expected conditions. For both sites, sensitivity analyses were conducted using maximum and minimum transmissivity values calculated for each site (Reed 1993). Therefore, the hydraulic parameters appear to be adequate for the purpose of the model.

For the Church Rock site, Westwater Canyon aquifer water level declines were modeled based on the average transmissivity value of 107 $m^2$/day (1154 gal/day/ft). At the Church Rock site, there are no local water wells to influence water level drawdowns in the Westwater Canyon. This is probably because extensive dewatering during previous underground mine operations at the site have had extensive impacts on the Westwater Canyon aquifer in the area of the Church Rock site.

Modeled drawdowns for the Unit 1 and Crownpoint sites were based on the higher transmissivity values of the Crownpoint site. However, the pumping rate from an indivdual well has a bigger effect on the modeled drawdowns than the exact transmissivity value chosen for the simulation. In this case, a simulated mine plan was modeled using the maximum estimated pumping volume. Therefore, if somewhat lower or higher transmissivity values were used, it is doubtful that the conclusions of the model would be significantly changed.

Groundwater direction and flow were modeled at all three sites. At the Church Rock site, average transmissivity values were used. At the Unit 1 and Crownpoint sites, the higher transmissivity values of the Crownpoint site were used. The range of transmissivity values projected for the three sites should not have a large effect on calculated flow directions. Velocity flow data were used to reach conclusions about the speed with which contaminants could move from the site and affect local wells in the

Westwater Canyon aquifer. At the Church Rock site, there are no local wells in the Westwater Canyon aquifer. At the Unit 1 and Crownpoint sites, groundwater velocities and flow times to the town of Crownpoint wells were modeled by HRI using average transmissivity values. Given the close proximity of the Crownpoint site to the town of Crownpoint wells relative to the Unit 1 site, it is doubtful that the decisions made with regard to the length of the flow time would significantly change if somewhat larger or smaller transmissivity values were used.

### A.7.2.4 Lixiviant Injection and Control of Fluids

*Commenters*

David J. Farrel, USEPA Region 9
Stephen Hoffman, EPA HQ
Jim Walker, Navajo Nation EPA
Mervyn Tilden
Chris Shuey, Southwest Research and Information Center
Ray Morton
George Brodie
Glen Huling

***Summary of Issues.*** Commenters expressed concerns about lixiviant injection and control of mining fluid. Comments generally identified concerns about HRI's ability to control lixiviant. Three commenters were concerned about the potential for lixiviant injection pressures to cause fracturing in the formation. One commenter expressed a belief that HRI would use sulfuric acid as a lixiviant and not carbonated water.

***Discussion and Response to Comments.*** HRI has proposed and would be required by license condition to use only oxygen and bicarbonate as chemical lixiviants in the proposed mining operation. Mining solutions at ISL extraction operations are controlled by maintaining greater pumping rates than injecting rates through continuously removing a minimum volume of water from the process circuit. This removal volume, referred to as "process bleed," creates a net positive pumping balance in the well field. Rates on individual pumping and injection wells are also manually balanced to maintain the net positive pumping balance among individual well patterns within the well field. If the well field is properly balanced, mining solutions will remain within the well field area outlined by the perimeter monitoring wells. Section 4.3 of the FEIS contains a discussion of injection and fracture pressures. Injection pressures at the three sites would be maintained below casing rupture and aquifer fracture pressures.

### A.7.2.5 Excursion Detection and Monitoring

*Commenters*

Mary Lou Jones, Zuni Mountain Coalition
Ann Reitz, M.D., IHS-Crownpoint Health Care Facility
E. Ann Hosmer, M.D.
Glenn B. Sekavec, U.S. DOI

Matthew Dixon
David J. Farrel, USEPA Region 9
W. Peter Balleau
Patrick Antonio, Navajo Nation EPA
Julie Curtiss, Navajo Nation EPA
Jim Walker, Navajo Nation EPA
Mike Johnson, Department of Water Resource Management, Navajo Nation
Mervyn Tilden
Rita Capitan

***Summary of Issues.*** Commenters expressed concerns about excursion detection and monitoring. Several commenters stated that monitoring should be performed more frequently than every two weeks and at more locations than proposed. Several commenters also recommended including additional constituents and parameters for monitoring, including total uranium, mercury, selenium, polycyclic aromatic hydrocarbons, and water level, and conducting bioassays. Other commenters identified inadequacies in the DEIS descriptions of excursions and corrective actions. Two commenters recommended monitoring in the deeper aquifer beneath the Westwater Canyon aquifer.

***Discussion and Response to Comments.*** Monitor wells would encircle the well field and would be placed in the upper aquifer above the zone of mining. At the Church Rock site, monitor wells would also be placed in the second overlying aquifer. Upper control limits would provide early warning if mining solutions are moving away from the well fields so that groundwater outside the monitor well ring would not be significantly threatened. This would be accomplished by choosing parameters that are strong indicators of the ISL mining process and that do not greatly attenuate due to geochemical reactions in the aquifers. If possible, the chosen parameters should be easy to analyze, allowing timely data reporting. The concentration of the chosen indicator parameters should be set high enough that false positives (false alarms due to natural fluctuations in water chemistry) are not a frequent problem but not so high that significant groundwater quality degradation occurs by the time an excursion is identified.

The applicant would:

1. Use chloride, alkalinity, and conductivity (corrected to a temperature of 25 °C, as described in Clesceri et al. 1990) as upper control limit parameters.

2. Set upper control limit concentrations for chloride, bicarbonate, and conductivity for each well field by calculating the baseline mean and adding five standard deviations to sampling premining mine area well (monitor) water quality data. Prior to calculating the baseline, mean outliers would be eliminated using a statistical method described in HRI's operating plan.

HRI proposed uranium as an excursion indicator (HRI 1992d). However, one of the problems with using uranium as an indicator is that while it is mobilized by ISL mining, it is not considered an early indicator that solutions are moving away from the well field and therefore is not considered a suitable parameter to use as an upper control limit. However, even though HRI no longer plans to monitor uranium as an excursion indicator, HRI would continue to monitor and record values for uranium during biweekly monitor well sampling.

An excursion would be declared if any two excursion indicators in any monitor well exceed their respective upper control limits or if a single excursion indicator exceeds its upper control limit by 20 percent

### A.7.2.6 Impacts of Previous Conventional Mining and Exploration Borings

*Commenters*

David J. Farrel, USEPA Region 9
Jim Walker, Navajo Nation EPA
Chris Shuey, Southwest Research and Information Center
Paul Robinson, Southwest Research and Information Center

***Summary of Issues.*** Commenters expressed concerns pertaining to contaminant migration from ISL mining in the area of abandoned mine shafts and tunnels at the Church Rock site and from improperly sealed exploration bore holes. Commenters indicated that the DIES did not provide an adequate discussion of the potential impacts of these existing features.

***Discussion and Response to Comments.*** HRI has logs of the holes drilled at each project site. From an inspection of these records, HRI has concluded that few of the holes were drilled any significant distance into the Recapture Shale, which lies beneath the Westwater Canyon aquifer. Therefore, the primary concern for old drill holes is their potential to act as pathways for contaminant movement to upper pathways.

The drill hole records also indicate that drill holes at the Crownpoint and Unit 1 sites were plugged in compliance with the New Mexico State Engineer's Regulation NMSA Section 69-3-6. Holes at the Church Rock site were drilled before the plugging requirements of the New Mexico State engineer were promulgated (1968), and therefore the holes are plugged with drilling mud and geologic materials that have collapsed into the hole. The confining units at the Church Rock site contain clays and shales. HRI does not believe open bore holes would be a problem at the Church Rock site because drilling experience at the Church Rock site indicated that the clays of the shales units over the Westwater Canyon aquifer tended to squeeze the boreholes shut after a few days. HRI possesses the surveyed drill hole locations for each site. This would make it easy to locate a drill hole should vertical monitoring indicate that there is a problem with leakage.

At the Crownpoint site, mine shafts have been excavated from the surface into the Westwater Canyon aquifer. The Crownpoint mine shafts are lined with steel and grouted to the surface. In addition, they were never cut into the Westwater unit. They do not present an avenue for interformation transfer of groundwater.

The southern end of the Church Rock site (Section 17) contains shafts and tunnels from a previous underground mining operation. HRI has reviewed maps of these mine workings and determined that the shafts are open to the Westwater Canyon aquifer, the Brushy Basin "B," and may be open 1 or 2 ft to the bottom of the Dakota Sandstone aquifer. Therefore, in the area of the shaft and workings, the potential for vertical excursions to occur is greater. However, it should be possible to mine in the Westwater Canyon aquifer and not create a vertical excursion. This can be accomplished by sealing off the shafts or structuring well field pressures so that in the area around the shafts they are less than overlying aquifer pressures.

In recognition of the increased potential for vertical excursions to occur, HRI proposes to place monitor wells within 40 ft of any likely openings of the mine workings into either the overlying Dakota Sandstone or the Brushy Basin "B" Sand. These monitor wells would be placed downgradient of the suspected open section, in the direction of groundwater movement, to ensure that any excursions would be detected (HRI 1996k).

The potential to detect horizontal excursions at the Church Rock site should be high. Monitor wells would encircle the well field and the mine workings to detect horizontal excursion should they ever occur. In addition, monitor wells would be located by treating production mine workings as if they were injection or production wells (HRI 1996k). Therefore, monitor wells would encircle each well field at a distance of 400 ft from the edge of the production and injection wells and mine workings and would be located 400 ft apart (HRI 1992a; HRI 1993a; HRI 1992b). The angle formed by lines drawn from any production or injection well or mine working to the two nearest monitor wells would not be greater than 75 degrees (HRI 1996f; HRI 1996k). This means that the detection of horizontal excursions would not be degraded by the presence of the mine workings.

Since it cannot be guaranteed that the mine workings do not extend beyond the injection and production wells of the well field, the potential for horizontal excursions could be increased in areas of existing mine workings. However, HRI's proposed monitoring program should detect any horizontal excursions and, thus, HRI would be required to correct them if they occur.

### A.7.2.7 Hydrogeologic Characterization and Impacts of Geologic Structures

*Commenters*

Ann Reitz, M.D. IHS-Crownpoint Health Care Facility
Matthew Dixon
Patrick Antonio, Navajo Nation EPA
Stephen Hoffman, EPA HQ
Julie Curtiss, Navajo Nation EPA
Jim Walker, Navajo Nation EPA
Mike Johnson, Department of Water Resource Management, Navajo Nation
Chris Shuey, Southwest Research and Information Center

***Summary of Issues.*** Commenters provided comments about the degree of geologic characterization performed at the sites and questioned the ability of HRI to control lixiviant and mining fluids. Commenters identified joints, fractures, and faults as geologic features of particular concern in the overlying and underlying confining layers for evaluating whether mining fluid could be controlled.

***Discussion and Response to Comments.*** Given the projected thickness and rock type of the overlying confining units, there is little likelihood that faults and fractures at the Crownpoint, Church Rock, and Unit 1 sites would act as vertical pathways for groundwater migration from the mining zone to an overlying aquifer. However small, though, the potential for faults to act as vertical pathways does exist. Therefore, hydrologic tests for vertical confinement would be conducted prior to mining in a well field. After a mine area has been identified, monitor wells (both overlying and in the production zone) and baseline mining wells would be installed. A single well relatively central to the proposed mining area would be pumped at a constant flow rate so that the pressure drawdown (cone-of-depression) caused by water production would stress the formation and any potential hydraulic boundaries or barriers, such as the overlying confining clays and possible nonsealing faults (additional information is provided in Section 4.3). Therefore, prior to the injection of lixiviant, any geologic features that could act as vertical pathways should be identified. With the exception of the mine workings at the Church Rock site, no significant large-scale structures have been identified that could act as horizontal pathways for contaminant movement from the well field.

### A.7.2.8 Recommended Additional or Changed License Conditions

***Commenters***
W. Peter Balleau
Jon Martin, Bureau of Indian Affairs

***Summary of Issues.*** Commenters provided the following suggested license conditions:

1. Monitor well, production well, and injection well hydraulic head shall be reported quarterly with computer-generated contours indicating hydraulic head gradients to determine excursion control. Eight or more monitor wells (at least two per quadrant) at a 200-ft distance outside the primary monitor perimeter shall be installed for the purpose of monitoring gradients on hydraulic head across the perimeter.

2. Groundwater restoration criteria for each mining unit shall be proposed based upon the well field average for each monitored parameter in DEIS Table 2.4.

3. The initial mining unit (Church Rock mining unit 1) of about 25 acres shall serve to demonstrate the achievable degree of aquifer restoration. Injection at the remaining 1,265 acres of mining units will succeed the Church Rock mining unit 1 field restoration.

4. In the event that groundwater restoration criteria are not achieved in the Church Rock mining unit 1 field demonstration, the license may be reconditioned with relaxed goals for restoration with the consent of property owners and permitting agencies.

5. At least three months prior to injecting lixiviant in a mining unit, the licensee shall submit a plan for groundwater restoration and postrestoration monitoring. The goal of restoration and the duration of postrestoration monitoring shall be in accordance with preceding conditions 2 and 4.

6. The licensee shall not inject or dispose of saline or elution brine in the lixiviant solution.

7. The soil salinity in any area of land application for water or salt disposal shall be monitored and corrected to meet upper control limits established for that purpose.

A second commenter stated that well integrity testing should be increased from every 5 to every 3 years, since the life cycle of the Church Rock facility would only be 9 years.

*Discussion and Response to Comments.* While water level data would not be treated as excursion parameters, they would be collected by HRI and would be available to NRC inspectors. Water level data can be very helpful in defining excursions; however, they are prone to many more false alarms than are chemical parameters.

Groundwater restoration goals would be based on well field averages calculated for each individual parameter.

HRI proposes to complete a concurrent groundwater restoration demonstration at each of the three sites within 18 months of the date on which mining commences. The NRC staff would require that prior to the injection of lixiviant (i.e., prior to the extraction of uranium) at either the Unit 1 or Crownpoint site, a restoration demonstration be conducted at the Church Rock site. The demonstration should be conducted on a large enough scale to determine the number of pore volumes that would be required to restore a production-scale well field.

Primary and secondary groundwater restoration goals have been established. If a groundwater parameter cannot be returned to the secondary goal, HRI would have to make a demonstration to the NRC that leaving the parameter at the higher concentration would not be a threat to public health and safety and, on a parameter-by-parameter basis, that water use would not be significantly degraded.

The mechanical integrity of all wells would be determined after completion, before the well is placed in service, and at least once every 5 years it is in use. This duration covers mining and restoration operations.

## A.7.3 Groundwater Restoration

### A.7.3.1 Core Leach Tests and Restoration of Previous Mining Studies

*Commenters*

Mary Lou Jones, Zuni Mountain Coalition
Matthew Dixon
W. Peter Balleau
Patrick Antonio, Navajo Nation EPA
Julie Curtiss, Navajo Nation EPA
Jim Walker, Navajo Nation EPA

Mike Johnson, Department of Water Resource Management, Navajo Nation
Chris Shuey, Southwest Research and Information Center

***Summary of Issues.*** Commenters expressed various concerns about the appropriateness of using core leaching studies to demonstrate the feasibility of groundwater restoration after mining. Specific comments identified concerns about a laboratory-scale procedure representing a field-scale condition. Commenters questioned the applicability and validity of the pilot restoration demonstrations provided by HRI and presented in the DEIS. Several commenters stated that the information presented for the Mobil pilot project indicated that full restoration was not achieved.

***Discussion and Response to Comments.*** Comments noted. The NRC staff had strong reservations about using a small number of small-scale core tests to demonstrate site-scale groundwater restoration. In this case, 7 ft of core are being used to demonstrate the restoration potential of approximately 200 ft of aquifer over about 3 miles$^2$, with one site located about 20 miles away. However, the staff also recognized that core restoration tests can provide useful information about which water quality parameters are expected to be mobilized and which parameters may be problems for restoration.

The NRC staff's review of core and larger scale tests (Section 4.3) concluded that some parameters can be restored to average premining well field concentrations and that all the parameters can be restored to water use standards. However, the data presented do not strongly indicate that restoration to average baseline or water use standards is likely to be achieved for all groundwater quality parameters within 4 pore volumes. Therefore, the NRC staff would require that surety (bonding) for groundwater restoration of the initial well fields be based on 9 pore volumes unless HRI demonstrates that some other pore volume is appropriate. The 9 pore volume estimate is based on an inspection of the data submitted by HRI. Depending on the parameter and the test chosen, the pore volumes required to achieve the lower water quality of the secondary restoration goal or background ranged from less than 1 pore volume to greater than 28 pore volumes. However, plots of total dissolved solids concentrations and specific conductivity values (an indirect measure of total dissolved solids) show little improvement with continued pumping after 8 to 10 pore volumes. The Mobil test site is the largest restoration demonstration conducted in the project area to date. During groundwater restoration activities after 6.9 and 9.7 pore volumes, total dissolved solids concentrations were close to the total dissolved solids secondary restoration goal of 500 mg/L. Therefore, it is estimated that practical production-scale groundwater restoration activities would at most require a 9 pore volume restoration effort. Furthermore, NRC staff would require that surety be maintained at this level until HRI can demonstrate the number of pore volumes required to restore a production-scale well field.

### A.7.3.2 Groundwater Restoration and Restoration Demonstration

*Commenters*

Mary Lou Jones, Zuni Mountain Coalition
Ann Reitz, M.D., IHS-Crownpoint Health Care Facility
Joan Klonowski, M.D.
Glenn B. Sekavec, U.S. DOI
David J. Farrel, USEPA Region 9

Mark Pelizza, HRI, Inc.
Lila Bird, Water Information Network
W. Peter Balleau
Patrick Antonio, Navajo Nation EPA
Julie Curtiss, Navajo Nation EPA
W. Peter Balleau
Patrick Antonio, Navajo Nation EPA
Julie Curtiss, Navajo Nation EPA
Mike Johnson, Department of Water Resources Management, Navajo Nation
Paul Robinson, Southwest Research and Information Center
Mervyn Tilden
Chris Shuey, Southwest Research and Information Center
Lester Sharpton, M.D., Crownpoint Hospital

***Summary of Issues.*** Commenters expressed concern about groundwater restoration for the proposed project. A majority of the commenters expressed concern about whether restoration to premining water quality could be achieved since HRI had not conducted a large-scale restoration demonstration. Three commenters stated that the descriptions of restoration standards and restoration demonstrations in the DEIS were not clear. Four commenters recommended that HRI be required to demonstrate its ability to restore groundwater before mining could proceed.

***Discussion and Response to Comments.*** At the end of groundwater restoration activities, postrestoration or stability monitoring of the groundwater is conducted. This period of monitoring is done to confirm that the water quality is stable and that groundwater contaminants are not being remobilized. Postrestoration monitoring is commonly conducted for a period of 6 to 9 months. At the Crownpoint site, pumping of the groundwater would continue in restored well fields throughout the postrestoration monitoring period. This would assure that groundwater contaminants would not migrate from the well field due to the pumping influence of the town of Crownpoint water wells. If the town of Crownpoint wells are moved a significant distance away, continuous pumping may not be required. At the Church Rock and Unit 1 sites, groundwater pumping would not be continued in restored well fields during the postrestoration monitoring period because the rate of groundwater flow should assure that water would not move out of the well field area during the postrestoration monitoring period.

Restoration monitoring data cannot guarantee that some pockets of water containing higher concentrations than groundwater restoration goals do not remain in the rock. However, it is unlikely that any pockets would be very large because restoration monitoring data would be collected from the same wells used to establish baseline water quality parameters and because HRI has proposed that at least one production/injection well per acre in each well field would be sampled for baseline.

## A.7.4 Facility Decommissioning

### A.7.4.1 Contamination and Cleanup

*Commenters*

Ann Reitz, M.D., IHS-Crownpoint Health Care Facility
David J. Farrel, USEPA Region 9
Julie Curtiss, Navajo Nation EPA
Anna Frazier, Dineh Citizens Against Ruining our Environment (Dineh CARE)

***Summary of Issues.*** Commenters requested information on the standards that would be applicable during site decommissioning and cleanup of accidental spills or releases.

***Discussion and Response to Comments.*** Potential contamination of the air and land could occur through two pathways: routine operational events (air effluents) and accidents/spills. The potential health effects associated with possible contamination of both the air and land from routine air effluents are analyzed in Section 4.6 of the FEIS as part of the MILDOS-AREA modeling.

The potential for accidents at an ISL facility to contaminate large areas of land, such as occurred with the Church Rock dam break in 1979, is not significant, since ISL operations create small volumes of waste, especially when compared to conventional mill processing. Few of the uranium daughter products are brought to the accessible environment by the ISL process, thereby reducing the hazard. The potential for accidental release from evaporation ponds during storm events has also been included in the analysis of the proposed project.

Currently, there are no codified Federal standards for soil contamination by radionuclides other than for radium. Spills requiring cleanup/decontamination in either project areas or off-site would need to be cleaned to the applicable standards. The NRC is undertaking a rulemaking to codify cleanup standards for all radioactive materials and, currently, has staff guidance on approved concentration levels [for example, 1.1 Bq/g (30 pCi/g) for uranium] for cleanup and decommissioning. HRI's accident response protocol has included an action level for cleanup of 1.1 Bq/g (30 pCi/g). Hazardous material would need to be cleaned up to the applicable levels (either EPA or State, as appropriate).

### A.7.4.2 Soil Sampling

*Commenters*

Julie Curtiss, Navajo Nation EPA

***Summary of Issues.*** One commenter asked if the soil below pond liners would be sampled during decommissioning since leak detection systems are not foolproof. The commenter indicated that this was important considering the site would eventually be released to unrestricted use.

***Discussion and Response to Comments.*** A decommissioning plan would be submitted to the NRC prior to decommissioning activities. HRI has agreed to submit a detailed decommissioning plan to the

NRC for review and approval at least 12 months prior to planned final shutdown of mining operations. Sampling locations that contained radioactive materials is a common procedure in decommissioning activities. Therefore, staff would expect that sampling below the location of former ponds would be included in any decommissioning plan.

#### A.7.4.3 Existing Structures

*Commenters*
Jon Martin, Bureau of Indian Affairs

*Summary of Issues.* One commenter asked if HRI would assume liability for the existing structures at the sites and whether unwanted structures would be removed at the end of the mining.

*Discussion and Response to Comments.* HRI currently owns the existing structures at the Church Rock and Crownpoint sites. Existing structures and those constructed in the future as part of the proposed project would be removed or decontaminated for unrestricted use at the end of site operations. NRC regulations require that the dismantling, disposal, decommissioning, and decontamination of all structures and components of the proposed operations must be included in the financial surety funded by HRI.

## A.8. SURFACE WATER

### A.8.1 Surface Water Impacts

#### A.8.1.1 Runoff Containment

*Commenters*
Patrick Antonio, Navajo Nation EPA

*Summary of Issues.* One commenter stated that the DEIS did not clearly describe whether surface water runoff would be contained at each site to prevent potential contamination off-site.

*Discussion and Response to Comments.* The potential for surface water discharge from each site is addressed in Section 4.4 of the FEIS. All drainage channels near and at the sites are ephemeral washes that contain water only during infrequent periods of precipitation or snowmelt. The facilities would not discharge to drainage channels as result of well field or plant operations. However, at the Church Rock site the facility may discharge restoration water into surface water streams if groundwater sweep is chosen as the restoration option and sufficient water rights cannot be obtained to dispose of water by land application. Should surface water discharge be implemented, HRI would have to obtain any appropriate State or Federal permits.

### A.8.1.2 Surface Water Contamination

*Commenters*

David J. Farrel, USEPA Region 9

*Summary of Issues.* One commenter recommended that the FEIS indicate whether springs, seeps, or ephemeral streams would be affected by the project.

*Discussion and Response to Comments.* Section 4.4 of the FEIS contains a description of expected environmental impacts on surface water bodies. This section concludes that any effect on water quality during infrequent periods of runoff is likely to be small and temporary. There are no known springs in any of the plant or well field areas at any of the sites. It is possible that ephemeral seeps may occur at different times of the year around the mesa areas of the Church Rock site. However, these areas would be higher in elevation than the well field and plant areas and, therefore, could not be affected by them.

At the Church Rock site, two properties being considered for land application are located above the site on flat mesa land. If these properties are used as land application areas, they might influence or create small perched water bodies in the mesa that could, in turn, form temporary seeps around the mesa cliff face. However, should these seeps form, they should not have any significant effect on surface water or groundwater.

### A.8.1.3 Drainage Modeling

*Commenters*

Patrick Antonio, Navajo Nation EPA

*Summary of Issues.* One commenter asked if the drainage near the Crownpoint site had been modeled hydrologically.

*Discussion and Response to Comments.* HRI provided some information related to potential flooding at the Crownpoint site. Flood magnitudes were estimated, and preliminary information was provided regarding designs and impoundment locations to minimize erosion associated with floods.

All drainage channels near and at the three project sites are ephemeral washes that contain water only during infrequent periods of precipitation or snowmelt. The Crownpoint site would not discharge to drainage channels as a result of well field or plant operations (Section 4.4). HRI has not provided detailed information regarding specific and unique details of the diversion channels or impoundment system. HRI has provided general information regarding the preliminary design layout of the facility and the potential for flooding of the site. HRI has committed to follow the guidance in NRC Staff Technical Position *Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites*.

Based on a review of the preliminary information provided by HRI, the NRC staff is not aware that there are any particularly unique design problems associated with the implementation and completion of the hydraulic design features of the site. Based on that knowledge, the staff considers that HRI can develop an acceptable engineering design. When that design is provided, the staff would evaluate its acceptability. Accordingly, the staff has recommended that a license condition requiring HRI to submit revised hydraulic design information and review/approval by the NRC be incorporated into the license.

## A.9. TRANSPORTATION RISK

### A.9.1 Local Accident Rates

*Commenters*

Lila Bird, Water Information Network
Wallace Charley, State Representative, New Mexico
LaJuanna Daye
Joan Klonowski, M.D.
Lynda M. Lovejoy, State Representative, New Mexico
Ray Morton
John Pinto, State Senator, New Mexico
Ann Reitz, M.D., IHS-Crownpoint Health Care Facility
Lester Sharpton, M.D., Crownpoint Hospital
Charles Shuey, Southwest Research and Information Center
Leonard Tsosie, State Senator, New Mexico
Leo C. Watchman, Jr., State Representative, New Mexico

***Summary of Issues.*** Commenters raised the issue of highway safety in connection with HRI's plans to transport yellowcake slurry and dried yellowcake produced by the project on local roads. Concerns were expressed that the accident rate in McKinley County is already high compared to other counties and that the addition of trucks hauling yellowcake to and from the Crownpoint processing facility would aggravate an already serious situation. Commenters identified specific hazards about driving in the area and asked whether the traffic model used in the DEIS considered such hazards.

***Discussion and Response to Comments.*** Accident statistics for local roads in the vicinity of the proposed project were obtained and are reported in Section 3.4 of the FEIS. To ensure a conservative analysis, the accident rate used in the transportation risk assessment in Section 4.5 of the FEIS is much higher than the accident rates of the local roads. The FEIS transportation risk analysis is based on the methodology in NRC's *Final Generic Environmental Impact Statement on Uranium Milling*.

### A.9.2 Local Road Conditions

*Commenters*

Herbert Enrico
David J. Farrel, U.S. Environmental Protection Agency
Mr. Largo
Valarie V. Murphy
Frank Chee Willeto

*Summary of Issues.* Commenters expressed concern about the poor condition of local roads. Commenters asserted that large trucks carrying yellowcake would likely be traveling at speeds that would be excessive for conditions on local roads and that accidents likely would occur.

*Discussion and Response to Comments.* The transportation routes proposed for the project and analyzed in the FEIS are the most direct routes possible and are on all-weather roads except the Route 9 bypass of the town of Crownpoint. To bypass Crownpoint, a 0.5-mile section of unpaved road would be used. The proposed routes are the ones with the lowest transportation risks in the area.

### A.9.3 Number of Trucks Involved In Transporting Yellowcake

*Commenters*

Lila Bird, Water Information Network
Chris Shuey, Southwest Research and Information Center
Frank Chee Willeto

*Summary of Issues.* Commenters asked about the number of trucks that would be used to transport yellowcake slurry from the Church Rock and Unit 1 sites to the Crownpoint processing facility. These questions were associated with concerns expressed about traffic safety on local roads.

*Discussion and Response to Comments.* The projected number of truck shipments is reported in Section 4.5 of the FEIS.

## A.10. ECOLOGY

### A.10.1 Off-Site Impacts to Ecological Resources

*Commenter*

Glenn B. Sekavec, U.S. Department of the Interior

*Summary of Issues.* One commenter stated that discussions regarding potential impacts to ecological resources should be revised to include an assessment of potential off-site impacts.

*Discussion and Response to Comments.* FEIS Section 4.7 has been revised to include a discussion of potential impacts to off-site ecological resources.

### A.10.2 Impact of Retention Ponds on Migratory Waterfowl

*Commenter*

Glenn B. Sekavec, U.S. Department of the Interior

*Summary of Issues.* One commenter stated that migratory waterfowl could be attracted to the proposed project's retention ponds and that the ponds should be designed in such a way as to exclude avian wildlife. The commenter recommends that bioassays be conducted on a periodic basis at all retention ponds to ensure that these areas are not toxic to fish and wildlife.

*Discussion and Response to Comments.* Although the ponds would be fenced to exclude large mammals, it is not practical to completely exclude waterfowl. However, the project area is not known for large concentrations of waterfowl, although it is possible that a project pond could be visited by waterfowl. It is expected that the water quality in the ponds would not be detrimental to wildlife. Nevertheless, the proposed license conditions require that pond design be reviewed and approved prior to construction. The review process would include provisions for stipulating water quality and for subsequent monitoring. Although bioassays may not be practical or necessary, methods of monitoring water and sludge quantity in the ponds and for controlling waterfowl access are stipulated in the proposed license conditions. NRC staff also recommend several physical measures to discourage waterfowl use of the ponds in the proposed license conditions.

### A.10.3 Land Area Disturbance

*Commenter*

Glenn B. Sekavec, U.S. Department of the Interior

*Summary of Issues.* One commenter stated that the DEIS does not provide a concise description of the land areas, particularly the types and quantities of wildlife habitat, that would be disturbed by the proposed project. The commenter stated that descriptions of drilling sites, access roads, pipeline routes, and locations of retention ponds are necessary for an evaluation of project impacts.

*Discussion and Response to Comments.* The actual areas to be mined within each project site would not be known until final exploration prior to initial drilling. Similarly, the precise location of access roads, pipelines, and evaporation ponds would be variable within the project sites. However, Section 2.1.4 of the FEIS has been revised to provide estimates of the land areas that would be disturbed within each project site. The FEIS addresses the potential disturbance of wildlife habitat in Section 4.7.1.

## A.11. LAND USE

### A.11.1 Residents Within Project Site Boundaries

*Commenters*

Larry King
Valarie V. Murphy
Ann Reitz, M.D., IHS-Crownpoint Health Care Facility
Dorothy Smith
Jeanette Vice, Eastern Navajo Health Board

*Summary of Issues.* Commenters asked what would happen to people who reside on land within the project sites and expressed concerns about the effects of the proposed project on land use.

*Discussion and Response to Comments.* In most cases, the individuals and families who would be relocated or denied access to their land would be voluntary signatories to the leases negotiated by HRI. The need for relocations and access restrictions, which would be temporary (i.e., for the duration of mining operations in the lease area and until the area has been released for public access), was explained to the signatories as a condition of the leases.

There may be some instances where individuals or families who are living on allotted lands but who are not signatories to the leases would be required to relocate. Funds to cover such relocations are the responsibility of the allottees who signed the leases and presumably have been set aside as a condition of the negotiated lease. However, NRC staff have recommended that HRI compensate those residents who would be relocated but who are not signatories to the leases negotiated by HRI (Appendix B).

## A.12. SOCIOECONOMICS

### A.12.1 General

*Commenters*

Paul Robinson, Southwest Research and Information Center
Chris Shuey, Southwest Research and Information Center
Mervyn Tilden

*Summary of Issues.* Commenters noted that some DEIS descriptions of socioeconomic resources in the vicinity of the proposed project were outdated or incorrect. Commenters maintained that an assessment of socioeconomic impacts based on such data would be inaccurate.

*Discussion and Response to Comments.* Relevant sections of the DEIS have been revised in response to these concerns. These revisions are contained in Sections 3.8.1, 3.9.1, 4.8.1, 4.9.1, 4.10.1, 4.11.1, and 4.12.1 of the FEIS.

### A.12.2 Local Emergency Response Capabilities

*Commenters*

Mitchell Capitan
Rita Capitan
LaJuanna Daye
E. Ann Hosmer, M.D.
Joan Klonowski, M.D.
Bernadine Martin
Valarie V. Murphy
Ann Reitz, M.D., IHS-Crownpoint Health Care Facility

Alex Sandval
Lester Sharpton, M.D., Crownpoint Hospital
Chris Shuey, Southwest Research and Information Center
Frank Chee Willeto

***Summary of Issues.*** Commenters stated that the emergency response capabilities of the Navajo Nation and the town of Crownpoint are inadequate and that this situation was not addressed in the DEIS. Police, fire, hazardous material, medical, and air evacuation functions were described as substandard by commenters who said these services are not prepared to handle the major accidents that could occur at the HRI facilities. Commenters also stated that emergency response plans for such contingencies do not exist.

***Discussion and Response to Comments.*** Text has been added to Section 4.9.1 of the FEIS to address the emergency response capabilities and plans of HRI, the Navajo Nation, and the local community.

## A.12.3 Local Socioeconomic Benefits

***Commenters***

Annie Julian
Lincoln Perry, Sr.
Mervyn Tilden
Gladys Yazzie

***Summary of Issues.*** Commenters stated that they hope the proposed project will bring improvements to the Crownpoint area. Road and water system improvements and job opportunities were mentioned as possible benefits associated with the project. One commenter was concerned that local economic development would be controlled by HRI rather than the affected members of the local community.

***Discussion and Response to Comments.*** The FEIS addresses the potential local benefits of the proposed project in Section 4.9.1. FEIS Section 5 summarizes anticipated costs and benefits associated with the proposed project. As with all the NRC licensing actions, local citizens and communities have the opportunity to provide information that could influence the licensing decision through NRC's hearing process. If a license is granted, other opportunities for public input may also be available when public comments are solicited in the *Federal Register* for significant license amendments. Although the project would be a private venture, the NRC license would stipulate that it be constructed and operated in accordance with applicable State, Federal, and Tribal laws and regulations.

## A.12.4 Negative Perceptions of the Local Community

***Commenter***

Ann Reitz, M.D., IHS-Crownpoint Health Care Facility
Mervyn Tilden

***Summary of Issues.*** Commenters stated that the proposed project would have a negative effect on perceptions of the Crownpoint community and that these negative perceptions could, in turn, affect the desirability of the community as a place to live. Another concern was the potential for adverse effects on the local economy if (1) tourists and visitors believe local water supplies are contaminated or (2) accidental spills occur on the project site.

***Discussion and Response to Comments.*** The desirability of a community as a place to live is dependent on many factors. Proximity to the proposed project could have both negative and positive influences on desirability, depending on how the project is perceived by residents and prospective residents. For example, *perceptions* of health and safety risks associated with the project could be a negative factor in some individual decisionmaking. Conversely, *perceptions* of employment opportunities associated with the project could be a positive factor. It would be speculative to estimate what perceptions of the proposed project and its effects might be. To some degree, perceptions would depend on the performance—real and perceived—of HRI's local operation if the project is licensed. The past and ongoing performance records of other ISL facilities, particularly HRI's in Texas, could also influence perceptions in New Mexico.

The FEIS addresses the potential health impacts of the proposed project in Section 4.6.1. Whether there would be *perceptions* of local public water supplies being undrinkable or dangerous to drink is unknowable at this time. Potential effects on tourism or on the monthly rug auctions are also unknowable at this time. Under any set of circumstances, existing regulations would be enforced to maintain safe public water supplies throughout the proposed project's duration.

Any spills would be cleaned up according to appropriate State and Federal regulations, and any affected areas would be certified as safe before they would be opened to the public. Whether potential visitors or tourists to the region might perceive the affected areas as "unsafe" or "contaminated" is unknowable at this time. Similarly, the potential effect of such perceptions on the tourist economy is unknowable at this time.

## A.13. CULTURAL RESOURCES

### A.13.1 General

***Commenters***

Kenneth Cody
Leigh Jenkins, Hopi Tribe Cultural Preservation Office
Mervyn Tilden

***Summary of Issues.*** Commenters criticized the DEIS for its inadequate treatment of and disregard for potential impacts to Native American culture. Commenters maintained that the DEIS relied on faulty, biased information and demonstrated a general lack of knowledge about Native American culture.

***Discussion and Response to Comments.*** In preparing the FEIS and in developing and monitoring HRI's compliance with the proposed license conditions, the NRC will ensure that HRI follows all requirements of the National Historic Preservation Act, the Native American Graves Protection and Repatriation Act, the American Indian Religious Freedom Act, and the Navajo Nation Policies and Procedures Concerning the Protection of Cemeteries, Gravesites, and Human Remains. Native American tribes having members who currently occupy the project area or who have cultural affiliation with groups that have historically occupied or used the area will be provided the opportunity to help identify and protect human, funerary, and sacred objects recovered during construction and operation of the proposed project.

Section 4.13 of the FEIS and the proposed license conditions (Appendix B) detail the monitoring program HRI must implement to protect cultural resources. Although a qualified archaeologist would be on site during all periods of road building, facility construction, and well development, no archaeologist typically would be present during periods of project operation. Several measures would be implemented during project operations. The cultural resources management plan described in Section 4.13 would govern activities that have the potential for adversely affecting cultural resources. All cultural resources would be flagged and avoided by all personnel. All personnel admitted to the site, including HRI, subcontractor, and vendor personnel, must be trained on required protective measures toward cultural resources. Initial discussions with appropriate officials indicate that the National Historic Preservation Act Section 106 process will require annual cultural resources monitoring reports submitted by the project archaeologist. Unscheduled inspections would be made by the archaeologist in conjunction with this monitoring report.

HRI contracted with a consultant permitted by both the New Mexico State Historic Preservation Office and the Navajo Nation Historic Preservation Division to conduct surveys to determine whether culturally significant resources [often called traditional cultural properties (TCP)] are located in or near the three proposed project sites. The consultant worked with all interested Native American tribes to identify TCPs at all three sites. Representatives of each tribe were asked to identify any TCPs, including plants used medicinally or ceremonially; rock art; rock formations; viewsheds; etc., that their tribes or clans considered sacred or culturally important. The results of these surveys are included in Sections 3.9, 4.11, and 4.13 of the FEIS and in documents developed as part of NRC's compliance with Section 106 of the National Historic Preservation Act.

## A.13.2 Consultation Under Section 106 of the National Historic Preservation Act and All Other Applicable Federal and/or Navajo Nation Laws

***Commenters***

Leigh Jenkins, Hopi Tribe Cultural Preservation Office
Peter Noyes, Navajo Nation Historic Preservation Department

***Summary of Issues.*** Commenters representing Native American tribes requested that the tribes be included as interested parties in the Section 106 process and that they be consulted in accordance with all other applicable Federal and/or Navajo Nation laws. Commenters also noted inconsistencies in the DEIS regarding cultural resource survey findings. In addition, commenters requested that the cultural resource management plan discuss impacts on properties located outside the boundaries of the leased areas.

***Discussion and Response to Comments.*** Native American tribes having members who currently occupy the project area or who have cultural affiliation with groups that have historically occupied or used the area have been invited to participate as interested parties in the Section 106 consultation process pursuant to requirements of the National Historic Preservation Act of 1966 (as amended).

In addition, FEIS Section 4.11.1 states that cultural resources will be treated in accordance with the Navajo Cultural Resources Protection Act (CMY-19-88). The proposed license conditions specify that the cultural resources management plan that HRI would develop prior to any project construction must treat the Navajo Nation as a consulting party (Appendix B).

The Hopi tribe has been invited to participate as an interested party in the Section 106 consultation process. The Hopi tribe could also become a party to the cultural resources management plan (FEIS Section 4.13).

Inconsistent statements regarding cultural resource surveys have been corrected. Also, HRI's cultural resource management plan will address traditional cultural properties identified in the TCP survey, including those located outside the bounds of the HRI lease area that may be potentially affected by the proposed project.

### A.13.3 Consultation Under the Native American Graves Protection and Repatriation Act and/or Other Federal and Navajo Nation Laws and Regulations

***Commenters***

Leigh Jenkins, Hopi Tribe Cultural Preservation Office
Peter Noyes, Navajo Nation Historic Preservation Department

***Summary of Issues.*** Commenters representing Native American tribes requested that the tribes be consulted under the Native American Graves Protection and Repatriation Act and/or other Federal and Navajo Nation laws and regulations.

***Discussion and Response to Comments.*** Necessary consultation pursuant to the Native American Graves Protection and Repatriation Act will be coordinated with consultation required to develop the memorandum of agreement for Section 106 (see response to issue A.13.2). Native American tribes having members who currently occupy the project area or who have cultural affiliation with groups that have historically occupied or used the area have been invited to participate.

## A.13.4 Respect for Navajo Religious Beliefs

*Commenters*

Kenneth Cody
LaJuanna Daye
Valarie V. Murphy
Mervyn Tilden

***Summary of Issues.*** Commenters noted that the DEIS did not consider impacts to "Mother Earth," the Navajo religious belief that the earth and its resources are sacred and should not be abused. Commenters believe that drilling project wells would constitute such abuse and would be in opposition to their religious beliefs.

***Discussion and Response to Comments.*** The monitoring and mitigation requirements specified in the proposed license conditions (Appendix B) are designed to meet Federal, State, and Tribal regulations. The NRC recognizes that, for some Navajo people, any alteration or pollution of the earth that is caused by humans can be interpreted as damaging to Mother Earth and associated religious values. The NRC has endeavored to reduce any such damages to a minimum, consistent with its responsibilities under the law.

## A.13.5 Respect for Navajo Traditional Cultural Values

*Commenters*

Art Arviso
Lalare Charles
Valarie V. Murphy
Peter Noyes, Navajo Nation Historic Preservation Department
Paul Robinson, Southwest Research and Information Center
Mervyn Tilden

***Summary of Issues.*** Commenters expressed general concerns about the proposed project interfering with Navajo traditional cultural values associated with the natural environment. Commenters stated that the DEIS ignored or misrepresented such values, which are central to the Navajo way of life. One commenter suggested that HRI's interest in making a profit was responsible for a lack of sensitivity to Native American cultural values. Another commenter felt that the proposed project was being imposed on a populace that had previously been living peacefully in the area.

***Discussion and Response to Comments.*** The proposed license conditions (Appendix B) stipulate that HRI must comply with numerous Federal, State, and Navajo tribal regulations intended to protect public health and safety. The NRC recognizes that the potential for emotional distress caused by disruption of lifestyles and livelihoods does exist and has required HRI to identify and protect culturally sensitive resources at the three sites proposed for development.

Revised text describing Navajo traditional cultural values and resources has been added to Sections 3.2, 3.6, 3.9, 4.8, 4.11, and 4.13 of the FEIS. The traditional cultural resources surveys conducted by HRI in 1996 have provided additional information concerning the presence or absence of important plants and other cultural resources in the project area.

The NRC's responsibility under the Atomic Energy Act of 1954, as amended, is to protect public health and safety and the environment related to source and by-product nuclear material. As part of this responsibility, the NRC must ensure through license conditions that HRI would comply with all applicable laws and regulations that would affect its operations, including those designed to protect the practice of traditional culture. These laws include the Navajo Nation Policy to Protect Traditional Cultural Properties; the Navajo Nation Polices and Procedures Concerning the Protection of Cemeteries, Gravesites and Human Remains; the National Historic Preservation Act of 1966, as amended; the Native American Graves Repatriation Act; and the American Indian Religious Freedom Act.

The decision of whether to issue a license for the proposed project is the NRC's and will not represent the imposition of a single company's will on a local populace. The licensing decision will be made by the NRC after conducting independent environmental and safety analyses of the proposed project. The written comments received by NRC and the transcripts of the oral comments received at the three public meetings held in Crownpoint and Church Rock have been included as part of the input for the analyses.

## A.13.6 Destruction of Culturally Important Plants

*Commenters*

Kenneth Cody
Leigh Jenkins, Hopi Tribe Cultural Preservation Office
Mr. Largo
Peter Noyes, Navajo Nation Historic Preservation Department
Chris Shuey, Southwest Research and Information Center

***Summary of Issues.*** Commenters expressed concern that construction and operation of the proposed project would destroy culturally important plants and herbs and the environment in which they grow. Commenters were concerned that surveys of the project sites would not identify all such plants because the individuals conducting the surveys might not be knowledgeable about culturally important plants and herbs.

***Discussion and Response to Comments.*** HRI contracted with a consultant permitted by both the New Mexico State Historic Preservation Office and the Navajo Nation Historic Preservation Division to conduct surveys to determine whether culturally significant resources [often called traditional cultural properties (TCP)] are located in or near the three proposed project sites. The consultant worked with all interested Native American tribes to identify TCPs at all three sites. Representatives of each tribe were asked to identify any TCPs, including plants used medicinally or ceremonially; rock art; rock formations; viewsheds; etc., that their tribes or clans considered sacred or culturally important. The results of these surveys are included in Sections 4.11 and 4.13 of the FEIS and in documents developed as part of NRC's compliance with Section 106 of the National Historic Preservation Act (as amended).

# A.14. ENVIRONMENTAL JUSTICE

## A.14.1 Treatment of Environmental Justice in the DEIS

*Commenters*

Wallace Charley, State Representative, New Mexico
Neville Davis, M.D.
LaJuanna Daye
Jana Gunnell, M.D., State of New Mexico Department of Health
Lynda M. Lovejoy, State Representative, New Mexico
Bernadine Martin
John Pinto, State Senator, New Mexico
Ann Reitz, M.D., IHS-Crownpoint Health Care Facility
Chris Shuey, Southwest Research and Information Center
Mervyn Tilden
Leonard Tsosie, State Senator, New Mexico
Leo C. Watchman, Jr., State Representative, New Mexico

***Summary of Issues.*** Commenters criticized the DEIS for its failure to discuss Executive Order 12898 on Environmental Justice. The executive order requires that the lead Federal agency consider potential adverse impacts on poor and minority populations to determine if those groups might suffer disproportionately while others benefit if the proposed action is implemented. Commenters maintained that the limited availability of the DEIS and the difficulties many Navajos had in understanding it were indicative of the NRC's attitude about environmental justice.

***Discussion and Response to Comments.*** The NRC has met Federal requirements for providing information and making the DEIS available and in some cases exceeded the requirements by providing additional copies of the DEIS and translators at all meetings. The NRC also acknowledges that the technical information contained in the DEIS is difficult to understand, especially for native speakers of languages other than English, and that language barriers may have prevented some people from becoming informed about the proposed action and from commenting on the DEIS. Nevertheless, many people did comment and those comments are addressed in this appendix and reflected in revisions made throughout the FEIS. In the context of environmental justice, particularly the U.S. Presidential executive order and NRC guidelines, and because so many people have shown their interest in the EIS process, additional reasonable efforts to facilitate communication between the public and the NRC are being made. These efforts include wider distribution of the FEIS and development of a video summary of the FEIS in Navajo.

## A.14.2 Treatment of Navajo People Under Executive Order 12898

*Commenters*

LaJuanna Daye
Jana Gunnell, M.D., State of New Mexico Department of Health
Mr. Largo
Bernadine Martin
Peg Rogers, Navajo Nation DOJ
Chris Shuey, Southwest Research and Information Center
Mervyn Tilden

*Summary of Issues.* Commenters criticized the DEIS for its failure to assess impacts to Navajo people in the context of environmental justice as required under Executive Order 12898. Commenters maintain that the Navajo fall under the executive order because they are an ethnic, minority, and poor population.

*Discussion and Response to Comments.* Because the DEIS did not specifically determine whether impacts to the Navajo population would be "disproportionately high and adverse," it did not comply with the requirements of Federal Executive Order 12898 on environmental justice. Since the publication of the DEIS, the NRC has developed guidance for considering environmental justice in EISs. This guidance has been implemented, the staff has conducted additional analysis, and sections on environmental justice have been added to the FEIS (Sections 3.10 and 4.12).

## A.14.3 Navajo Tribal Sovereignty

### A.14.3.1 General

*Commenters*

Julie Curtiss, Navajo Nation EPA
Peg Rogers, Navajo Nation DOJ
Chris Shuey, Southwest Research and Information Center

*Summary of Issues.* Commenters criticized the DEIS and the Federal agencies that prepared it for focusing a disproportionate amount of the Federal government's trust responsibilities on allottees rather than the Navajo Nation. Commenters also criticized the DEIS for its failure to discuss or acknowledge the authority of the Navajo Nation in various jurisdictional issues.

*Discussion and Response to Comments.* The NRC, BIA, and BLM have endeavored to fulfill their trust obligations to the Navajo Nation and people and to acknowledge Navajo Nation sovereignty on various issues through substantial revisions and additions to the DEIS. These include new sections on environmental justice (FEIS Sections 3.10 and 4.12) and a revised section on regulatory and jurisdictional issues (FEIS Sections 1.6 and 1.7). Further, the FEIS identifies additional mitigation and monitoring measures that reflect changes to the DEIS and that will be implemented through license conditions to protect the health and welfare of the Navajo people near the proposed project.

### A.14.3.2 Navajo Nation's Moratorium on Uranium Mining

*Commenters*

Patrick Antonio, Navajo Nation EPA
Matthew Dixon
Barbara Graham
Jana Gunnell, M.D., State of New Mexico Department of Health
Mary Lou Jones, Zuni Mountain Coalition
Bernadine Martin
Peg Rogers, Navajo Nation DOJ
Chris Shuey, Southwest Research and Information Center
Mervyn Tilden

***Summary of Issues.*** Commenters criticized the DEIS for failing to acknowledge the Navajo Nation's moratorium on uranium mining until human and animal health issues are resolved in a manner that is conducive to maintaining safe health standards. The commenters argued that failing to acknowledge the moratorium indicates the NRC's lack of concern about Navajo tribal sovereignty.

***Discussion and Response to Comments.*** The NRC is aware of the Navajo Nation's moratorium on uranium mining, first issued in 1983 and renewed by tribal executive order in 1992 (a discussion of the moratorium has been added to Section 4.12.9 of the FEIS). The moratorium is to be effective on Navajo lands until the Navajo people are assured that the safety and health hazards associated with uranium mining activity can be addressed and resolved.

There are, however, conflicts between the Navajo Nation's position and that of the Navajo chapters and individuals involved with the proposed project. The NRC acknowledges the Navajo Nation's claim to jurisdiction over trust lands, Navajo fee lands, and tribal allotted lands in accordance with the definition of Indian Country in 18 U.S.Code § 1151 (see 40 CFR §144.3). However, the Church Rock and Crownpoint chapters, where the proposed project would be located, held referenda indicating their support for the HRI proposal despite the moratorium. Also, given that many allottees have agreed to lease their land to HRI, the applicability of the moratorium to allotted lands is not clear. At issue is whether the Nation's moratorium overrides the individuals' decisions about their land. Abiding by the moratorium also conflicts with the Federal Mining Law of 1872. Given these conflicts, the NRC will proceed in its determination of whether the condition contained in the moratorium can be met (i.e., that the safety and health hazards associated with the mining activity can be addressed and resolved) by preparing a safety evaluation report and an FEIS for the proposed project.

### A.14.3.3 Sovereignty Over Water Rights

*Commenters*

Emma J. Begay
Malcolm P. Dalton, Navajo Tribal Utility Authority
Jana Gunnell, M.D., State of New Mexico Department of Health
Alice W. Hoylan

Mike Johnson, Navajo Nation Department of Water Resources Management
Mary Lou Jones, Zuni Mountain Coalition
Bernadine Martin
Janice Perry
Ann Reitz, M.D., IHS-Crownpoint Health Care Facility
Peg Rogers, Navajo Nation DOJ
Chris Shuey, Southwest Research and Information Center
Mervyn Tilden
Jim Walker, Navajo Nation EPA

***Summary of Issues.*** Commenters raised the issue of which government has authority over water rights in the area in which HRI proposes to withdraw groundwater. Some of these comments were stated in terms that included all natural resources. Commenters generally asserted that the water, as well as other resources, is the property of the Navajo Nation and could not be regulated by the NRC or appropriated by HRI.

***Discussion and Response to Comments.*** Arbitrating disputes about jurisdiction over water rights is not the function of this FEIS in particular or the NRC in general. However, as an agency of the Federal government, the NRC has an obligation to recognize and protect the tribal sovereignty of the Navajo Nation. In addition, the context and mandates of environmental justice suggest that the Navajo Nation (because Navajo people would be potentially affected) should be involved in regulatory processes. To that end, NRC staff have revised the DEIS text and recommended that the Navajo Nation play a role in developing an approach and process through which HRI's applications for water rights would be considered. See Section 4.12.1 and Appendix B of the FEIS.

### A.14.3.4 Sovereignty Over Underground Injection Permits

***Commenters***

Patrick Antonio, Navajo Nation EPA
David J. Farrel, U.S. Environmental Protection Agency
Frances H. Harwood, Rio Grande Bioregional Project
Mary Lou Jones, Zuni Mountain Coalition
John Martin, Bureau of Indian Affairs
Ann Reitz, M.D., IHS-Crownpoint Health Care Facility
Peg Rogers, Navajo Nation DOJ
Chris Shuey, Southwest Research and Information Center
Jim Walker, Navajo Nation EPA

***Summary of Issues.*** Commenters questioned how the DEIS could specify which governmental agency has jurisdiction over underground injection control (UIC) permitting when the matter is still in dispute. Other commenters questioned which agency standards would be used to resolve groundwater issues.

***Discussion and Response to Comments.*** UIC permitting for the proposed action would occur separately from the EIS process. Further, it is not a function of this FEIS in particular or the NRC in general to arbitrate among the competing jurisdictional claims over UIC permitting. However, the NRC has determined that certain issues must be considered in resolving this jurisdictional dispute. These issues are the requirements of 40 CFR § 144.2, tribal sovereignty, and the need to ensure environmental justice. Because the proposed action would occur in an area traditionally held and currently occupied mostly by Navajo people and some of the land is indisputably "Indian Country," it is the NRC staff's position that the Navajo Nation should be involved in UIC permitting and regulation of HRI facilities (see Section 4.12.1 and Appendix B of the FEIS).

### A.14.3.5 Sovereignty Over Project Reclamation Plans

*Commenters*

Julie Curtiss, Navajo Nation EPA
Jana Gunnell, M.D., State of New Mexico Department of Health
Bernadine Martin
Ann Reitz, M.D., IHS-Crownpoint Health Care Facility
Peg Rogers, Navajo Nation DOJ
Chris Shuey, Southwest Research and Information Center
Mervyn Tilden
Jim Walker, Navajo Nation EPA

***Summary of Issues.*** Commenters questioned the DEIS treatment of general jurisdictional issues as well as ones that were specific to project reclamation plans. Commenters argued that Navajo tribal authority was being ignored by the DEIS.

***Discussion and Response to Comments.*** The development and review of the project reclamation plan would occur separately from the EIS process (see Appendix B). However, various agencies (including the BIA, BLM, and EPA) and sovereigns (the State of New Mexico and the Navajo Nation), depending on the section of land involved, would have responsibility to review and approve the reclamation plan.

On private lands, HRI would be responsible for protection and restoration in accordance with the NRC license and the negotiated lease. On public lands, such oversight would be the responsibility of the administrative agency with jurisdiction over the land in question. On tribal lands or tribal trust lands, the Navajo Nation would generally have oversight responsibility. On allottee lands, the BIA would have oversight responsibility.

## A.14.4 Navajo Nation Boundaries

*Commenters*

Julie Curtiss, Navajo Nation EPA
Bernadine Martin
Mervyn Tilden

***Summary of Issues.*** Commenters noted that the maps used in the DEIS showed incorrect boundaries for the Navajo Nation by omitting the "checkerboard" area, which put the town of Crownpoint and some other potentially affected communities outside the reservation. Commenters expressed concern over the potential loss of Navajo sovereignty and subsequent lack of jurisdiction over mining activities proposed by HRI.

***Discussion and Response to Comments.*** FEIS Figures 1.1 and 2.6 reflect the relationship between Navajo Reservation lands and the checkerboard lands, which historically have been largely related to Navajo occupation. DEIS Figures 3.1 and 3.2 have been redrawn as FEIS Figures 2.8 and 2.9 to recognize the checkerboard lands. The FEIS addresses jurisdictional issues among the various Federal, State, and Tribal agencies involved in Sections 1.6 and 1.7.

## A.14.5 Project Benefits to Navajos

***Commenters***

Richard Brostrom, M.D.
Anna Frazier, Dineh Citizens Against Ruining our Environment
Rita Rose Freeland
Ann Reitz, M.D., IHS-Crownpoint Health Care Facility
Peg Rogers, Navajo Nation DOJ
Marilyn Sam
Mervyn Tilden

***Summary of Issues.*** Commenters asked why HRI's project has been proposed for an area with a low income, minority population. Commenters asked who would benefit from HRI's proposed project—Navajo individuals, the Navajo Nation, the community, HRI? Commenters asked how many Navajos would be employed by the project as opposed to skilled people who may be brought in from other parts of the country.

***Discussion and Response to Comments.*** FEIS Section 4.9 contains new text that addresses the potential local benefits of the proposed project. FEIS Section 5 summarizes anticipated costs and benefits associated with the proposed project. The environmental justice sections (3.10 and 4.12) of the FEIS discuss potential effects (including cumulative effects) specific to the Navajo people. In addition, NRC staff have recommended several measures to help ensure that members of the local community benefit from the proposed project (Appendix B).

## A.14.6 Project Impacts on Navajo Livestock Grazing

***Commenters***

Lila Bird, Water Information Network
Valarie V. Murphy
Chris Shuey, Southwest Research and information Center
Mervyn Tilden

***Summary of Issues.*** Commenters expressed concern about how the proposed project would affect Navajos who graze their livestock on project lands. The importance of livestock as an economic resource is substantial to these individuals, and commenters fear that the Navajo will not be compensated.

***Discussion and Response to Comments.*** HRI has secured mineral leases from the individuals or organizations possessing legal titles or having allotments to the resources to be developed. Pursuant to the Federal General Mining Law of 1872, mineral rights owners can interrupt surface grazing permits in order to remove minerals. Therefore, HRI's leases prohibit livestock grazing during mining operations. NRC recognizes that individuals who currently have grazing permits will lose those permits when mining occurs, as discussed in Section 4.9.1 of the FEIS.

While grazing permits would be revoked during the proposed mining operations, the NRC staff has recommended that permitees be compensated directly by HRI (for private lands) or indirectly by HRI through the relevant tribal (for tribal lands) or Federal agency (BIA for allottee lands) for the temporary loss of grazing rights. The staff has recommended that the BIA approve compensation arrangements for lands where allottees have permits, and that the Navajo Nation approve compensation arrangements for lands where permits are held in tribal trust. These staff recommendations are contained in Section 4.8.3 and Appendix B of the FEIS.

# APPENDIX B

## NRC STAFF'S PROPOSED LICENSE CONDITIONS AND ADDITIONAL RECOMMENDATIONS

## B.1 INTRODUCTION

This appendix contains the NRC staff's proposed license conditions and additional recommendations for the proposed project. These requirements and recommendations were developed as a result of the environmental analyses described in Section 4 of this FEIS.

The NRC staff requirements and recommendations are in addition to the commitments contained in HRI's license application and Environmental Report (ER) submitted by cover letter dated April 25, 1988, superseded by supplements and page changes as follows:

| | |
|---|---|
| May 8, 1989 | Crownpoint Facility supplemental ER |
| July 31, 1992 | Unit 1 and Crownpoint project ERs |
| April 5, 1993 | page changes |
| April 6, 1993 | page changes |
| July 26, 1993 | page changes |
| October 11, 1993 | page changes |
| October 19, 1993 | Church Rock surface hydrology analysis |
| October 19, 1993 | Church Rock and Crownpoint aquifer modeling supplement |
| November 11, 1993 | page changes |
| January 24, 1994 | page changes |

In addition, HRI shall conduct its activities in accordance with the provisions and commitments in the following submittals and in any other HRI-submitted material referenced in this FEIS:

| | |
|---|---|
| February 23, 1994 | Description of radon emission controls |
| September 30, 1996 | Crownpoint Uranium Project Consolidated Operations Plan |

Notwithstanding the above, the conditions listed in the attached December 20, 1996, letter from the NRC to HRI shall override any conflicting statements contained in HRI's application and other submittals. The NRC staff has subsequently dropped recommendation B5 since HRI has agreed to better placement of vertical and horizontal excursion monitor wells. In addition, HRI would develop an operating plan procedure for monitoring in the area of previous mining at the Church Rock site.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 20, 1996

Mr. Richard F. Clement, Jr., President
Hydro Resources, Inc.
2929 Coors Blvd, NW
Suite 101
Albuquerque, NM 87120

SUBJECT: PROPOSED REQUIREMENTS AND RECOMMENDATIONS FOR THE CROWNPOINT, NM URANIUM SOLUTION MINING PROJECT

Dear Mr. Clement:

The purpose of this letter is to transmit the enclosed list of proposed requirements and recommendations by the U.S. Nuclear Regulatory Commission staff for licensing the Crownpoint, NM uranium solution mining project. This list is comprised of additional requirements and recommendations beyond those already committed to by Hydro Resources, Inc. (HRI) in is license application submittal.

The NRC staff has determined that the requirements contained herein are of significant health, safety, and/or environmental importance, and requests that HRI respond in writing by December 27, 1996 to its acceptance of these conditions. Additionally, the recommendations in the list have been identified as items of importance to the NRC staff, and HRI should plan to implement these objectives.

If you have any questions concerning this subject, please contact Mr. Robert Carlson of my staff at (301) 415-8165.

Sincerely,

Joseph J. Holonich, Chief
Uranium Recovery Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosure: As stated

cc: B. Saulsbury, ORNL

**ADDITIONALLY PROPOSED NRC REQUIREMENTS AND RECOMMENDATIONS FOR LICENSING THE CROWNPOINT, NM URANIUM SOLUTION MINING PROJECT**

A. REQUIREMENTS

1. Prior to the injection of lixiviant at any of the three project sites, Hydro Resources, Inc. (HRI) shall collect sufficient water quality data to generally characterize the water quality of the Cow Springs aquifer beneath the project sites, and shall conduct sufficient hydrologic confinement tests to determine if the Cow Springs aquifer beneath the sites is hydraulically confined from the Westwater Canyon aquifer.

2. It is the decision of the NRC staff that surety (bonding) for ground-water restoration of the initial well fields should be based on nine pore-volume estimates unless the applicant demonstrates that some other pore volume is appropriate. The nine pore volume estimate is based on an inspection of the submitted data. Depending on the parameter and the test chosen, the pore volumes required to achieve the lesser water quality of the secondary restoration goal or background, ranged from less than one pore volume to greater than 28 pore volumes. However, plots of total dissolved solids (TDS) concentrations and specific conductivity values (an indirect measure of TDS) show little improvement with continued pumping after eight to ten pore volumes. The Mobil ground-water demonstration is the largest restoration demonstration conducted in the local area to date. During ground-water restoration activities, after 6.9 and 9.7 pore volumes, TDS concentrations were close to the TDS secondary restoration goal of 500 mg/l. Therefore, it is estimated that practical production scale ground-water restoration activities will at most implement a nine pore volume restoration effort. Furthermore, surety should be maintained at this level until the number of pore-volumes required to restore the groundwater quality of a production scale well field has been demonstrated by the applicant.

3. Prior to the injection of lixiviant at either the Unit 1 or Crownpoint site, HRI shall conduct an acceptable restoration demonstration at the Church Rock site. The demonstration shall be conducted at a large enough scale to determine the number of pore volumes that would be required to restore a production-scale well field. Surety (bonding) for groundwater restoration of these initial well fields shall be based on nine pore-volumes. Surety shall be maintained at this level until HRI can demonstrate the number of pore volumes required to restore a production-scale well field.

4. Prior to the injection of lixiviant at either the Unit 1 or Crownpoint sites, HRI shall conduct a Westwater Canyon aquifer step-rate injection test (fracture test) within project site boundaries, but outside future well field areas. Since the Unit 1 and Crownpoint sites are in reasonably close proximity to each other, only one test at either site shall be required prior to the injection of lixiviant at either site.

5. Prior to the injection of lixiviant at the Crownpoint site, HRI shall replace the town of Crownpoint water supply wells NTUA-1, NTUA-2, BIA-3,

BIA-5, and BIA-6. In addition, HRI shall construct a water system pipeline and provide funds so that the Navajo Tribal Utility Athority (NTUA) and Bureau of Indian Affairs (BIA) water supply systems can be connected. The wells, pumps, pipelines, and any other necessary changes to the existing water supply system shall be made so the system can continue to provide the same quantity of water. The new wells shall be located so that the water quality at each individual well head would not exceed EPA primary and secondary drinking water standards and a concentration of 0.44 mg/l uranium as a result of future in situ leach mining activities at the Unit 1 and Crownpoint sites. HRI shall coordinate with the appropriate agencies and regulatory authorities, including the BIA, the Navajo Nation Division of Water Resources and the Navajo Nation Environmental Protection Agency (NNEPA), and the NTUA, to determine the appropriate placement of the new wells. Further, the existing wells shall be abandoned and sealed in accordance with applicable guidelines so that they cannot become future pathways for the vertical movement of contaminants.

6. In the event of a vertical excursion, HRI shall explore any significant aquifer above the Dakota sandstone aquifer for vertical excursions, as opposed to just the deepest saturated sand of the Mesa Verde Group. The specific aquifers to be monitored in the event of a vertical excursion shall be identified in HRI's 60-day excursion report.

7. When ground water restoration activities begin at a production scale well field at either the Unit 1 or the Crownpoint sites, the applicant will be require to reimburse the Town of Crownpoint for increased pumping and well work-over costs. This requirement does not include smaller restoration demonstration well fields.

8. The applicant will be required to periodically retest the integrity of injection and production wells. It is recommended that integrity testing be conducted every five years.

9. Until the applicant can demonstrate otherwise, the applicant will be required to collect three independent baseline water quality samples from each well.

10. The Bureau of Land Management (BLM) will require that wells be completed to meet the following specifications:

    a) Minimum design factors for tension (1.6 dry or 1.8 buoyant), collapse (1.125), and burst (1.0) that are incorporated into casing design.

    b) Casing collars shall have a minimum clearance of 0.4222 inches on all sides in the hole/casing annulus.

    c) All waiting on cement times shall be adequate to achieve a minimum of 500 psi compressive strength at the casing shoe prior to drill out.

d) All casing shall be new and reconditioned and tested used casing that meets or exceeds API standards for new casing.

e) Casing shall be cemented back to the surface (150% calculated volume needed will be available on-site during cementing operations).

f) Casing shall have centralizers on every fourth joint (about every 120 to 150 feet) of casing, starting with the shoe joint and up to the bottom of the collar.

g) Top plugs shall be used to reduce contamination of cement by displacement fluid. A bottom plug of other acceptable technique shall be utilized to help isolate the cement from contamination by the mud fluid being displaced ahead of the cement slurry.

h) All casing strings shall be pressure tested to 125% of actual wellfield operating pressure, not to exceed 70 percent of the minimum burst strength (measured on surface usually using water and the rig pump). If pressure declines more than 10 percent in 30 minutes, corrective action shall be taken.

B. RECOMMENDATIONS

1. Staff recommends that HRI use dust suppression techniques to reduce fugitive dust emissions during project shipments on non-paved roads.

2. Staff recommends that prior to the injection of reverse osmosis processed water into the aquifer, HRI determine if iron and manganese would be a problem during production-scale groundwater restoration activities. This recommendation does not apply to restoration demonstration activities, which could supply valuable information to address this question.

3. Staff recommends that HRI work with the U.S. Environmental Protection Agency (EPA) and the State of Mexico to ensure that the Navajo Nation be involved in the Underground Injection Control (UIC) permitting. Specifically, the Navajo Nation should be a party to all negotiations regarding UIC permitting and its concerns should be reflected in the permitting decision or conditions.

4. Staff recommends that HRI facilitate negotiations between the State of New Mexico (i.e., the State engineer) and the Navajo Nation (i.e., the Division of Water Resources) that would develop an approach and process through which HRI's applications for utilization of water rights would be considered.

5. Staff recommends that prior to mining in the area of existing mine workings at the Church Rock site, HRI provide a report explaining how the upper aquifer monitor well locations would provide adequate coverage for the well field, as well as the area around the vertical workings.

6. In the event a lixiviant excursion is confirmed by groundwater monitoring, staff recommends that HRI notify the Navajo Nation (Executive Director, NNEPA, Shiprock Office), the BIA (Branch Chief, Minerals Section, Branch of Real Estate Services, BIA Navajo Area Office), and the BLM (Minerals Team Leader, Albuquerque Field Office) by telephone within 24 hours, and by letter within 7 days from the time the excursion is confirmed.

7. Staff recommends that a written report be submitted to the Navajo Nation (Executive Director, NNEPA, Shiprock Office), the BIA (Branch Chief, Minerals Section, Branch of Real Estate Services, BIA Navajo Area Office), and the BLM (Minerals Team Leader, Albuquerque Field Office) within 60 days of excursion confirmation. The report should contain the same information as the report submitted to the NRC.

8. In the event that retention pond standpipe water analyses indicate that a pond is leaking, staff recommends that HRI notify the Navajo Nation (Executive Director, NNEPA, Shiprock Office), the BIA (Branch Chief, Minerals Section, Branch of Real Estate Services, BIA Navajo Area Office), and the BLM (Minerals Team Leader, Albuquerque Field Office) by telephone within 48 hours of verification.

9. Staff recommends that a written report be filed with the Navajo Nation (Executive Director, NNEPA, Shiprock Office), the BIA (Branch Chief, Minerals Section, Branch of Real Estate Services, BIA Navajo Area Office), and the BLM (Minerals Team Leader, Albuquerque Field Office) within 30 days of first notifying the agencies that a leak exists. The report should contain the same information as the report submitted to the NRC.

10. Staff recommends that HRI notify the Navajo Nation (Executive Director, NNEPA, Shiprock Office), the BIA (Branch Chief, Minerals Section, Branch of Real Estate Services, BIA Navajo Area Office), and the BLM (Minerals Team Leader, Albuquerque Field Office) by telephone within 48 hours of any solution spill or embankment failure which may have a radiological impact on the environment. Staff recommends that such notification be followed, within seven days, by submittal of a written report to the agencies detailing the conditions leading to the failure or potential failure, corrective actions taken, and results achieved.

11. Staff recommends that HRI revegetate disturbed areas with the seed mixture listed in the following table:

**Seeding mixture recommended by NRC staff for revegetating sites with various soil characteristics**

| Plant species | Northern Desert sandy sites[a] | Pinyon/Juniper and Ponderosa Pine clay and loamy sites[a] |
|---|---|---|
| Western wheatgrass (Arriba) | 3.0 | 3.0 |
| Pubescent wheatgrass (Luna) | 0.0 | 0.0 |
| Fairway crested (Hycrest) | 3.0 | 0.0 |
| Fairway crested (Ephraim) | 0.0 | 3.0 |
| Slender wheatgrass (San Luis) | 0.0 | 3.0 |
| Alkali sacaton (Native Hachita) | 2.0 | 0.0 |
| Indian ricegrass (Paloma) | 3.0 | 3.0 |
| Galleta (Viva) | 2.0 | 0.0 |
| Sand dropseed (Native) | 2.0 | 2.0 |
| Blue grama (Lovington) | 0.0 | 2.0 |
| Sideoats grama | 2.0 | 2.0 |
| Fourwing saltbush | 2.0 | 2.0 |
| Scarlet globemallow (Native) | 0.5 | 0.5 |
| Lewis flax | 0.0 | 0.5 |
| Rocky mountain penstemon (Bandera) | 0.5 | 0.0 |
| Palmer penstemon (Cedar) | 0.0 | 0.5 |
| **Total pounds per acre** | **20.0** | **21.5** |

[a]In pounds per acre.
Name in parenthesis ( ) is the cultivar name.

12. Staff recommends that HRI seed Pinyon/Juniper and Ponderosa Pine areas between July 15 and August 15, and Northern Desert areas between November 1 and December 15. Staff further recommends that a tractor with a mechanical grain drill be used to seed areas, that seed be planted into topsoil, that straw or woodchip mulch be used on seeding, and that seeded areas be fenced to protect plantings.

13. Staff recommends that methods for discouraging waterfowl use of project retention or evaporation ponds be implemented. Possible methods include limiting bank vegetation, constructing ponds with steep banks, using

visual and sound devices to frighten birds, and placing wire screens over the water surface.

14. Staff recommends that HRI compensate individuals who hold livestock grazing permits on project lands that would be interrupted during project construction and operation. Compensation to these permitees should be directly (for private lands) or indirectly through the relevant tribal (for tribal lands) or Federal agency (BIA for allotee lands). HRI and the Navajo Nation should negotiate compensation arrangements for lands where grazing permits are held in a tribal trust, and HRI and BIA should negotiate compensation arrangements for lands where allotees have grazing permits.

15. Staff recommends that HRI evaluate potential impacts on, and provide direct compensation to, any residents of allotted lands who are not signatories to the leases negotiated by HRI, but who may be required to relocate during project construction and operation.

16. Staff recommends that HRI's preference for hiring local Navajo be made explicit in a written project hiring plan. The plan should provide the basis for hiring qualified Navajo from the six local Navajo Chapters identified in Section 4.9.1 of the Final Environmental Impact Statement (FEIS). The plan should be developed with input from, and reviewed by, the BIA and presidents of the six local Navajo Chapters.

17. Staff recommends that HRI provide an annual report stating the number of project employees who are Navajo, the number who are non-Navajo, and the number of Navajo employed from each Chapter. The report should be submitted to the BIA and the six local Navajo Chapters identified in Section 4.9.1 of the FEIS.

18. Staff recommends that HRI develop a memorandum of understanding with appropriate local officials to outline respective responsibilities with regard to emergency medical response and training.

19. Should land application be planned for any land other than privately-owned or State land, staff recommends that HRI work with the EPA to ensure that the Navajo Nation is involved in land application permitting.

20. Staff recommends that all delivery trucks used to transport project materials (uranium slurry, yellowcake, and process chemicals) carry the appropriate certifications of safety inspections, and that all delivery truck drivers hold appropriate licenses.

21. Staff recommends that HRI's cultural resources specialist consult with traditional practitioners of both the Crownpoint and Church Rock chapters to ascertain whether specific ceremonies or blessings are in order. Based on these consultations, the cultural resource specialist should identify ceremonies that must be facilitated (through funding and access to the site) by HRI.

22. HRI shall develop and implement a final cultural resources management plan for all mineral operating lease areas and other land affected by licensed activities, pursuant to the National Historic Preservation Act Section 106 review and consultation process. The plan will provide specific procedures to implement HRI's policy of avoiding cultural resources. The plan shall include archaeological and traditional cultural property surveys of all lease areas, identification of protection areas where human activity will be prohibited, archaeological testing (by an archaeologist contracted to HRI and holding appropriate permits from the Navajo Nation and the State of New Mexico) before subsurface disturbance occurs at a specific location, and archaeological monitoring during all ground disturbing construction, drilling, and operation activities. In the event that previously unidentified cultural resources or human remains are discovered during project activities, the activity in the area will cease, appropriate protective action and consultation shall be conducted, and, if indicated, the artifacts or human remains will be evaluated for their significance.

# HRI, Inc.

2929 Coors Road, NW - Suite 101 Albuquerque, NM 87120-2929
505-833-1777 Voice 505-833-0777 Fax

26 December 1996

Mr. Joseph J. Holonich
High Level Waste & Uranium
Recovery Projects Branch
Division of Waste Management
NMSS (T-7-J9)
Nuclear Regulatory Commission
11545 Rockville Pike
Rockville, MD 20850

Dear Mr. Holonich

This letter is written in response to your letter of December 20, 1996, whereby you requested our concurrence on several points of requirements and recommendations determined to be important by the NRC staff for licensing our Churchrock and Crownpoint projects.

With this letter, Hydro Resources, Inc., (HRI) accepts these requirements and conditions. Additionally, to the extent possible, HRI will plan on implementing these objectives outlined in the NRC staff recommendations in its operating plan.

Sincerely,

HYDRO RESOURCES, INC. (HRI)

Richard F. Clement, Jr.
President

cc: Tony Thompson - Shaw, Pittman, Potts & Trowbridge
Mark Pelizza - HRI

# APPENDIX C

## SECTION 106 (NATIONAL HISTORIC PRESERVATION ACT) CONSULTATION

## C.1 INTRODUCTION

This appendix contains copies of the letters the NRC staff sent to the New Mexico State Historic Preservation Officer, the Navajo Nation Historic Preservation Division, and Federal agencies and interested parties in compliance with provisions requiring consultation under Section 106 of the National Historic Preservation Act (the attachments to the letters are available in the HRI project document file located in the NRC Public Document Room, Washington, D.C.). As discussed in the letters and in Section 3.9 of this FEIS, the Section 106 review process would continue throughout the life of the proposed project.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 2, 1996

Dr. Phillip Shelley
New Mexico State Historic Preservation Officer
Historic Preservation Division (ATTN: Lynne Sebastian)
228 E Palace Avenue
Santa Fe, New Mexico 87501

SUBJECT: NATIONAL HISTORIC PRESERVATION ACT (SECTION 106) SUPPORT REQUEST FOR HYDRO RESOURCES, INC. CROWNPOINT, NM PROJECT

Dear Dr. Shelley:

The purpose of this letter is to request the assistance of the New Mexico State Historic Preservation Office (NMSHPO) in determining whether the proposed Hydro Resources, Inc. (HRI) in situ leach (ISL) mining project would affect properties eligible for, or listed on the National Register of Historic Places, pursuant to Section 106 of the National Historic Preservation Act (NHPA) of 1966 (as amended through 1992).

The U.S. Nuclear Regulatory Commission (NRC) staff is reviewing a license application submitted by HRI to construct and operate ISL facilities for mining uranium in the vicinity of Crownpoint, NM. Three specific sites would be mined - Church Rock, Unit 1, and Crownpoint (see Attachment A). Initial uranium production would occur at satellite processing facilities which HRI proposes to construct at the Church Rock and Unit 1 sites. Uranium slurry would then be shipped by truck from these satellite facilities to HRI's existing central processing facility at Crownpoint. This proposed activity is described in detail in Attachment B to this letter.

In consultation with Ms. Lynne Sebastian of your staff, NRC is providing information in Attachments C and D that will encompass the first five years of HRI's license term. The proposed overall project includes a large area of land and phased development over a 20-year period. NMSHPO has expressed a preference for evaluating this project incrementally. The development area and buffer zones, which include monitoring wells and peripheral disturbance areas, are hereafter referred to as the five-year project area.

The first step in the NHPA Section 106 process is determining whether the project area contains any sites, structures, or properties listed on or potentially eligible for listing on the National Register. HRI has taken initial steps to identify any of these locations in the five-year project area. A cultural resources consultant to HRI has drafted cultural resource management plans for the Crownpoint (see Attachment E), Unit 1 (see Attachment F), and Church Rock sites (see Attachment G). These plans identify areas within the project area that have previously been subjected to archaeological survey, and archaeological sites that were identified in the course of surveying. A complete bibliography of known archaeological survey reports and management reports is included as Attachment H. However, two shortcomings exist. First, not all of the area has been surveyed for archaeological resources (see Attachments C and D, which compare the five-year project area to the areas surveyed for archaeological resources). Second, no previous survey work in the project area has attempted to identify traditional cultural properties that are potentially eligible for the National Register.

To remedy the first shortcoming, HRI has committed in its cultural resource management plans to survey all property within its lease area, including verification of previously identified sites. An archaeological research firm, licensed by the state and the Navajo Nation, and who is under contract to HRI, will conduct a Phase I (or Class III, in BLM terms) archaeological survey of those parts of the five-year area that have not previously been surveyed. The survey of Section 12 T17N R13W and the 1977 survey of the Church Rock area (Ford and DeHoff 1977) are suspected to be inadequate. Therefore, the contractor will resurvey these areas with the exception of the southeastern quarter of Section 8 at the Church Rock site, which already has been resurveyed. The contractor also will verify and define the boundaries of sites that were identified in the resurvey of this quarter section, and all other areas within the five-year project area that have been previously surveyed. Attachments C and D indicate the areas that will be surveyed, resurveyed, and those that will be verified. Results of these surveys will be reviewed by the NRC and provided to your office. HRI has also committed, in its cultural resource management plans and in subsequent communications, to a "total avoidance" plan (i.e., all activities would be located so as to avoid any archaeological site).

Steps to remedy the second shortcoming, the absence of information about traditional cultural properties, are currently underway. As the National Environmental Policy Act (NEPA) review process is proceeding ahead of the NHPA Section 106 process, HRI's cultural resource consultant has sought preliminary information about traditional cultural properties from local tribes and pueblos, which are: the Navajo, the Hopi, the Zuni, the Laguna, the Acoma, and the All Indian Pueblo Council. A letter report summarizing the preliminary information received from these parties will be submitted to your office when it is completed. A thorough follow-up of the preliminary information will be conducted by experienced, local ethnographers in conjunction with the archaeological survey work. Cultural resource specialists of some of the aforementioned tribes and pueblos have indicated that the additional archaeological surveys may provide information about traditional cultural properties in the area. Therefore, the final information and report about traditional cultural properties will depend on, and likely be done in conjunction with, the archaeological resources report.

HRI's proposed policy of total avoidance of archaeological resources should preclude the disturbance of human remains. Nevertheless, there is a slight possibility that human remains would be encountered during ground-breaking or ground-disturbing activities. Such finds will be handled on a case-by-case basis through the implementation procedures of the appropriate law, either the federal Native American Graves Protection and Repatriation Act on Indian lands or the New Mexico state law protecting human burials on other lands.

Through the NEPA public scoping process and subsequent cultural resource information collection efforts, some groups already have expressed a desire to be involved as interested parties in the NHPA Section 106 review process. These groups are the Navajo Nation, the Hopi Tribe, and the Pueblo of Zuni. In addition, the Pueblos of Acoma and Laguna, the All Indian Pueblo Council, the Bureau of Land Management, the Bureau of Indian Affairs, and the Navajo Crownpoint and Church Rock Chapter Houses will be notified of the initiation of this review process.

NRC would appreciate a response to this letter from NMSHPO that would include, as necessary, any direction or advice about advancing the review process, and comments about the planned or on-going survey work. If you have any questions concerning this subject, please contact Mr. Robert Carlson of my staff at (301) 415-8165.

Sincerely,

Daniel M. Gillen

Daniel M. Gillen, Acting Chief
Uranium Recovery Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Attachments: As stated

cc: M. Pelizza, HRI (w/o attach. E,F,G)

UNITED STATES
**NUCLEAR REGULATORY COMMISSION**
WASHINGTON, D.C. 20555-0001

October 2, 1996

Federal Agencies and Interested Parties
on the Enclosed List

SUBJECT: NATIONAL HISTORIC PRESERVATION ACT (SECTION 106) SUPPORT REQUEST FOR HYDRO RESOURCES, INC. CROWNPOINT, NM PROJECT

Dear Ladies and Gentlemen:

The U.S. Nuclear Regulatory Commission (NRC) is reviewing a license application submitted by Hydro Resources, Inc. (HRI) to construct and operate facilities for *in situ* leach uranium mining in the vicinity of Crownpoint, NM. You have either expressed interest, or the NRC has determined that you may have an interest in the consultations being conducted for the Section 106 review process of the National Historic Preservation Act of 1966, as amended. Please see the enclosed letter to the New Mexico State Historic Preservation Officer initiating the Section 106 review process.

Thank you for your interest. We will keep you informed as the review process proceeds. If you have any questions concerning this subject, please contact Mr. Robert Carlson of my staff at (301) 415-8165.

Sincerely,

Daniel M. Gillen

Daniel M. Gillen, Acting Chief
Uranium Recovery Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosures: As stated

# Interested Parties

Allen Downer
Navajo Nation Historic Preservation Department
P.O. Box 4950
Window Rock, AZ 86515

(ATTN: Peter Noyes)

Roger Anyon, Director
Pueblo of Zuni Heritage and Historic Preservation Office
P.O. Box 339
Zuni, NM 87327

Leigh Jenkins, Director
Hopi Cultural Preservation Office
P.O. Box 123
Kykotsmovi, AZ 86039

Ron Shutiva, Governor
Pueblo of Acoma
P.O. Box 309
Acoma, NM 87304

Roland Johnson, Governor
Pueblo of Laguna
P.O. Box 194
Laguna Pueblo, NM 87026

Roy Bernal, Chairman
All Pueblo Indian Council
3939 San Pedro NE
Albuquerque, NM 87190

(ATTN: Terrell Muller)

Joe Incarding, Chief
Lands and Minerals
Bureau of Land Management
435 Montano, NE
Albuquerque, NM 87107

Enclosure 1

Jenni Denetsone, Area Realty Officer
Bureau of Indian Affairs
Navajo Area Office
Real Estate Services
P.O. Box 1060
Gallup, NM 87305-1060

Charles Long, President
Crownpoint Chapter, Navajo Nation
P.O. Box 336
Crownpoint, NM 87313

Ernest Becenti, President
Churchrock Chapter, Navajo Nation
P.O. Box 549
Churchrock, NM 87311

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001
January 31, 1997

Dr. Alan S. Downer
Navajo Nation Historic Preservation
Department (ATTN: Peter Noyes)
Box 4950
Window Rock, Arizona 86515

SUBJECT: HYDRO RESOURCES, INC. SOLUTION MINING PROJECT AT CROWNPOINT, NM

Dear Dr. Downer:

The U.S. Nuclear Regulatory Commission (NRC) is reviewing a license application submitted by Hydro Resources, Incorporated (HRI) to construct and operate an *in situ* leach uranium mining facility near Crownpoint, New Mexico. Three separate sites, Church Rock, Unit 1, and Crownpoint, would be mined under this license. Initial uranium processing would occur at satellite processing facilities HRI proposes to construct at the Church Rock and Unit 1 sites. Uranium slurry would be shipped by truck from these satellite facilities to HRI's existing central processing facility in Crownpoint. Much of the proposed project area is Tribal trust land and allotted land. The proposed activity is described in detail in Attachments A and B to this letter.

You were previously notified of this proposed activity, and of NRC's consultation with the New Mexico State Historic Preservation Office (SHPO) regarding the proposed activity. With that notification, you received a detailed project description, maps, and a bibliography. Pursuant to Section 106 of the National Historic Preservation Act (NHPA) of 1966 (as amended through 1992), the Navajo Nation Cultural Resources Protection Act, and to your role as contract agent for the Bureau of Indian Affairs, the NRC requests consultation with the Navajo Nation Historic Preservation Department. It is our understanding that Navajo Nation Tribal Code (specifically, the Navajo Nation Cultural Resources Protection Act) requires approval by the Navajo Nation Preservation Officer of activities occurring on Navajo Tribal lands.

Also, through preliminary consultation with your staff, we have been informed that you are in possession of a letter of approval from the U.S. National Park Service allowing you to act as the SHPO for Navajo lands. Therefore, we are aware of the possibility that you could assume SHPO activities sometime during the Section 106 consultation process. It is our understanding that because consultation under Tribal code would be consistent with Section 106 consultation, no additional consultation (for Section 106 purposes) would be required in the event that you assume SHPO activities before the project's implementation. Because the NRC is the lead agency for this project, we will continue consultation with the New Mexico SHPO during the interim period.

The license term for the proposed activity would be 20 years. Because the project is to be developed incrementally, the project's potential area of disturbance is vast, and the research methodologies and interpretations could change during the proposed license term, the NRC proposes that this review be limited to the area proposed for development in the first five years of HRI's license term. The development area, including the buffer area added for monitoring wells and peripheral disturbance, is hereafter referred to as the five-year project area (please see Attachments C and D of your initial project notification letter).

Because the first step in this review process is determining whether the project area contains any sites, structures, or properties listed on or potentially eligible for listing on the National Register of Historic Places and the Navajo Nation Register of Cultural Properties and Cultural Landmarks, NRC and HRI have taken initial steps in identifying resources in the project area. A cultural resources consultant to HRI has drafted cultural resource management plans for the Crownpoint, Unit 1, and Church Rock sites (See Attachments E, F, and G). These plans identify areas within the project area that have previously been subjected to archaeological survey, and archaeological sites that were identified in the course of surveying. However, two shortcomings exist. First, not all of the area has been surveyed for archaeological resources. Second, no previous survey work in the project area has attempted to identify traditional cultural properties that are potentially eligible for the Register.

To remedy the first shortcoming, HRI has committed in its cultural resource management plans to survey all property within its lease area, including verification of previously identified sites. An archaeological research firm, licensed by the state and the Navajo Nation and under contract to HRI, will conduct a Phase I (or Class III, in BLM terms) archaeological survey of those parts of the five-year area that have not been previously surveyed. The survey of Section 12 T17N R13W and the 1977 survey of the Church Rock area (Ford and DeHoff 1977) are suspected to be inadequate. Therefore, the contractor will resurvey these areas , with the exception of the SE 1/4 of Section 8 at the Church Rock site, which already has been re-surveyed. Also, the contractor will verify and define the boundaries of sites that were identified in the re-survey of this 1/4 section and all other areas within the five-year project area that have been previously surveyed. Attachments C and D indicate the areas that will be surveyed, those that will be resurveyed, and those that will be verified. Results of these surveys will be reviewed by the NRC and provided to your office. HRI has also committed, in its cultural resource management plans and in subsequent communications, to a "total avoidance" plan (i.e., all activities would be located so as to avoid any archaeological site).

Steps to remedy the second shortcoming - the absence of information about traditional cultural properties - are currently underway. As the National Environmental Policy Act (NEPA) review process is proceeding ahead of the NHPA Section 106 process, HRI's cultural resource consultant has sought preliminary information about traditional cultural properties from the following local tribes and pueblos: the Navajo, the Hopi, the Zuni, the Laguna, the Acoma, and the All Indian Pueblo Council. A letter report summarizing the preliminary information received from these parties will be submitted to your office when it is completed. A thorough follow-up of the preliminary information will be conducted by experienced, local ethnographers in conjunction with the archaeological survey work. Cultural resource specialists of some of the aforementioned tribes and pueblos have indicated that the additional archaeological surveys may provide information about traditional cultural properties in the area. Therefore, the final information and report about traditional cultural properties will depend on and likely be done in conjunction with the archaeological resources report.

HRI's proposed policy of total avoidance of archaeological resources should preclude the disturbance of human remains. Nevertheless, there is a slight possibility that human remains would be encountered during ground-breaking or ground-disturbing activities. Such finds will be handled on a case-by-case basis through the implementation procedures of the appropriate law, either the federal Native American Graves Protection and Repatriation Act and the Navajo Nation Policies and Procedures Concerning the Protection of Cemeteries, Gravesites and Human Remains on Indian lands, or the New Mexico state law protecting human burials on other lands.

As noted above, the NHPA Section 106 review process already is underway with the New Mexico SHPO. Parties, in addition to the Navajo Nation, that have been informed of the initiation of the Section 106 process are the Hopi Tribe, the Pueblo of Zuni, the Pueblo of Acoma, the Pueblo of Laguna, the All Indian Pueblo Council, the Bureau of Land Management, the Bureau of Indian Affairs, and the Navajo Crownpoint and Church Rock Chapter Houses.

NRC would appreciate a response to this letter from your office that would include, as necessary, any direction or advice about advancing the review process and comments about the intended or ongoing survey work.

If you have any questions concerning this subject, please contact Mr. Robert Carlson of my staff at (301) 415-8165.

Sincerely,

Joseph J. Holonich, Chief
Uranium Recovery Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosures: As stated

cc: See attached list (w/o encl.)

List of Addressees:

Mark Pelizza
Hydro Resources, Inc.
2929 Coors Blvd., NW
Suite 101
Albuquerque, NM 87120

Roger Anyon, Director
Pueblo of Zuni Heritage and Historic Preservation Office
P.O. Box 339
Zuni, NM 87327

Leigh Jenkins, Director
Hopi Cultural Preservation Office
P.O. Box 123
Kykotsmovi, AZ 86039

Ron Shutiva, Governor
Pueblo of Acoma
P.O. Box 309
Acoma, NM 87304

Roland Johnson, Governor
Pueblo of Laguna
P.O. Box 194
Laguna Pueblo, NM 87026

Roy Bernal, Chairman
All Pueblo Indian Council (ATTN: Terrell Muller)
3939 San Pedro NE
Albuquerque, NM 87190

Joe Incarding, Chief
Lands and Minerals
Bureau of Land Management
435 Montano, NE
Albuquerque, NM 87107

Jenni Denetsone, Area Realty Officer
Bureau of Indian Affairs
Navajo Area Office
Real Estate Services
P.O. Box 1060
Gallup, NM 87305-1060

Charles Long, President
Crownpoint Chapter, Navajo Nation
P.O. Bx 336
Crownpoint, NM 87313

Ernest Becenti, President
Churchrock Chapter, Navajo Nation
P.O. Box 549
Churchrock, NM 87311

# THE NAVAJO NATION

ALBERT A. HALE
PRESIDENT

THOMAS E. ATCITTY
VICE PRESIDENT

October 31, 1996

Daniel M. Gillen, Acting Chief
Uranium Recovery Branch, Division of Waste Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Attention: Robert Carlson

*RE: NHPA § 106 Process for Hydro Resources, Inc. In Situ Leach Mining Project in Crownpoint and Church Rock, McKinley County, New Mexico (HPD-91-633.1).*

Dear Mr. Gillen:

The Cultural Resource Compliance Section (CRCS) of the Navajo Nation Historic Preservation Department (NNHPD) has received and reviewed a copy of a letter from the Nuclear Regulatory Commission (NRC) to the New Mexico State Historic Preservation Officer regarding the National Historic Preservation Act (NHPA) § 106 process for the Hydro Resources, Inc. (HRI). HRI's proposed undertaking involves construction and operation of facilities for an in situ uranium leaching in the vicinity of Crownpoint and Church Rock, McKinley County, New Mexico. The proposed overall project includes a large area of land and phased development would occur over a 20-year period. We understand that NRC will serve as lead federal agency for compliance with § 106 and that NRC proposes to conduct that compliance based on anticipated activities included in 5-year development plans. We have received and reviewed the first 5-year area plan. We agree that incremental review of accurate five-year plans is appropriate.

NNHPD's approved plan for assumption of State Historic Preservation Officer functions pursuant to 16 U.S.C. 470 § 101 (d)(2) et seq. is in the Navajo Nation's SAS process for review and approval. NNHPD will be flexible about the SHPO's role for consultation purposes. However, undertakings occurring on Navajo Tribal lands (Trust, Allotment, and Tribal Fee) shall comply with and be authorized to proceed by written approval pursuant to the Navajo Nation Cultural Resources Protection Act (19 N.N.C. 1001 et seq.).

We agree that not all areas of the proposed undertaking have been surveyed for cultural resources or traditional cultural properties or places. NHPA states that "[p]roperties of traditional religious and cultural importance to an Indian Tribes or Native Hawaiian organization may be determined to be eligible for inclusion on the National Register" [16 U.S.C. 470 § 101(d)(6)(A)]. We note that some progress on TCP identification efforts have taken place and CRCS will review the report on Navajo TCPs when it arrives. As outlined in the Navajo Nation Policy to Protect Traditional Cultural Properties, these steps involve 1) consulting the available literature, 2) contacting representatives of the Navajo Nation chapters most likely to be concerned about the project (normally in those in which the project is located, or, if the project is outside any chapter area, those that are nearest, 3) interviewing Navajo residents and land users in or near your project area, and 4) interviewing other knowledgeable people as recommended by chapter officials and local residents or land users. Further, 5) interviews must also take place with **Navajo traditional practitioners** in an attempt to identify those areas of concern to the Navajo people.

NNHPD agrees that a cultural resources inventory is necessary for all the property within HRI's lease area, including verification and updating previously identified historic properties or archaeological sites that may have been inadequately documented. Additionally, the "Area of Potential Effect" (APE) may include areas outside HRI's lease area, since the proposed undertaking may have effects that may diminish the integrity of the property's location, setting, feeling or association by introducing visual, audible, or atmospheric elements that are out of character and/or altering the setting of the property located outside the lease area. As the Lead Agency, all determination of effects on historic properties identified will be made by the Nuclear Regulatory Commission (NRC) in consultation with this office. The identification efforts will be conducted by HRI's archaeological contractor and will be conducted within the 5-year lease area.

Finally, if human remains are discovered during the course of project implementation or ground disturbing activities, all operations within the vicinity of the discovery shall cease and NNHPD shall be notified. We agree that when human remains are discovered, such finds will be handled on a case-by-case basis and the appropriate law will be implemented (Native American Graves Protection and Repatriation Act on Federal and Indian lands; N.M.S.A. § 18-6-11.2 on private or state lands). If human remains found on Navajo Nation lands, the "Navajo Nation Policy for the Protection of Jishchaa', Human Remains, and Funerary Items" will be followed. In all cases, NNHPD shall be consulted on the appropriate treatment and disposition of human remains discovered. If you have any questions regarding this matter, please call Rolf J. Nabahe or Peter T. Noyes at (520) 871-7132.

Sincerely,

Alan S. Downer, Director
Navajo Nation Historic Preservation Department
P.O. Box 4950
Window Rock, Arizona 86515

xc: Susan Schexnayder-Oak Ridge National Laboratory
Mark S. Pelizza-Hydro Resources, Inc.
Lorraine Heartfield-Stratigraphic Services. S.A.
Lynne Sebastian-NMSHPO
Charles Long, President-Crownpoint Chapter
Ernest Bencenti, President-Church Rock Chapter
file
desk

# APPENDIX D

## SECTION 7 (ENDANGERED SPECIES ACT) CONSULTATION

# D.1 INTRODUCTION

This appendix contains copies of the letters the NRC staff sent to the U.S. Fish and Wildlife Service and the New Mexico Department of Game and Fish in compliance with provisions requiring consultation under Section 7 of the Endangered Species Act (the enclosures that accompanied the letters are available in the HRI project document file located in the NRC Public Document Room, Washington, D.C.). This appendix also contains preliminary responses from both the U.S. Fish and Wildlife Service and the New Mexico Department of Game and Fish.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 24, 1996

Ms. Jennifer Fowler-Propst, Field Supervisor
U.S. Fish and Wildlife Service
New Mexico Ecological Field Services Office
2105 Osuna NE
Albuquerque, NM 87113

SUBJECT: INFORMATION REQUEST ON PROTECTED PLANT AND ANIMAL SPECIES

Dear Ms. Fowler-Propst:

The U.S. Nuclear Regulatory Commission (NRC) is preparing an environmental impact statement (EIS) on Hydro Resources, Inc.'s (HRI) license application to conduct solution mining for uranium at the proposed Crownpoint, NM project site. The EIS is scheduled to be complete in December 1996. As part of the environmental assessment being conducted on this project, the NRC staff is requesting any information regarding listed, proposed, and candidate endangered or threatened species.

The Crownpoint project consists of three separate sites. These individual sites are Church Rock, Unit 1, and Crownpoint. The locations of the proposed sites are shown on the enclosed map.

Also enclosed is an NRC conducted plant and animal literature assessment of the project area. This was performed as a supplement to HRI's plant and animal site survey of the project area. Based on this information, the NRC staff currently has no reason to expect any such plant or animal species to be adversely affected on or near the site. However, the NRC would appreciate any information or concerns you might have regarding effects of this planned mining project on listed, proposed, or candidate endangered and threatened species, as well as any other sensitive-species concerns.

If you have any questions concerning this subject, please contact Mr. Robert Carlson of my staff at (301) 415-8165. Thank you for your prompt assistance on this matter.

Sincerely,

Daniel M. Gillen

Daniel M. Gillen, Assistant Chief
Uranium Recovery Projects Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosures: As stated

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 24, 1996

Mr. Jerry Maracchini, Director
New Mexico Department of Game and Fish
Villagra Building
Sante Fe, NM 87504

SUBJECT: INFORMATION REQUEST ON PROTECTED PLANT AND ANIMAL SPECIES

Dear Mr. Maracchini:

The U.S. Nuclear Regulatory Commission (NRC) is preparing an environmental impact statement (EIS) on Hydro Resources, Inc.'s (HRI) license application to conduct solution mining for uranium at the proposed Crownpoint, NM project site. The EIS is scheduled to be complete in December 1996. As part of the environmental assessment being conducted on this project, the NRC staff is requesting any information regarding listed, proposed, and candidate endangered or threatened species.

The Crownpoint project consists of three separate sites. These individual sites are Church Rock, Unit 1, and Crownpoint. The locations of the proposed sites are shown on the enclosed map.

Also enclosed is an NRC conducted plant and animal literature assessment of the project area. This was performed as a supplement to HRI's plant and animal site survey of the project area. Based on this information, the NRC staff currently has no reason to expect any such plant or animal species to be adversely affected on or near the site. However, the NRC would appreciate any information or concerns you might have regarding effects of this planned mining project on listed, proposed, or candidate endangered and threatened species, as well as any other sensitive-species concerns.

If you have any questions concerning this subject, please contact Mr. Robert Carlson of my staff at (301) 415-8165. Thank you for your prompt assistance on this matter.

Sincerely,

Daniel M. Gillen

Daniel M. Gillen, Assistant Chief
Uranium Recovery Projects Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosures: As stated

GOVERNOR
Gary E. Johnson

DIRECTOR AND SECRETARY
TO THE COMMISSION
Gerald A. Maracchini

STATE OF NEW MEXICO

**DEPARTMENT OF GAME & FISH**

Villagra Building
P.O. Box 25112
Santa Fe, NM 87504

Visit our Web Site home page at http://gmfsh.state.nm.us
For basic information or to order free publications: 1-800-862-9310



November 26, 1996

Mr. Daniel M. Gillen, Assistant Chief
Uranium Recovery Projects Branch
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Mr. Gillen:

The New Mexico Department of Game and Fish responded on November 7 to your letter of October 24, 1996. Your letter described the preparation of an EIS to address uranium mining at three sites in McKinley County, New Mexico. Mr. Robert Carlson, of your agency, called yesterday, informing me that our response had not been received. This is a new response to your request.

Although, we do not disagree with the provided list of special status species, due to staff limitations, site specific surveys of project areas to obtain base-line data are the responsibility of proponent agencies. The Zuni bluehead (mountain) sucker, Catostomus discobolus yarrowi, occurs in the Zuni River watershed, however, it is not expected on your project area. We are enclosing a list of endangered, threatened, and candidate species that may occur in McKinley County. We hope this information is useful to you.

Based upon the provided information, we can make no further evaluation of the potential for impacts from this project upon wildlife resources. We look forward to the opportunity to review the DEIS. If you have any questions, please call Bob Wilson of my staff at (505) 827-7827.

Sincerely,

Andrew V. Sandoval

Andrew V. Sandoval, Chief
Conservation Services Division

AVS/BW/ia

xc: Jennifer Fowler-Propst (Ecological Services Supr., USFWS)
Dan Pursley (Northwest Area Operations Chief, NMGF)
Jim Bailey (Asst. Cons. Services Division Chief, NMGF)
Bob Wilson (Habitat Specialist, NMGF)

# NEW MEXICAN WILDLIFE
# of
# SPECIAL CONCERN

# * BY COUNTY *

October 29, 1996

**INCLUDES SPECIES THAT ARE:**

STATE THREATENED & ENDANGERED †

FEDERAL THREATENED, ENDANGERED & CANDIDATE

EXTIRPATED IN EACH COUNTY

| TABLE HEADING | LEGAL STATUS |
|---|---|
| FEDERAL END. | Federal Endangered |
| FED. THREAT. | Federal Threatened |
| PROP. CAND. | Federal Proposed Endangered (PE) & Federal Candidate (C) |
| Prev. C2 ‡ | previously federal candidate category 2 (Of concern but provides no legal standing) |
| STATE END. | State Endangered |
| STATE THREAT. | State Threatened |

† Note: The New Mexico list of threatened and endangered species has not been modified with new information since 1990. This list may contain species extirpated from the state, species non-native to the state, and species whose classification as threatened or endangered may be outdated. In addition, the list does not include some species that are rare in New Mexico.

‡ The Prev. C2 category is no longer an official federal category. This information is provided to alert users that the status of these species is uncertain and justifies concern and caution.

# COMPLETE SPECIES ACCOUNTS

Information pertaining to taxonomy, status, distribution, habitat, environmental association, food habits and management practices for any vertebrate or high profile invertebrate in New Mexico is available from:

Internet / World Wide Web

**htt://www.fw.vt.edu.fishex/states/nm.htm**

or

Jon Klingel
Conservation Services Division
New Mexico Department of Game & Fish
P.O. Box 25112
Santa Fe, New Mexico 87504

voice:505-827-9912
fax:505-827-9956
e-mail:j_klingel@gmfsh.state.nm.us

## THREATENED, ENDANGERED, PROPOSED & CANDIDATE WILDLIFE: McKinley County, New Mexico

| Common Name............................ | SCIENTIFIC NAME.................................. | FEDERAL END. | FED.... THREAT. | PROP. CAND. | Prev.. C2... | STATE END. | STATE.. THREAT. |
|---|---|---|---|---|---|---|---|
| Zuni Bluehead Sucker | Catostomus discobolus jarrovi | - | - | - | X | X | - |
| White-faced Ibis | Plegadis chihi | - | - | - | X | - | - |
| Bald Eagle | Haliaeetus leucocephalus | - | X | - | - | - | X |
| Northern Goshawk | Accipiter gentilis | - | - | - | X | - | - |
| Ferruginous Hawk | Buteo regalis | - | - | - | X | - | - |
| American Peregrine Falcon | Falco peregrinus anatum | X | - | - | - | X | - |
| Arctic Peregrine Falcon | Falco peregrinus tundrius | - | - | - | - | X | - |
| Black Tern | Chlidonias niger | | | | X | | |
| Burrowing Owl | Speotyto cunicularia hypugaea | - | - | - | X | - | - |
| Mexican Spotted Owl | Strix occidentalis lucida | - | X | - | - | - | - |
| Southwestern Willow Flycatcher | Empidonax traillii extimus | X | - | - | - | - | X |
| Gray Vireo | Vireo vicinior | - | - | - | - | - | X |
| Occult Little Brn. Myotis Bat | Myotis lucifugus occultus | - | - | - | X | - | - |
| Long-eared Myotis Bat | Myotis evotis | - | - | - | X | - | - |
| Fringed Myotis Bat | Myotis thysanodes | - | - | - | X | - | - |
| Long-legged Myotis Bat | Myotis volans | - | - | - | X | - | - |
| Western Small-footed Myotis Bat | Myotis ciliolabrum | - | - | - | X | - | - |

## NATIVE WILDLIFE APPARENTLY NO LONGER OCCURRING IN McKINLEY COUNTY

| | | |
|---|---|---|
| Roundtail Chub | Gila robusta | (federal endangered; NM threatened) |
| Bonytail Chub | Gila elegans | (extirpated from NM; federal endangered) |
| Golden Shiner | Notemigonus crysoleucas | |
| Grizzly Bear | Ursus arctos | (extirpated from NM; federal threatened) |
| Gray Wolf | Canis lupus | (extirpated from NM; federal endangered) |
| Black-footed Ferret | Mustela nigripes | (extirpated from NM; federal endangered) |

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New Mexico Ecological Services Field Office
2105 Osuna NE
Albuquerque, New Mexico 87113
Phone: (505) 761-4525 Fax: (505) 761-4542

January 7, 1997

Cons. #2-22-94-I-126
Cons. #2-22-96-I-028

Daniel M. Gillen, Assistant Chief
Uranium Recovery Projects Branch
Division of Waste Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Mr. Gillen:

This responds to your October 24, 1996, letter requesting concurrence that the proposed Crown Point Project will not adversely affect any federally listed endangered or threatened species, or their designated critical habitat, in the project area. The project proposes to conduct solution mining for uranium at the Crown Point project sites in McKinley County, New Mexico. This letter also reflects the discussions of our teleconference on this date with Messrs. Alan Eggleston and Mark Paliza concerning the information provided in the October 24, 1996, transmittal.

Comments generated by this office on the October 1994 Draft EIS were included in the January 30, 1995, letter of comment from the Department of the Interior's Regional Environmental Officer to the Nuclear Regulatory Commission. The Preliminary Draft Final EIS did not contain responses to those comments. Therefore, this letter will address only the review of the information on protected plant and animal species provided in your October 24, 1996, letter and not the EIS. As we discussed during today's teleconference, the background information furnished on October 24, 1996, does not provide sufficient data upon which the Service can concur with the conclusions reached in that letter.

Some of the information included appears dated, i.e. "...no confirmed sightings of the bird [bald eagle] in McKinley County as of 1978"; and an unoccupied prairie dog town was reported in 1978. Although the specific prairie dog town observed in 1978 was visited and still unoccupied in 1995, no information is provided to explain if a survey was conducted as part of the site visit or if any other portions of the proposed project area have been surveyed since 1978. For a more complete record upon which to base a decision, we recommend that information on protected species (some of which is almost 20 years old) be updated. Also, some information appears incomplete, i.e. "The spotted owl [Mexican] is found in suitable forested habitat (e.g., closed canopy forest in canyons and riparian zones) ..." While this statement is true, the owl also occupies rocky, open canyons with mixed, sparse vegetation, such as pinon and juniper, which do occur in or near the proposed project sites. We also recommend that any surveys conducted be inclusive of the area of project impacts. Such impacts may extend beyond the boundaries of the immediate action area.

An updated list of endangered, threatened, and candidate species, and species of concern that may be found in the county where the proposed project is located is enclosed. Under the Endangered Species Act (Act), it is the responsibility of the Federal action agency or its designated representative to determine whether the proposed action "may affect" any listed or proposed species.

Candidates are those species for which the Service has sufficient information on their biological status and threats to propose them as endangered or threatened, but for which issuance of a proposed rule is precluded by work on higher priority species. Species of concern include those for which further biological research and field study are needed to resolve their conservation status. Candidate species and species of concern have no legal protection under the Act and are included in this document for planning purposes only. However, the Service is concerned and would appreciate receiving any status information that is available or gathered on these species.

The Service recognizes that there are few legal requirements to apply conservation measures towards species of concern. However, the western burrowing owl is a species of concern that may occur in or near your project area. These small owls are opportunists when it comes to locating roosting or nesting burrows. Western burrowing owls are generally found in open habitats, particularly in association with burrowing mammals, and often in proximity to human activity. Biological as well as construction personnel should be alerted to the potential presence of this species, since conservation measures may be taken to prevent harm to the individual burrowing owls, as well as preventing delays to projects. Proactive conservation for the western burrowing owl may help prevent the need for future listing.

We appreciate the opportunity to provide input to the planning of this proposal. With respect to further discussions on the types of data needed to fully address assessment of impacts on protected species and their habitats, we look forward to continuing working with you.

We suggest you contact the Navajo Nation Fish and Wildlife Department, New Mexico Department of Game and Fish and the New Mexico Energy, Minerals, and Natural Resources Department, Forestry and Resources Conservation Division for information concerning fish, wildlife, and plants of Tribal or State concern.

If we can be of further assistance, please contact this office at (505) 761-4525.

Sincerely,

Jennifer Fowler-Propst
Field Supervisor

Enclosure

cc: (wo/enc)
Director, New Mexico Department of Game and Fish, Santa Fe, New Mexico
Director, Navajo Nation Fish and Wildlife Department, Window Rock, Arizona
Director, New Mexico Energy, Minerals, and Natural Resources Department, Forestry and Resources Conservation Division, Santa Fe, New Mexico

Threatened, Endangered, and Candidate Species, and Species of Concern
McKinley County, New Mexico

January 7, 1997

McKinley

Black-footed ferret, Mustela nigripes, E
Fringed myotis, Myotis thysanodes, SC
Long-eared myotis, Myotis evotis, SC
Long-legged myotis, Myotis volans, SC
Occult little brown bat, Myotis lucifugus occultus, SC
Small-footed myotis, Myotis ciliolabrum, SC
Spotted bat, Euderma maculatum, SC
American peregrine falcon, Falco peregrinus anatum, E
Arctic peregrine falcon, Falco peregrinus tundrius, T (S/A)
Bald eagle, Haliaeetus leucocephalus, T
Black tern, Chlidonias niger, SC
Ferruginous hawk, Buteo regalis, SC
Loggerhead shrike, Lanius ludovicianus, SC
Mexican spotted owl, Strix occidentalis lucida, T w/CH
Northern goshawk, Accipiter gentilis, SC
Southwestern willow flycatcher, Empidonax traillii extimus, E w/PCH
Western burrowing owl, Athene cunicularia hypugea, SC
White-faced ibis, Plegadis chihi, SC
Zuni bluehead sucker, Catostomus discobolus yarrowi, SC
Acoma fleabane, Erigeron acomanus, SC
Arizona leatherflower, Clematis hirsutissima var. arizonica, C
Goodding's onion, Allium gooddingii, C
Parish's alkali grass, Puccinellia parishii, PE
Sivinski's fleabane, Erigeron sivinskii, SC
Zuni (=rhizome) fleabane, Erigeron rhizomatus, T

Index

| | | |
|---|---|---|
| E | = | Endangered |
| PE | = | Proposed Endangered |
| PE w/CH | = | Proposed Endangered with critical habitat |
| T | = | Threatened |
| 1PT | = | Proposed Threatened |
| PT w/CH | = | Proposed Threatened with critical habitat |
| PCH | = | Proposed critical habitat |
| C | = | Candidate Species |
| SC | = | Species of Concern |
| S/A | = | Similarity of Appearance |
| * | = | Introduced population |

# APPENDIX E

# COOPERATING AGENCY CONCURRENCE LETTERS

# United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Rio Puerco Resource Area
435 Montano N.E.
Albuquerque, New Mexico 87107


IN REPLY REFER TO:
NM-010-93-02 (017)

NOV 27 1996

Mr. Robert D. Carlson, Project Manager
Uranium Recovery Branch
Division of Waste Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Mr. Carlson:

We have reviewed the Preliminary Draft Final Environmental Impact Statement (PDFEIS) for "The Crownpoint Uranium Solution Mining Project, Crownpoint, New Mexico" proposed by Hydro Resources Inc. This PDFEIS was prepared by the Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission with the Navajo Area Office, Bureau of Indian Affairs and the Albuquerque District Office, Bureau of Land Management, as Cooperating Agencies.

As a Cooperating Agency, we concur in the printing of the FEIS with Alternative #3, the Specialist Recommended Alternative, as the preferred alternative.

If you have any questions concerning this, please contact David Sitzler at (505) 761-8919.

Sincerely,

Michael R. Ford
District Manager

United States Department of the Interior
BUREAU OF INDIAN AFFAIRS
Navajo Area Office
P. O. Box 1060
Gallup, New Mexico 87305

IN REPLY REFER TO:
500/Environmental Services

DEC 12 1996

Joseph J. Holonich, Chief
Uranium Recovery Branch
Division of Waste Management, ONMS&S
U.S. Nuclear Regulatory Commission MS T-7J9
Washington, D.C. 20555-0001

Dear Mr. Holonich:

As cooperating agencies, the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Material Safety and Safeguards, the Bureau of Land Management (BLM), Branch of Lands and Minerals, and the Navajo Area Office (NAO), Bureau of Indian Affairs, have reviewed the Crownpoint Uranium Solution Mining Project Preliminary Draft Final Environmental Impact Statement (PDFEIS), as proposed by Hydro Resources Incorporated. The Final Environmental Impact Statement provides a basis for a Federal decision for issuing the requested license and proposed leases that would authorize HRI to proceed with the in-situ leach uranium mining operation. The NAO, after assessing the environmental, technical, and potential economic benefits, concurs with the PDFEIS. The Navajo Nation participated in the review of the EIS as an observing agency.

The NAO proposes to further address the Navajo concerns regarding leasing provisions and understands the NRC will be preparing a Safety Evaluation Report (SER) for the proposed project and will further conduct public hearings regarding the project and SER. The BLM Branch of Land and Minerals will also develop an in-situ leach mining plan for the Crownpoint Uranium Solution Mining Project. Based on the environmental and economic assessment contained in the PDFEIS, the NAO makes recommendation to proceed with publication of the final EIS and NRC "licensing decision", normally designated as the "record of decision" in the National Environmental Policy Act.

Should you require additional information on the subject matter, please contact me at (505)863-8314.

Sincerely,

Area Director, Navajo

NRC FORM 335 (2-89) NRCM 1102, 3201, 3202

U.S. NUCLEAR REGULATORY COMMISSION

# BIBLIOGRAPHIC DATA SHEET

*(See instructions on the reverse)*

**1. REPORT NUMBER** (Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.)

NUREG-1508
BLM NM-010-93-02
BIA EIS-92-001

**2. TITLE AND SUBTITLE**

Final Environmental Impact Statement to Construct and Operate the Crownpoint Uranium Solution Mining Project, Crownpoint, New Mexico

**3. DATE REPORT PUBLISHED**

| MONTH | YEAR |
|---|---|
| February | 1997 |

**4. FIN OR GRANT NUMBER**

**5. AUTHOR(S)**

See Section 8- List of Preparers

**6. TYPE OF REPORT**

Final

**7. PERIOD COVERED** *(Inclusive Dates)*

April 1988 - January 1997

**8. PERFORMING ORGANIZATION - NAME AND ADDRESS** *(If NRC, provide Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)*

**9. SPONSORING ORGANIZATION - NAME AND ADDRESS** *(If NRC, type "Same as above"; if contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address.)*

Division of Waste Management
Office of Nuclear Materials Safety and Safegaurds
U.S. Nuclear Regulatory Commmission
Washington, D.C. 20555-0001

**10. SUPPLEMENTARY NOTES**

Co-authored by U.S. Bureau of Land Management and U.S. Bureau of Indian Affairs

**11. ABSTRACT** *(200 words or less)*

This Final Environmental Impact Statement (FEIS) addresses issuing a combined source and 11e(2) byproduct material license and minerals operating leases for Federal and Indian lands to Hydro Resources, Inc. (HRI). This action would authorize the company to conduct in situ leach uranium mining in McKinley County, New Mexico. Such mining would involve drilling wells to the ore bodies, then recirculating ground water fortified with dissolved oxygen and sodium bicarbonate to mobilize uranium minerals found in the rock. Uranium would then be removed from the aqueous mining solutions using ion exchange technology in processing plants located in three separate project areas. A central plant would provide drying and packaging equipment for yellow-cake production for the entire project.

The FEIS was prepared by a joint interagency review group, including the U.S. Nuclear Regulatory Commission (NRC), the U.S. Bureau of Land Management (BLM) and the U.S. Bureau of Indian Affairs (BIA). This FEIS describes the staffs analyses concerning the evaluation of : (1) the purpose of and need for the proposed action; (2) alternatives to the proposed action; (3) the environmental resources that could be affected by the proposed action and alternatives; (4) the potential environmental consequences of the proposed action and alternatives; and (5) the economic costs and benefits associated with the proposed action. The evaluation is based on a comprehensive review of HRI's license application, environmental reports, related submittals, independent information sources, and written and oral comments received on the Draft Environmental Impact Statement. On the basis of its independent review, the staff concludes that the potential significant impacts of the proposed project can be mitigated, and that HRI should be issued a combined source and 11e(2) byproduct material license from NRC, and minerals operating leases from BLM and BIA.

**12. KEY WORDS/DESCRIPTORS** *(List words or phrases that will assist researchers in locating the report.)*

ISL; in situ leach; solution mine; uranium; Crownpoint; New Mexico; McKinley County; Church Rock; Unit 1; Navajo Nation

**13. AVAILABILITY STATEMENT**

unlimited

**14. SECURITY CLASSIFICATION**

*(This Page)* unclassified

*(This Report)* unclassified

**15. NUMBER OF PAGES**

**16. PRICE**

Printed on recycled paper

Federal Recycling Program

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC 20555-0001

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

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PERMIT NO. G-67

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